Interreg North Sea Region ART-Forum
European Regional Development Fund
EUROPEAN UNION

THE FUTURE OF PUBLIC TRANSPORT

AUTOMATED VEHICLES AS PART OF THE SOLUTION?

A SITUATION ANALYSIS
OF THE INTERREG NORTH SEA REGION

A.R.T.Forum
Automated Road Transport

MOBILE ZEITEN
Mit Leidenschaft für Mobilität.

Imprint

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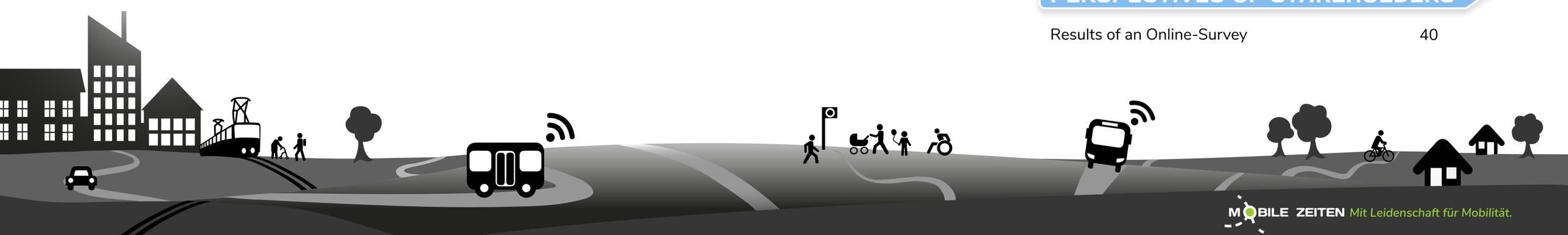
ART-Forum (Automated Road Transport-Forum) is a transnational EU funded project, co-funded within the North Sea Region (NSR) Programme, Interreg VB.

ART-Forum will create a debating ground for local/regional authorities in the NSR, address risks and opportunities and help guide policy development with regard to the impact that automated transport could have on the entire road transport system and life in cities and regions in the NSR.



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THE FUTURE OF PUBLIC TRANSPORT

- Automated vehicles as part of the solution?

Autonomous vehicles: A potential game changer for mobility

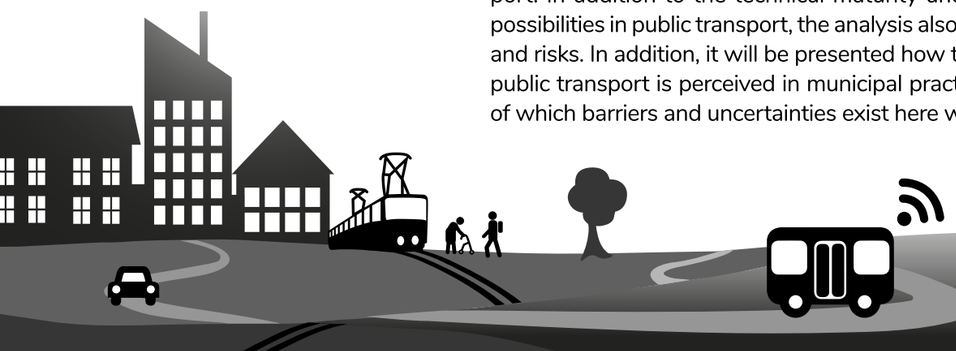
Introduction

Digitalisation accompanies people throughout everyday life and plays a major role in the transport and mobility sector, where various digital applications are already influencing the choice of means of transport. The potential for an increased quality of mobility and a sustainable turnaround is great, as the demand for a comprehensive transformation of the transport sector presents our society with a highly demanding task.

Technological developments around autonomous driving can help to ensure access to mobility as well as to make transport more efficient, low-emission and safer. There are completely new challenges for the area of Public Passenger Transport.
The automated shuttle busses have been and are already being tested in many research projects, so that the technology has developed to such an extent that it can be tested on public roads under restricted conditions.

Nevertheless, the use of these vehicles on public roads is still of a testing nature, both in terms of vehicle and loading technology and the mobility concepts that can be implemented with them. Not only for the transport companies and municipalities, the autonomous operations are still newcomers, but also for the licensing authorities and technical examinations. To prevent the negative effects of digitalisation on mobility, it is essential that municipalities, cities, and other influential institutions make a significant contribution to shaping and controlling the development.

This situation analysis is part of the EU Interreg project A.R.T-Forum (Automated Road Transport Forum). It gives a comprehensive overview of the current situation in the countries of the Interreg North Sea Region regarding automated vehicles in public transport. In addition to the technical maturity and current application possibilities in public transport, the analysis also shows opportunities and risks. In addition, it will be presented how the topic of driverless public transport is perceived in municipal practice and the question of which barriers and uncertainties exist here will be examined.



THE LONG ROAD TO AUTONOMOUS DRIVING

The assumption of individual driving functions by technical support has been encouraged since the end of world war II. The invention of cruise control and antilock braking systems were developed as early as in the 1950s. Automated driving functions as lane departure warning systems, brake assist and parking assistant is standard equipment in today's vehicles. The dynamic process of digitalisation continuesly leads to even more complex automation systems which aim to relieve the driver of generic tasks.

These ideas, which are linked to autonomous driving, are not new.

With the advancing digitalisation, individual driver assistance systems have meanwhile been developed towards more complex automation. This dynamic process has been going on for decades and is constantly being further developed. As a result, more and more tasks are gradually being relieved of drivers by vehicle technology.

From driver assistance systems to automated driving

Levels of Driving Automation

A look at the public debate on the automation of vehicles reveals a certain lack of clarity in the terminology used. A clear definition of the term "autonomous driving" used is therefore required.

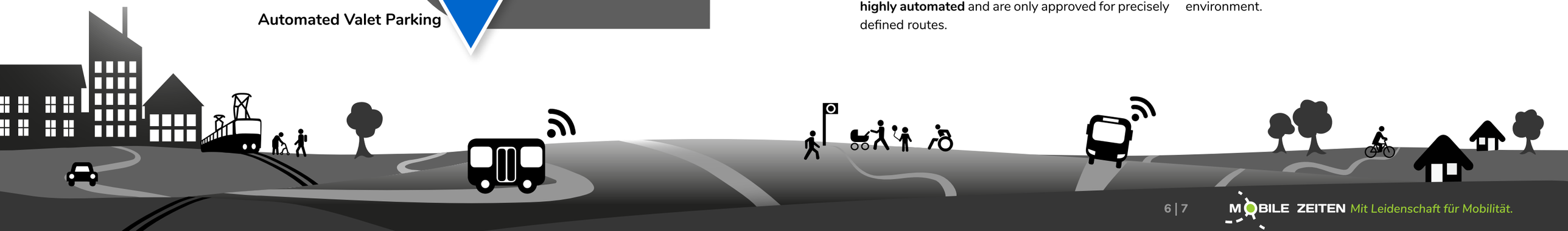
According to international standards, a differentiation is made between five development stages (definition of the Society of Automotive Engineers SAE). In order to understand the current status of technology, it is important to know these levels.

For technical and legal reasons, there is currently no application on public roads in the North Sea Region in which automated buses are on the road without accompanying operator. The automated system must be constantly monitored by a vehicle operator.

The vehicles are therefore currently in use **partially or highly automated** and are only approved for precisely defined routes.

Today and in the near future, the first thing that matters is that the vehicles automatically handle all the situations that occur in a learned area. In this case, it can be called fully automated.

One can only speak of **autonomous driving** if the start and finish are not limited to a previously learned environment.



AUTOMATED DRIVING ON ROADS WITH PUBLIC TRANSPORT - THE LEGAL FRAMEWORK

International level

Vienna Convention on Road Traffic of 1968

International treaty designed to facilitate international road traffic and to increase road safety by establishing standard traffic rules among the contracting parties. Foundation of many national traffic laws. Countries signing the convention are obliged to bring their national traffic laws in conformity with it.

EU member states are signatories of the Vienna Convention (Except Spain)

In 2014 the UNECE amended the regulation to include highly automated systems, provided that these continue to have a driver who is ready to take over driving functions and who can override the system and switch it on and off.

Broadened the scope of action, but still presupposes that every vehicle must have a driver.

Fundamental principal:

A driver is always fully in control and responsible for the behavior of a vehicle in traffic (Article 8)

EU level

European Union

The European Commission has published its Sustainable and Smart Mobility Strategy with an Action Plan involving 82 initiatives that should guide transport policies in Europe for the next four years.

Draft EU ADS (Automated Driving Systems) Regulation represents first important step towards harmonising type-approval regulations for autonomous vehicles across EU Member States (shall enter into force 2022)

No EU-wide harmonization to date

National level

BELGIUM

- Only test drives under the supervision of an operator/host (in- or outside) allowed
- special permit needed

→ for experimental purposes only

DENMARK

- Only test drives under the supervision of an operator/host (in- or outside) allowed
- special permit needed

→ for experimental purposes only

GERMANY

- AVs allowed in regular operation on public roads without a driver being physically present, but only in defined operating areas.
- Permanent monitoring of the operation from the outside

→ regular operation on public roads possible

NETHERLANDS

- Only test drives under the supervision of an operator/host (in- or outside) allowed
- special permit needed

→ for experimental purposes only

NORWAY

- Only test drives under the supervision of an operator/host (in- or outside) allowed
- special permit needed

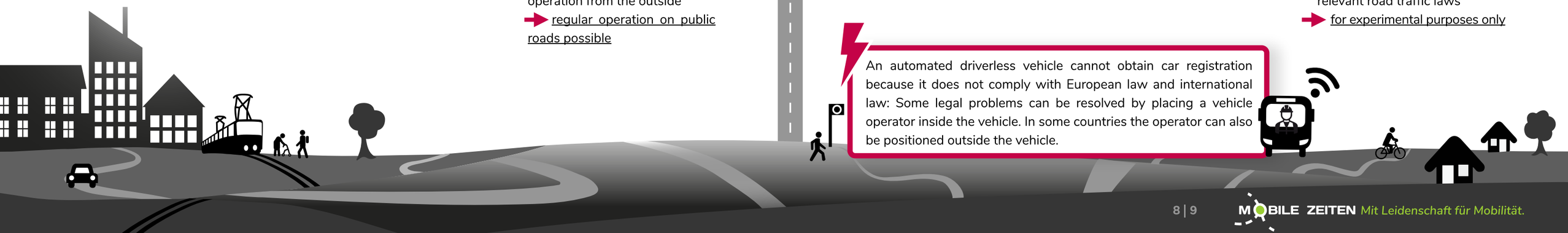
→ for experimental purposes only

UK

- Only test drives under the supervision of an operator/host (in- or outside) allowed
- No permit or licence needed as long as organisations obey all relevant road traffic laws

→ for experimental purposes only

An automated driverless vehicle cannot obtain car registration because it does not comply with European law and international law: Some legal problems can be resolved by placing a vehicle operator inside the vehicle. In some countries the operator can also be positioned outside the vehicle.



AUTOMATED BUSES

available in the North Sea Region

The range of automated minibuses that are available for use in public transport has so far been very limited. The European market is currently dominated by the French manufacturers Easy Mile and NAVYA. Occasionally there are also vehicles from other manufacturers on the roads in the North Sea region, e.g. Local Motors (US), Gacha (FIN), Aurrigo (GB) or 2getthere (NLD). Other vehicles are also exclusively prototypes that are built as part of research projects and test certain functions.

Meaning of the symbols:

- Number of passengers
- Operating times
- max. speed
- Market presence since
- Powertrain
- Sample projects
- Range
- Start

Navya Autonom® Shuttle Evo and Arma

FEATURES

15 (11 seated, 4 standing) · max. 25 km/h · electric · up to 9 h · 2015

NAF-Bus (GER)
Aalborg (DK)
Scheemda (NL)

Navya (FR)
www.navya.tech

EZ 10, Gen. 2 and 3

FEATURES

12 (6 seated, 6 standing) · max. 25 km/h · electric · up to 16 h · 2014

Hub Chain (GER)
Bad Birnbach (GER)
Kongsberg (NOR)

EasyMile (FR)
www.easymile.com

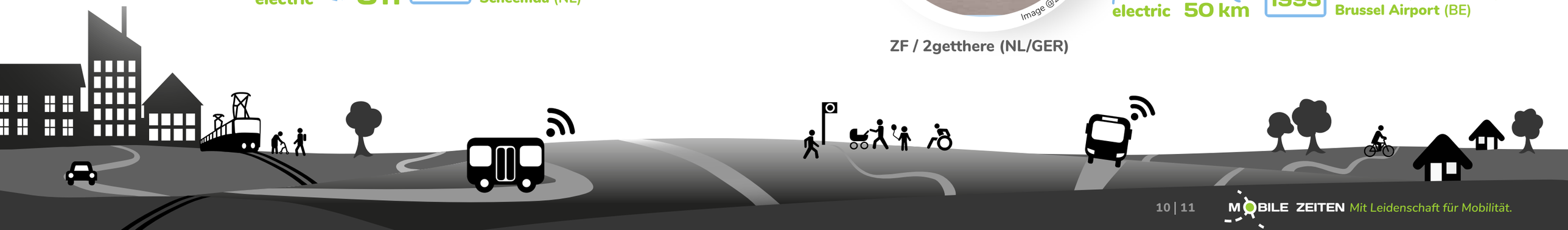
People Mover GRT Vehicle

FEATURES

22 (8 seated, 14 standing) · max. 60 km/h · electric · 50 km · 1995

Rotterdam Rivium (NL)
Masdar City (Abu Dhabi)
Brussel Airport (BE)

ZF / 2getthere (NL/GER)



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Auto-Shuttle

Aurrigo (GB)

FEATURES

- 10 passengers seated
- max. 48 km/h
- electric
- 190 km
- 2021
- Cambridge (GB)

GACHA

Sensible4 (FIN)

FEATURES

- 10
- max. 40 km/h
- electric
- 100 km
- 2017
- Helsinki (FIN)

Busbee

Hanseatische Fahrzeug Manufaktur GmbH (HFM) (GER)

FEATURES

- 8
- max. 100 km/h
- electric
- 150 km
- 2017
- Lunden/ Lehe (GER)

COMING SOON...

i-cristal

Transdev/Lohr (FR)

FEATURES

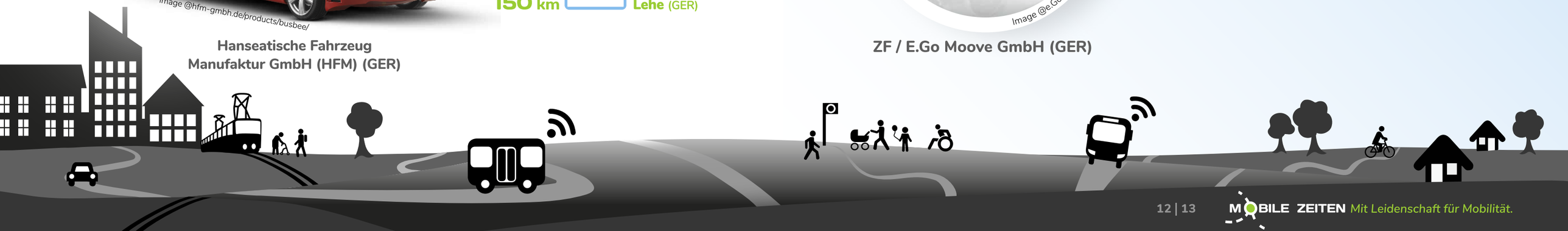
- 16 electric
- max. 50 km/h
- 2023

E.Go Mover

ZF / E.Go Moove GmbH (GER)

FEATURES

- 14
- 5 seated
- 10 standing
- electric



TECHNICAL MATURITY OF THE VEHICLES

The existing range of vehicles shows that the vision of driverless regular public transport in mixed traffic and the current state of the art are currently far apart. Many development steps still have to be mastered for fully automated or autonomous operation. Due to the technical limitations, current vehicles are only used in less complex traffic situations, sometimes with separate lanes.

How autonomous vehicles work

To reach a destination, a driverless bus needs to know the route, understand its surrounding, observe traffic rules, and make correct judgments when interacting with other vehicles, pedestrians and cyclists on the road. To accomplish all this, it relies on the following key technologies:

Meaning of the symbols:
- Perception of the environment
- Localization

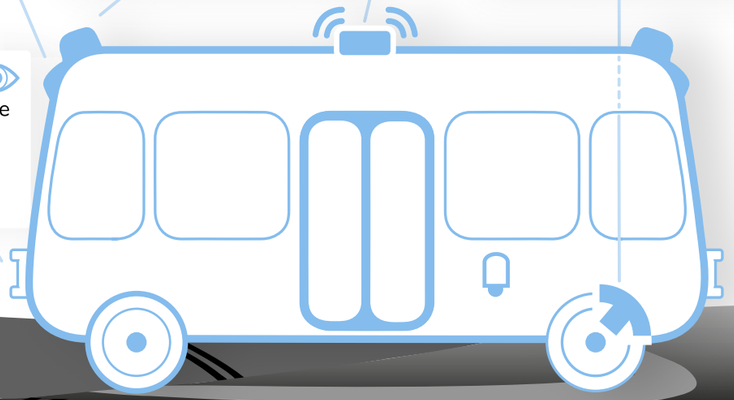
Cameras
Environment analysis (traffic lights, signs), recognize obstacles and road users and estimate the position relative to the vehicle

3D LIDAR
Used to measures distances and build a map of the environment

2D LIDAR
Perception of the environment; Detection of obstacles

GNSS antenna / GPS
Communication between a GPS sensor and a reference beacon to determine the exact position of the vehicle at all times.

Odometry and autonomous safety braking
Wheel speed measurement to estimate vehicle speed and confirm its position, complements GPS Information Automatic emergency brake for maximum safety



Barriers to regular public transport

Safety-oriented speed: Operation depending on the local situation max. 12 to 20 km/h and low speeds of the other vehicles of max. 30 km/h.

Insufficient legal framework in the road traffic regulations of the national states (exception Germany since 5/2021). Operation is only possible through exceptions and within the framework of experimentation clauses.

No driving maneuvers in the oncoming lane and no automated avoidance of obstacles without manual intervention by the safety driver.

Lack of accessibility for disabled people

Driving along a reference path: the route and prominent points in the area are recorded in advance (mapping), driving commands are programmed.

High procurement costs

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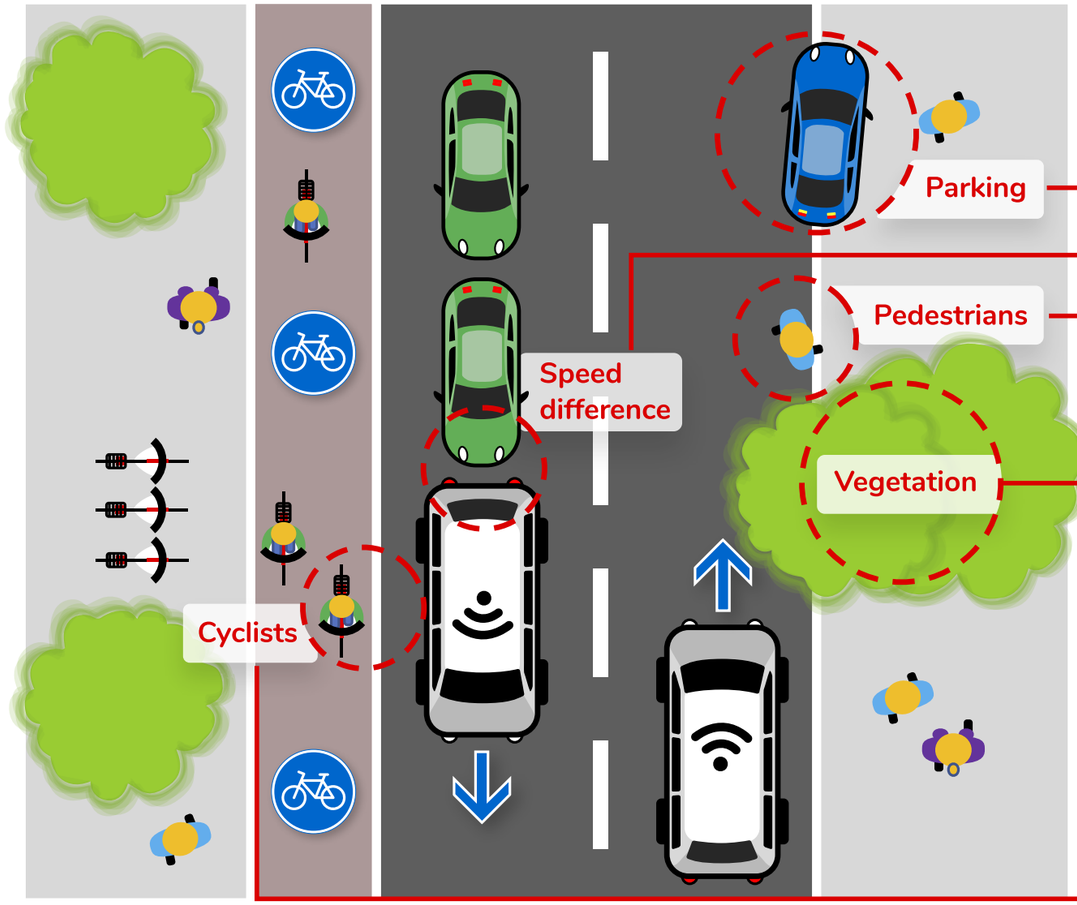
Typical conflicts in mixed traffic

In mixed traffic with other road users such as drivers of cars and cyclists, automated driving still has a number of challenges to master.

The AVs that are on the move today are subject to many restrictions that must be taken into account from the outset, for example when planning a route.



Parking: Unauthorized vehicles parked on the roadside are perceived as an obstacle. AV stops and waits, but cannot go around the parked car because it cannot deviate from the programmed path. Placing no parking signs and enforcing parking rules can be helpful here.

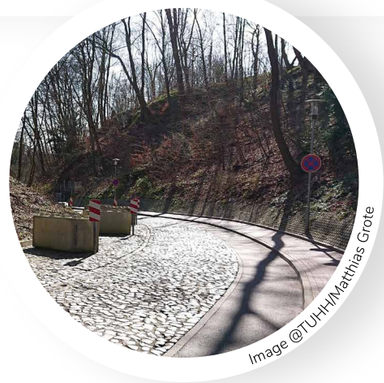
Speed differences: Large differences in speed between AV and other vehicles increase the risk of collision. The likelihood of risky overtaking maneuvers increases. When selecting a route, it should be noted that roads on which more than 30 km/h is driven are currently not feasible. Otherwise, speed adjustments are to be considered.

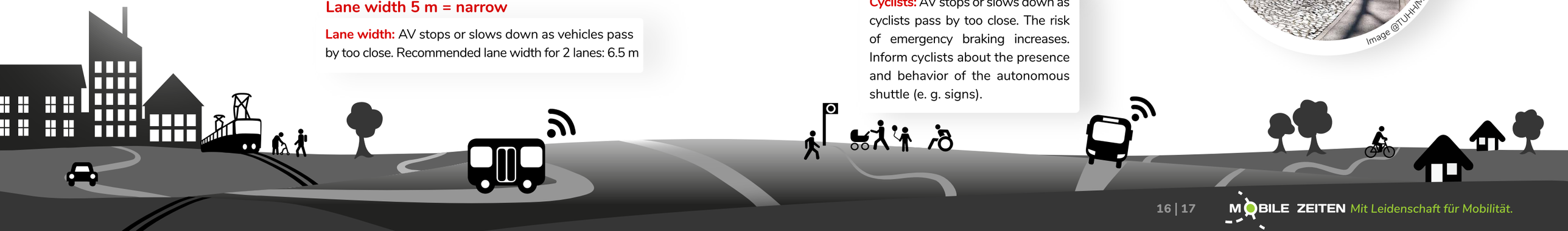
Cyclists: AV stops or slows down as cyclists pass by too close. The risk of emergency braking increases. Inform cyclists about the presence and behavior of the autonomous shuttle (e. g. signs).

Lane width: AV stops or slows down as vehicles pass by too close. Recommended lane width for 2 lanes: 6.5 m

Pedestrians: The unpredictable behavior of pedestrians increases the risk of emergency braking. AV reduces speed due to pedestrians moving too close to the vehicle. Inform pedestrians about the presence and behavior of the autonomous shuttle (e. g. signs). Reduce speeds in areas with many pedestrians.

Vegetation: Heavy vegetation and dense foliage along the route can lead to loss of GPS reception. Branches can be perceived as an obstacle. Additional reference points for localization (landmarks), ground markings and regular trimming of the vegetation may be necessary here.





FIELDS OF APPLICATION IN THE NORTH SEA REGION

What role can self-driving vehicles play today as an integral part of public transport?

Irrespective of the fact that the current test fields are not yet comparable with regular operation, they nevertheless show future application possibilities to close gaps in public transport, to strengthen local mobility or to cover the last mile.

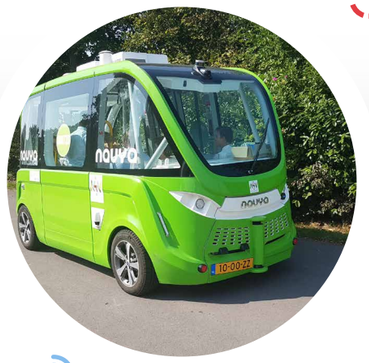
Since the vehicles are currently being developed and only low speeds are possible, both technically and for licensing reasons, the fields of application are currently limited to relatively short distances.

Applications where longer distances have to be covered, such as in rural areas, will only gain attention with higher speeds.

The test operations of automated minibuses in the North Sea region show that they are carried out in particular in areas where conventional public transport reaches its limits.

Most of the tested applications in the North Sea project area achieve automation levels 2-3. Higher levels of automation (e.g. level 4) have so far been tested on private property or separate lanes.

Feeder transport examples:



The automated bus runs between the main entrance of Ommeland Hospital and the nearest bus stop in Scheemda. An integrated offer for patients, visitors and staff that complements current public transport and uses existing infrastructure.

Scheemda, Province of Groningen
Netherlands
Project period: 07/2018 – 03/2021

@north testregion, province of Groningen, Ommerland Hospital, Arriva transport company

1,5 km, 2 bus stops

15 km/h

There is an operator/ safety driver on board.

Degree of automation: Level 2 – 3

Gent, Belgium
Project period: 03/2020 – ongoing

The automated bus runs between the main entrance of the Maria Middelares Hospital in Gent and the nearest tram stop. An integrated offer for patients, visitors and staff that complements the current public transport system.

Maria Middelares General Hospital, Vias Institute, AG, LM Industries Group

600 m on a traffic-calmed street

16 km/h

There is an operator/ safety driver on board.

Degree of automation: Level 2 – 3

Island of Ormøya und Malmøya, Oslo, Norway
Project period: 12/2019 – 12/2020

The automated bus connects residents and visitors to the islands of Ormøya and Malmøya with the public transport (bus stop: Nedre Bekkelaget). Line 85B complements another existing bus line to increase frequency for passengers in the area. The vehicles operated on a fixed route as an integral part of Oslo's public transport network.

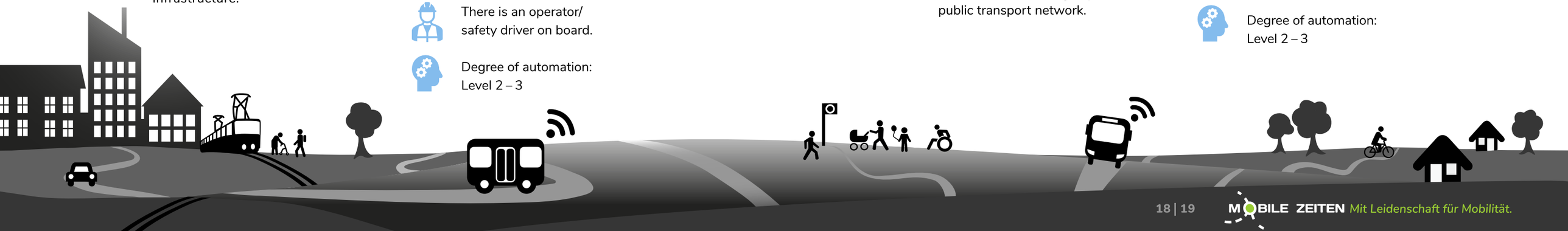
Ruter, Holo

1,5 km, 10 bus stops, public streets, mixed traffic

Max. 18 km/h

There is an operator/ safety driver on board.

Degree of automation: Level 2 – 3



Local/city transport in areas without a city bus

examples:

Aalborg Øst, Denmark
Project period: 03/2020 – 2022

Development of the residential area of Aalborg Øst and connection of the residential area to conventional public transport. On its route, the automated bus will include a community center, a library, a shopping center, several residential areas and a nursing home.

Municipality of Aalborg

2,1 km, 10 bus stops

18 km/h

There is an operator/ safety driver on board.

Degree of automation: Level 2 – 3

Test center for automated buses in Lauenburg
Project period: 01/2008 – 06/2020

The automated bus transports passengers through the old town via the central bus station and the upper town. This connects the old town with the upper town.

Federal Ministry of Transport and Digital Infrastructure, Technische Universität Hamburg (TUHH), Kreis Herzogtum Lauenburg

5 km, 8 bus stops, public road, difficult topographical conditions

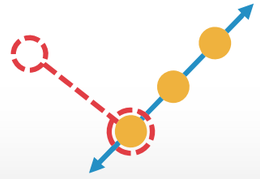
Max. 18 km/h

There is an operator/ safety driver on board.

Degree of automation: Level 2 – 3

Specific and restricted areas

examples:



Rivium, Rotterdam, Netherlands
Project period: 1999 – ongoing

Park shuttle between Rotterdam-Kralingse Zoom station and the business park in Capelle a / d IJssel. An extension of the route in public mixed traffic is planned. The route is to be extended to the waterfront where a water bus stop will be set up.

Stadsregio Rotterdam, Connexxion/Transdev

1,8 km, 5 bus stops, separate lane

Max. 32 km/h

No operator on board. The operator monitors the vehicles from the control room and can issue driving commands to the vehicles if necessary.

Degree of automation: Level 4

Enge-Sande, GreenTEC Campus, Schleswig-Holstein, Germany (Part of the NAF-Bus project)
Project period: 07/2017 – 06/2020

The automated minibus transports employees and visitors to the GreenTEC campus across the private test site.

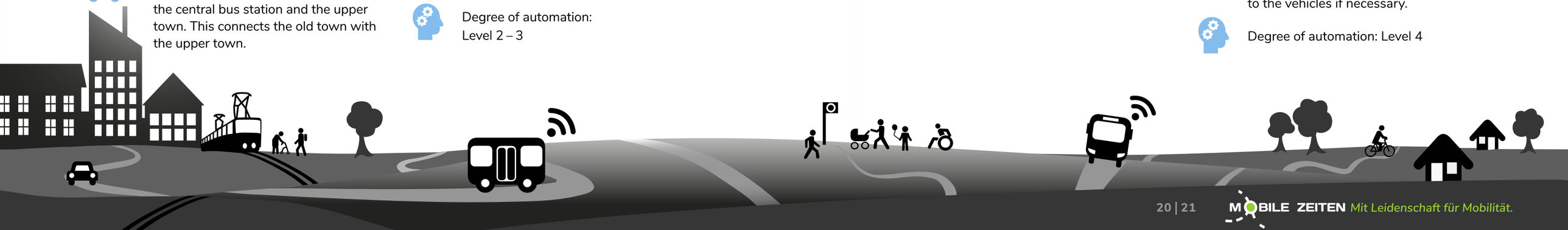
Federal Ministry of Transport and Digital Infrastructure (BMVI), EURA AG, GreenTec Campus GmbH

2,5 km, 4 bus stops, private ground

Max. 15 km/h

No operator on board. The operator monitors the vehicles from the control room and can issue driving commands to the vehicles if necessary.

Degree of automation: Level 4



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Effects of driverless bus operation

for different stakeholders

Depending on how they are rolled out AVs have the potential to either positively impact the environment and quality of life or have negative consequences. Most likely, the results will be some combination of positive and negative.

Passengers

Usability
- Attractiveness
- Security
- Acceptance
- Servicequality

+
- Greater use of public transport through better last mile, flexible and always available connections.
- More comfort and time savings: Mobility needs can be covered gaplessly.

–
- Privacy and security concerns
- No personal contact in conflict situations with other passengers.
- No assistance services for passengers with physical disabilities.

Citizens

Liveability
- Accessiblity
- Sustainability
- Social participation
- Car-ownership

+
- Increased mobility for the elderly, disabled, and those in transit-poor areas
- If autonomous vehicles are thoughtfully implemented with access and equity in mind, AV technology can expand access to employment, education, health care, and recreation for users of all ages, abilities and income.
- AVs offer blind, mobility impaired, and older people and those with cognitive and behavioral disorders the potential for a degree of personal autonomy that is presently unavailable to them.
- Citizens could be reconnected and reintegrated into the communities: higher quality of life
- With AVs, it will no longer be necessary for individuals to own and drive their own vehicle: less traffic, fewer emissions and noise leading to improvements in congestion, environment and public health.

–
- The better accessibility and attractiveness of public transport could also induce additional trips leading to more congestion, more emissions and more noise.
- Short distances are no longer covered on foot or by bike, but with an AV.

Transport companies/providers

Feasibility
- Operational realization
- Operating concepts
- Economic efficiency
- Role of the driver

+
- No driver costs: lower operating costs
- no limited staff availability
- Higher frequency of trips and extension of operating times
- It is possible to react promptly and more flexibly to changes in demand and operational disruptions.
- Bus drivers are already difficult to find in some regions. The increasing shortage of skilled workers among bus drivers could be counteracted.
- New professions and understanding of roles are emerging, e.g. for monitoring the digital infrastructure and systems.
- More options for new operating concepts that would otherwise have reached their economic limits:
- Service in off-peak times, on routes with low demand, last-mile-feeder systems, etc.

–
- No personal communication und interaction with passengers: less quality of service and loss of social control, e. g with difficult passengers. A drop in passenger numbers is possible as a result of an impairment of safety or the perception of safety.
- Job losses: Bus drivers will see their current jobs outright disappear.
- Difficulties caused by changing the driver's understanding of his/her role as system monitor: e. g. loss of competence
- Greater demands on maintenance and repair of the vehicles and thus on the qualification of the technical workshop staff.
- more highly qualified personnel is needed in the operations control center
- Increasing competition from private mobility providers as operations become more economical.

Local authorities/municipalities

Location
- Location attractiveness
- Land use
- Services of general interest
- Traffic

+
- Local areas become more desirable for residents/tourists
- More revenue/ income to improve attractiveness of the community
- The locational attractiveness of rural areas for companies increases due to better accessibility: Reviving the economy of rural areas
- Opportunity to save space: Reduced car ownership and better public transport means far less need for parking. This could go so far that stationary traffic is largely in favor of multifunctional areas.

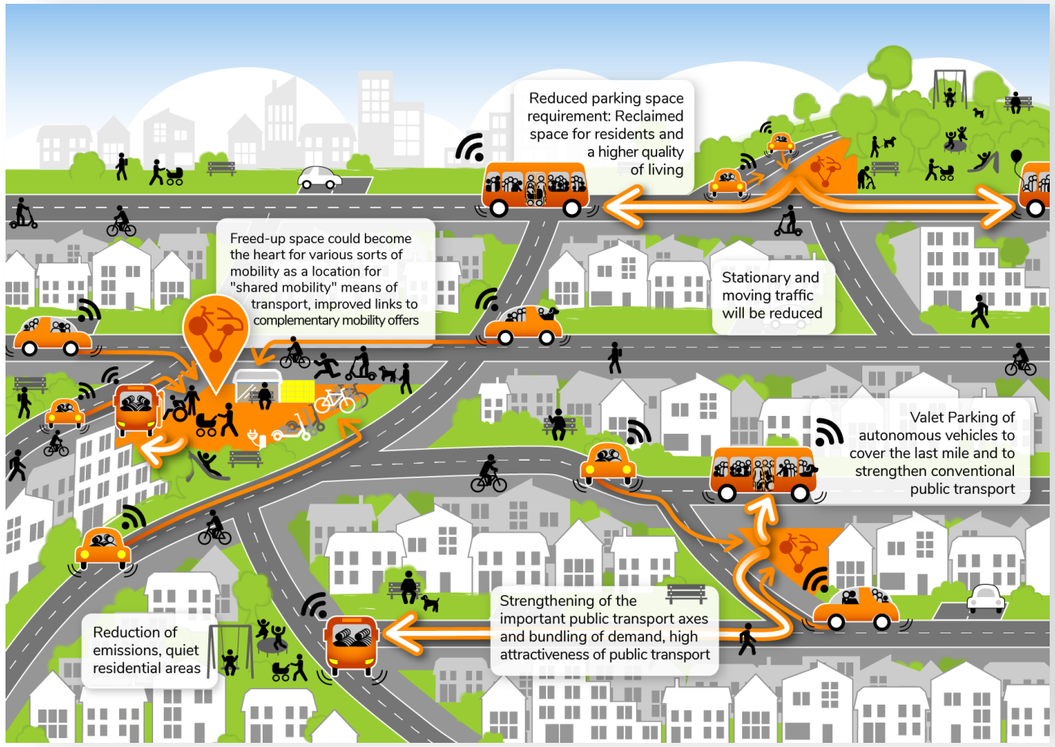
–
- Danger of increased sprawl: Autonomous vehicles can compensate for locational disadvantages (longer distances). One consequence would be the emergence of new settlement areas of comparatively low density and a low mix of uses, analogous to suburbanization in the second half of the last century.
- There is a danger of a structural separation between roadways and footpaths/cycle paths on individual main roads to avoid conflicts and to increase driving speeds: AV-friendly city

WHEN ROBOTS TAKE THE WHEEL
– EFFECTS ON MOBILITY IN AN AUTONOMOUS WORLD
the example of valet parking

planned as an addition to an integrated mobility concept

Assumptions of the best-case scenario:

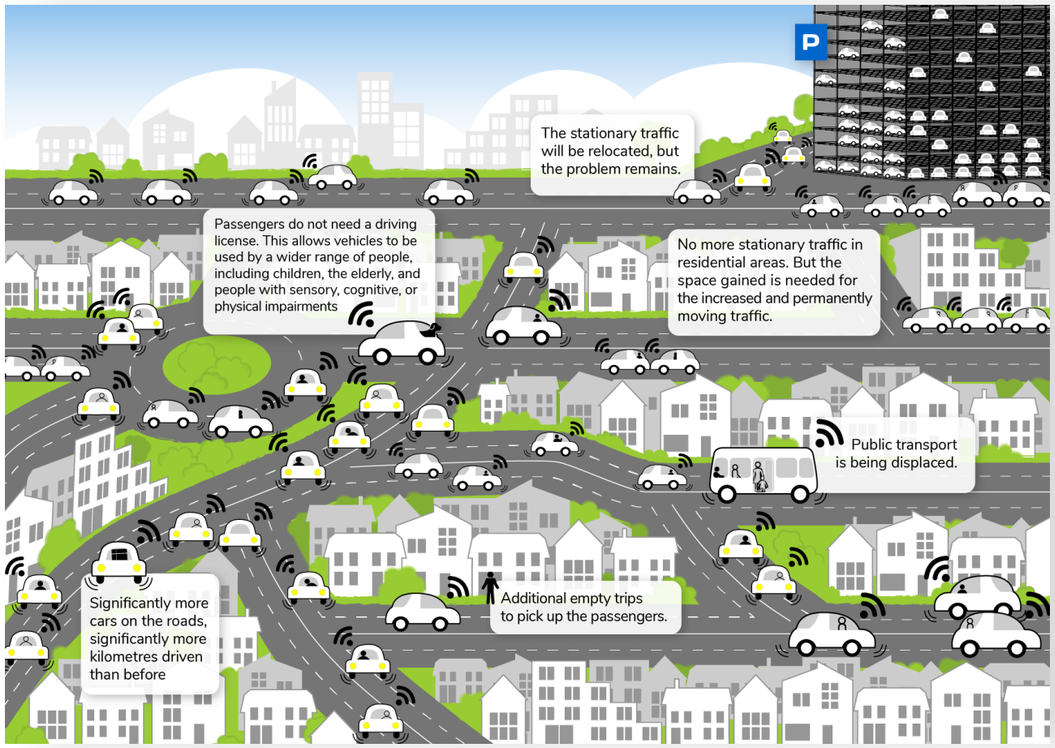
- autonomous, increasingly shared vehicles
- Valet Parking of autonomous vehicles complements and strengthens the mobility system

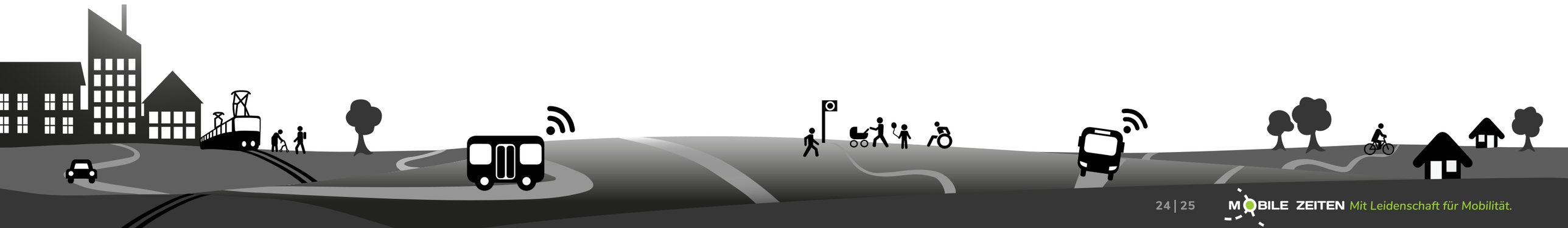


planned in isolation from the entire transport system

Assumptions of the worst-case scenario:

- Convenient door-to-door service
- Everyone who used to take the bus, train or bike calls an autonomous car
- Valet Parking of autonomous vehicles competes with public transport





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Driverless Pilot Projects

in the North-Sea-Region 2019-2022

Germany (7)
Keitum, Sylt
Enge-Sande
Lunden, Lehe
Hamburg
Lauenburg
Osnabrück
Bad Essen

Belgium (2)
Gent
Mechelen

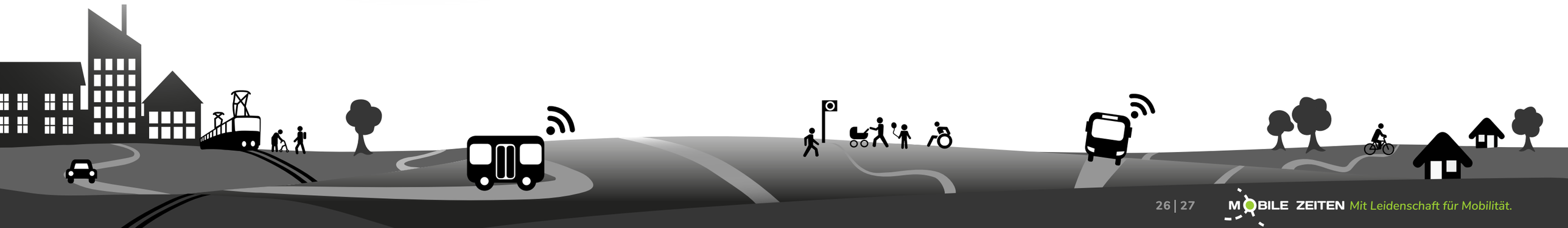
Denmark (3)
Aalborg
Copenhagen, Nordhavn
Slagelse

Netherlands (5)
Scheemda
Bourtange
Loppersum/Zernike
Eemshaven
Rotterdam

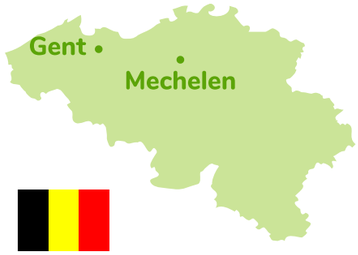
Norway (17)
Oslo 4 pilot projects:
- Akershusstranda
- Ormøya and Malmøya
- Kongens gate, Oslo
- Ski statio – Hebekk

Vestby
Førde
Kongsberg (2 pilot projects)
Drammen
Kolumbus (3 pilot projects)
Trondheim
Svalbard
Tromsø
Bodø
Bergen

UK (2)
Inverness
Edinburgh Park, Fife



Country Factsheet BELGIUM



Pilot projects in the Belgian NSR region 2019-2022

- **10/2020** – ongoing, Gent, hospital Maria Middelares (MM)
- **2021** in preparation, Mechelen

only test operations

§ need of a special permit

2 pilot projects

level 4 allowed

Operator in-/outside AV

600 m Longest test track

0,6 km Total test tracks

< 30 km/h max. speed

Approval authorities

Federal, regional and municipal authorities, police, road authority

Qualification of the operator

The appropriate driving licence for every test driver, Training plan followed by all test drivers, Test drivers and operators must know and understand the systems being tested and be able to anticipate and take over manual control at any time. They must have knowledge of proper risk management and process procedures.

§ Status of legislation

In 2016, the Belgian Minister of Transport presented a Code of Practice for testing automated vehicles in a real world environment in Belgium.

The implementation of these guidelines required adaptation of the Belgian traffic code to allow for their unambiguous application. Therefore, on March 18, 2018, the Belgian federal government passed a royal decree introducing a new provision (article 59/1) which allows the federal Minister of Mobility to deviate from all provisions of the Belgian traffic code in the framework of experiments with automated vehicles.

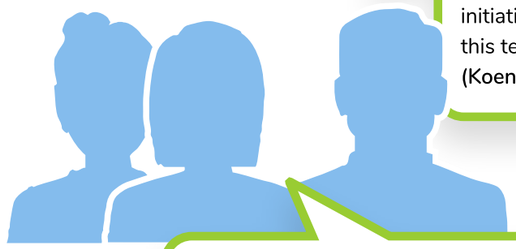
As a result of the adoption of this new provision, the federal Minister of Mobility can now allow the testing of fully autonomous vehicles on public roads without a driver, but the test must be supervised by an operator acting from a control room outside the vehicle.

Project Maria Middelares

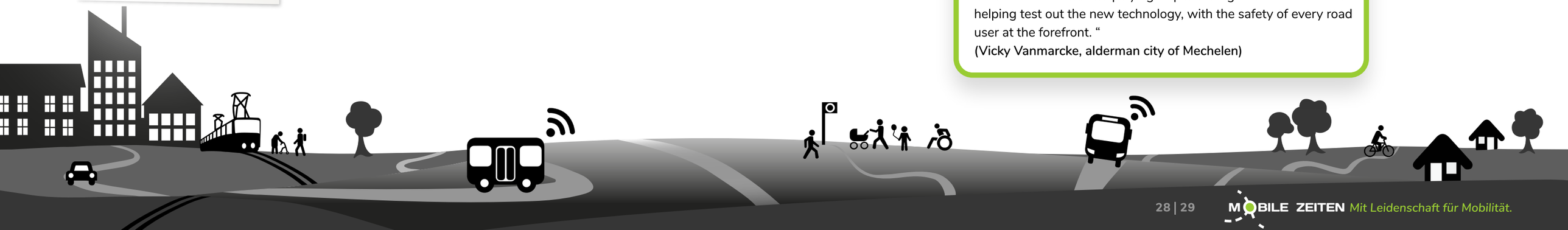
Stakeholder voices

„Current mobility problems - road safety, traffic jams, air pollution, climate impact, accessibility, parking problems, transport poverty - will not immediately disappear if autonomous transport is introduced on a large scale. However, if it is managed properly, autonomous transport can be part of the solution. If electric, collective and shared autonomous transport were integrated within a stronger, enforced modal shift, we could overcome the above problems to a great degree.“
(project coordinators city of Mechelen, Mpact & Autodelen.net)

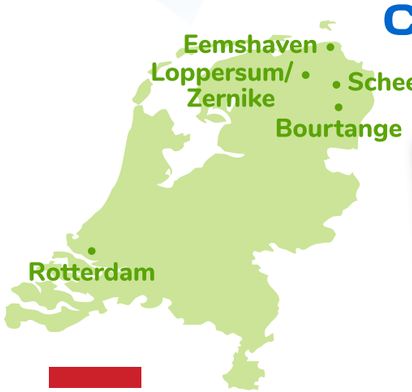
„The city of Antwerp believes that innovation contributes to solutions in the field of mobility. We have defined a number of locations in the city that are suitable for pilot projects with autonomous transport, and we look forward to the further initiatives that the Flemish government will take to introduce this technology to our region.“
(Koen Kennis, alderman city of Antwerp)



„For years, the City of Mechelen has been focusing on innovative mobility solutions. Shared, electric, self-driving transport is a sustainable step towards the mobility of the future. Mechelen remains committed to playing a pioneering role in this and to helping test out the new technology, with the safety of every road user at the forefront. “
(Vicky Vanmarcke, alderman city of Mechelen)



Country Factsheet Netherlands



Pilot projects in the Netherland NSR region

- **Loppersum/Zernike**, completed
- **Scheemda**, completed
- **1999** - ongoing, Rivium Rotterdam
- **Bourtange**, in preparation
- **Eemshaven**, completed

only test operations

§ need of a special permit

5 pilot projects

level 4 allowed

Operator in-/outside AV

1,2 km Longest test track

– Total test tracks

< 25 km/h max. speed

§ Status of legislation

The Netherlands has allowed public road testing of self-driving cars since 2015 through an exemption granted by the Dutch Road Authority (RDW) under the BOEV regulation. It is required that a human being is always in the vehicle to physically take over control if necessary. With effect from 1 July 2019 a new Experimental Law also enables remote-driver tests under strict conditions.

Approval authorities

The RDW (Dutch Road Authority) is responsible for the admission of vehicles to the public roads, including self-driving passenger cars and self-driving lorries. The RDW has the option of issuing an exemption for self-driving vehicles.

Qualification of the operator

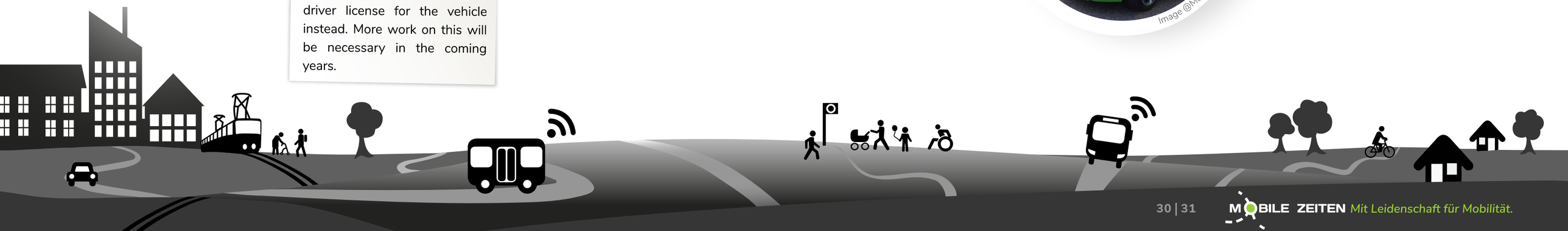
A regular B driver license and a specific training for the shuttle are needed to operate the shuttle. For the situation when the operator is no longer inside the shuttle we have been taken first steps with RDW, CBR and the Ministry towards a digital driver license for the vehicle instead. More work on this will be necessary in the coming years.

Stakeholder voices

„Autonomous vehicles could be a chance, if we do it well. There is a risk of increasing transport, but if we integrate it in the current transport system then it is a really big chance."
(Daniel Koelikamp, Province of Groningen)

provincie groningen

„Even if there are still a few challenges to be overcome when it comes to automated road transport, we should already be dealing with how it will change our built environment and mobility needs. It is important to grow with the increasing automation and to help shape the developments in our interest. To do this, we have to stay up to date and try things out."
(Rieja Raven, Municipality of Coevorden)



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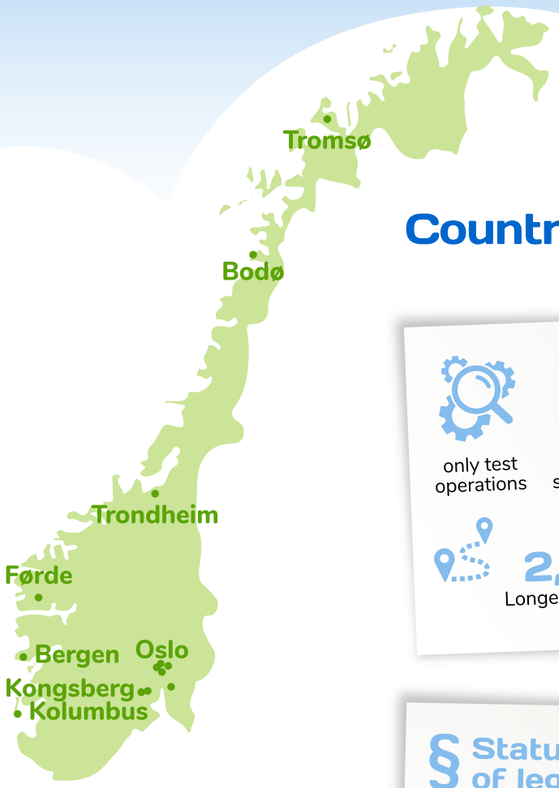


Country Factsheet Norway

only test operations

§ need of a special permit

17 pilot projects

level 4 allowed

Operator in-/outside AV

2,1 km Longest test track

10 km Total test tracks

< 40 km/h max. speed

§ Status of legislation

Legislation for the testing of automated vehicles on public roads entered into force from 2018.
It is possible to apply for a permit for trials on public roads, with or without a host. In principle all public roads might be used, but each route needs to be defined and accepted approved.

On non-public or privately own roads, there is no need for a permit and no host is required.

Pilot projects in the Norway NSR region

Oslo 4 pilot projects:
- Akershusstranda
- Ormøya and Malmøya
- Kongens gate, Oslo
- Ski statio – Hebekk

Vestby
Førde
Kongsberg (2 pilot projects)
Drammen
Kolumbus (3 pilot projects)
Trondheim
Svalbard
Tromsø
Bodø
Bergen

Approval authorities

The Norwegian Public Roads Administration (NPRA) approves the vehicles for self-driving mode. Routes and traffic regulation on national highways – approved by NPRA. The municipality is responsible for approval and regulation on the lower-status roads.

Qualification of the operator

Operators: Forus PRT, Applied Autonomy, Holo
All have received training from the shuttle providers (Navya, EasyMile)

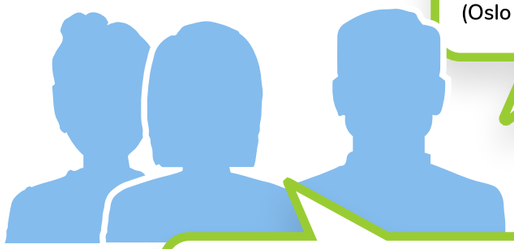
Project Oslo


Image @letsholo.com

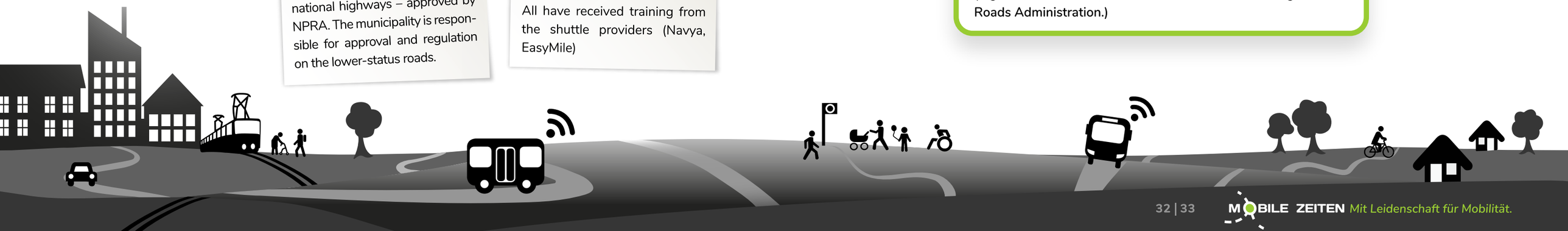
Stakeholder voices

„This is the future, and it must be very nice for instance for the elderly, providing door-to-door transport for them.“ **(Erna Solberg, former prime minister of Norway.)**

„These vehicles lower costs of running transport services.“ **(Oslo area PTA Ruter)**



„High quality mobility is about getting from A to B in a safe and efficient way. Self-driving vehicles will probably play an important role in the mobility services of the future. That is why the Norwegian Public Roads Administration wants to explore and learn more with our partners. We are collecting experience together on how to develop attractive and sustainable services, so that everyone can arrive safely at their destinations, also for the future.“
(Ingrid Dahl Hovland, General director of the Norwegian Public Roads Administration.)



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Country Factsheet Germany

Pilot projects in the German NSR region

- **2017 - 2020** Keitum Sylt
- **2017 - 2020** Enge-Sande
- **2017 - 2021** Lunden-Lehe
- **2018 - 2021** Hamburg
- **2018 - 2020** Lauenburg
- **2019 - 2021** Osnabrück
- **2019 - 2021** Bad Essen

regular operation possible

§ Operating license for vehicles with autonomous driving function

7 pilot projects

level 4 allowed

Operator in-/outside AV

5 km Longest test track

17 km Total test tracks

< 25 km/h max. speed

§ Status of legislation

In May 2021, Gemany approved a law according to which autonomous vehicles (level 4) in Germany can drive on public roads without a driver being physically present - but only in defined and pre-approved operating areas.
The application scenarios include:
Shuttle traffic from A to B, people movers (buses traveling on a set route), Hub2Hub traffic (e.g. between two distribution centers), demand-oriented offers in off-peak times, the transport of people and/or goods on the first or last mile, "Dual mode vehicles" such as Automated Valet Parking (AVP).

Approval authorities

First, an operating license for autonomous vehicles must be applied for at the Federal Motor Transport Authority (KBA). Then the approval of one or more vehicles of the same type for a defined operating area is requested from the competent authority. The municipality must agree for the approval, then an official number plate is assigned and the vehicle documents are issued.

Qualification of the operator

Technical supervision requirements:
- Possesses one of the following degrees: qualified engineer, bachelor's, master's or state-certified technician.
- Successfully completed training related to the vehicle with autonomous driving function at the vehicle manufacturer
- Valid driver's license, whereby the class of the driver's license must correspond to that of the vehicle with autonomous driving function.

Project NAF-Bus, Sylt

Image @Büro autoBus

Project HEAT, Hamburg


Image @Mobile Zeiten

Stakeholder voices

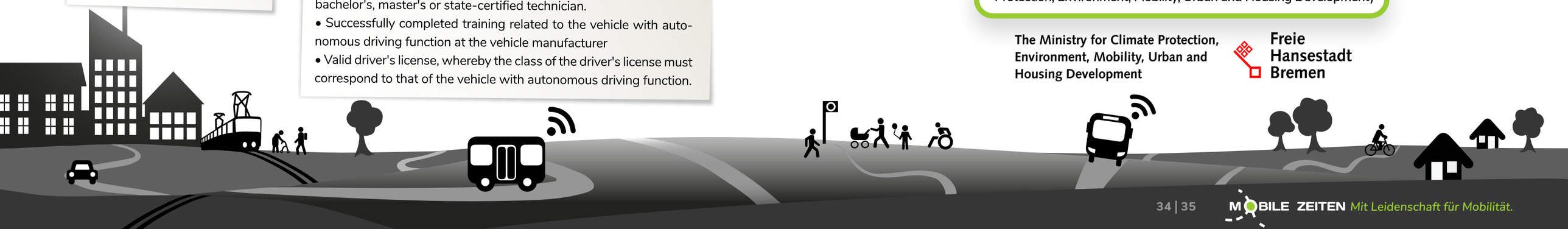
„Autonomous transport is a chance in any case, because I can be very flexible without additional staff costs. One can offer routes at prices, which I can't offer today."
(Prof. Dr.-Ing. Rainer Schwerdhelm, Jade University of applied science)

„I think, automated vehicles will be part of the public transport. Especially for rural areas it's an opportunity, but also for the so-called „last-mile." **(Marc-André Burgdorf, District Administrator Emsland)**

„Even if automated vehicles are not yet ready for regular operation, it is important to set up the right structures for this today. It will be crucial for cities and municipalities to help shape developments in their interest. Cities and municipalities are in demand in many respects. For example as initiators, planners, implementers, networkers, operators."
(Torben Quickert, Free Hanseatic City of Bremen, Ministry for Climate Protection, Environment, Mobility, Urban and Housing Development)

The Ministry for Climate Protection, Environment, Mobility, Urban and Housing Development

Freie Hansestadt Bremen



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Country Factsheet Denmark

Pilot projects in the Denmark NSR region

- **2020 - 2021** Aalborg
- **2020 - 2021** Copenhagen Nordhavn
- **2021** - in operation, Slagelse Hospital

only test operations

§ need of a special permit

3 pilot projects

level 4 allowed

Operator in-/outside AV

2,5 km Longest test track

5,9 km Total test tracks

< 30 km/h max. speed

Approval authorities

Testing of automated vehicles (SAE levels 0–5) is possible with a special permit under FL § 92h. The Minister of Transport, Building and Housing issues a special permit after a hearing with the police and road authorities.

§ Status of legislation

While autonomous vehicles are not yet permitted to operate on public roads, on May 30, 2017, the Danish Parliament adopted an amendment to the Danish Road Traffic Act allowing autonomous vehicle testing. According to the amended Act, any company, that wishes to carry out testing with self-driving cars, must apply to the Ministry of Transportation for a permit.

Qualification of the operator

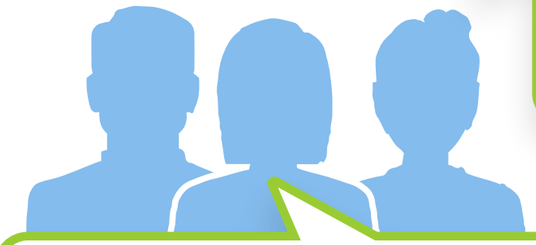
The driver must obtain a licence for passenger transportation, as well as a driving licence.

Project Smartbus Aalborg


Image @Mobile Zeiten


Image @Aalborg Kommune

Stakeholder voices

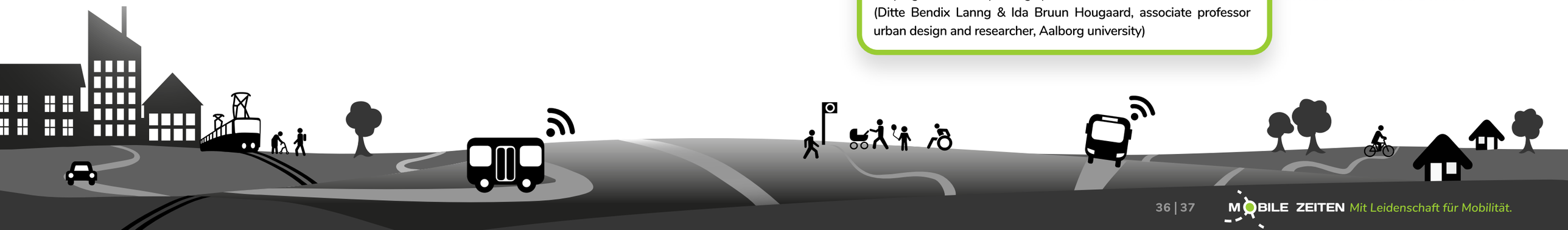


„Even if you can't use the vehicles everywhere today, they can still be a good addition and part of a future integrated transport system in which small and large buses, drones, etc. will have its place."
(Maria Vestergaard Department of Mobility, Aalborg Municipality, Denmark)

„Parking spaces are a ubiquitous part of contemporary cities. They require vast amounts of space and are partly empty outside of peak-hours. Autonomous vehicles come with new requirements regarding street lay-outs. In addition we emphasize that autonomous vehicles are in no ways guaranteed to become shared and if AV become mainly privately owned and people need simultaneously to be picked up during peak hours, it might necessitate keeping the current parking space in the cities after all."
(Ditte Bendix Lanng & Ida Bruun Hougaard, associate professor urban design and researcher, Aalborg university)

Aalborg Kommune

AALBORG UNIVERSITY



Country Factsheet United Kingdom

Pilot projects in the UK NSR region

- **2022** in preparation, Edinburgh and Fife

only test operations

§ approval from the CCAV needed

1 pilot project

level 2-3 allowed

Operator in-/outside AV

22,5 km Longest test track

22,5 km Total test tracks

determined by operating environment and by national legal speed limits

§ Status of legislation

In 2018, the UK Government's Centre for Connected and Autonomous Vehicles (CCAV) asked the Law Commission of England and Wales and the Scottish Law Commission to undertake a far-reaching review to enable the safe and responsible introduction of automated vehicles on GB roads and public places. The first of a three-part public consultation process was launched in November 2018, and looked at safety assurance and legal liability. The second part, in October 2020, focused on 'highly automated road passenger services' (HARPS), looking at how automated vehicles could be used to improve public transport. The third part was launched in December 2020 and drew on responses to both previous papers to formulate overarching proposals on the way forward. The Law Commission's final report was published on 26 January 2022, and has been laid before the UK and Scottish Parliaments. The UK, Scottish and Welsh Governments will now decide whether to accept the recommendations and introduce legislation to bring them into effect.

Public trials are theoretically possible on any UK road, if they meet three general legal requirements: 1) a driver or operator, in or out of the vehicle, who is ready, able and willing to resume control of the vehicle; 2) a roadworthy vehicle; and 3) appropriate insurance. Prior engagement with the local roads and planning authorities (i.e. local councils) and with the local police is also necessary. However, "advanced trials" on public roads require approval from the CCAV. Currently, 'POD'-type vehicles, with no steering wheels or wing mirrors, would not be classed as roadworthy, and could only be trialled on private land.

Approval authorities

Vehicle approvals are currently conducted by the UK Government Department for Transport's Vehicle Certification Agency (VCA). The Law Commissions have recommended that the future approvals process should ensure that the automated driving system (ADS) is "appropriately integrated with the vehicle".
UK test beds are coordinated by Zenzic (https://zenzic.io/), an organisation created by the UK Government and by industry partners, such as Cisco, Honda and IBM.

Qualification of the operator

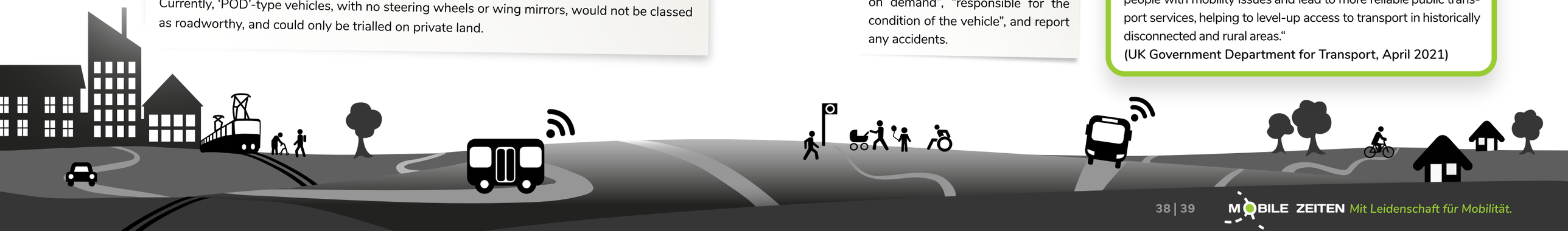
The CCAV's current Code of Practice on Automated Vehicle Trialling notes that operators should be "suitably licensed and trained".
The Law Commissions' final report considers a 'user in charge', which they define as an individual who is in the vehicle and in a position to operate the driving controls, if necessary. The Commissions indicate that a user-in-charge "must be qualified and fit to drive". They must also be "receptive to a transition demand", "responsible for the condition of the vehicle", and report any accidents.

Stakeholder voices

„Scotland's vision for CAV development and deployment is an integral part of wider ambitions for government, transport authorities and public infrastructure. CAV sits at the heart of the integrated transport solutions we are developing for the people of Scotland." **(Transport Scotland, 2019)**

„Connected and automated vehicle (CAV) technology is set to play a major role in the exciting transport revolution happening today in the UK, helping to improve and level up transport across the nation by making every day journeys greener, safer, more flexible and more reliable."
(UK Government's Centre for Connected and Autonomous Vehicles, 2020)

„Self-driving technology in cars, buses and delivery vehicles could spark the beginning of the end of urban congestion, with traffic lights and vehicles speaking to each other to keep traffic flowing, reducing emissions and improving air quality in our towns and cities. Not only are automated vehicles expected to improve road safety, the technology could also improve access to transport for people with mobility issues and lead to more reliable public transport services, helping to level-up access to transport in historically disconnected and rural areas."
(UK Government Department for Transport, April 2021)



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DRIVERLESS PUBLIC TRANSPORT FROM THE MUNICIPAL POINT OF VIEW

a snapshot

Online survey of employees and decision-makers from municipalities, politics and transport companies: **n=164, 02/2021.**

Driverless PT projects are known by a lot of stakeholders:

68,3 %
of the experts questioned know at least one driverless PT project.

8,5 %
of the respondents feel sufficiently prepared for driverless PT.

What do municipalities, politics and transportation companies think about driverless PT? *

- … luxury **30,5 %**
- … provides great potential for PT expansion **65,9 %**
- **37,8 %** … delicate legal regulations
- … is a future task for society as a whole **39 %**
- … a solution to skill shortages **20,7 %**
- … an ethical challenge **32,9 %**
- … a location factor that boosts economy **22 %**

Just wait and see:
Majority of those polled adopts a wait and see attitude regarding driverless PT

74,1 % wait-and-see

25,9 % involved

- **11,1 %** own projects
- **6,2 %** analysis, studies, feasibility checks
- **8,6 %** Embeddedness in in strategy and planning documents

Not an issue yet **38,3 %**

Observation of developments **35,8 %**

Existing obstacles: *

- **48,7 %** Lack of staff
- **47,5 %** Uncertain legal position
- **47,5 %** Lack of technical maturity
- **46,3 %** Lack of financial resources
- **43,9 %** Lack of knowledge

Driverless buses offer potential to solve pressing challenges. *

- **75,6 %** opportunity to close the gap
- **69,5 %** Strengthening of intermodal transport
- **61 %** ensuring services of general interest
- **65,8 %** Accelerating mobility transition

Support is desired here: *

- Stakeholder networking **31,7 %**
- Project funding **52,4 %**
- Identification of application areas **54,9 %**
- Best practice examples/guidelines **54,9 %**
- The exchange of knowledge with involved municipalities **68,3 %**

* Multiple answers possible

The bus for the last mile connection

75 %
of those polled recognize driverless buses as the most suitable solution for the last mile.

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A.R.T.-FORUM IMPRESSIONS OF THE PROJECT