14 Integrated strategic planning approaches to automated transport in the context of the mobility transformation

A case study in suburban and rural areas of Vienna/Lower Austria

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1. TRANSFORMING MOBILITY WITH CONNECTED AND AUTOMATED VEHICLES

This article uses case studies to set out specific ways in which connected and automated vehicles can be applied to bring about the required revolution in mobility. More specifically, the aim is to present and discuss strategic planning concepts for a selection of local authorities and regions in the Vienna/Lower Austria metropolitan region. These strategic planning concepts have been developed to complement existing design concepts and/or action plans that largely remain abstract and generic. They are the outcome of a transdisciplinary process: urban planners and researchers formed focus groups with policymakers and local government administrators from the chosen local authorities and regions, as well as connected and automated mobility experts. This partnership produced multistage strategic planning approaches with the aim of establishing connected and automated vehicles (CAVs) as an attractive alternative to motorized private transport.

Mobility and settlement planners must urgently engage with this technology in a structured, proactive (and, at least initially, theoretical) way. A glance at the wide range of relevant initiatives being put into action demonstrates why. Around the world, CAVs are being intensively put through their paces (for more on this, see the articles in Part I "Mobility and transport" and Part IV "Governance"). Moreover, in Europe the legal foundations are already being put in place to enable this technology to be regularly used on our roads (Kugoth 2020).

However, there is still some way to go before we see these technologies in our daily lives, and the initial euphoria has lessened significantly, at least among some experts. In recent years, research on the possible impacts of connected and automated vehicles has become markedly more cautious (for more on the early euphoria surrounding "self-driving cars", see Dangschat/Stickler 2020). Interviews carried out with experts across Europe confirm this lowering of expectations: many now think that this technology can only make a positive contribution to the mobility transformation if policy is designed to specifically regulate its use from the outset. Yet opinion remains divided on what form this regulation should take (Lenz/Fraedrich 2015; Mitteregger et al. 2022: 33–46).

These growing concerns have, however, been largely absent from the technology's ongoing development and promotion. Governments the world over have been supporting research and development in this field. In the EU, automated vehicles are seen as the key to a "digital single market" (Buchholz et al. 2020): funds are specifically being allocated to develop the technology, while the necessary infrastructural expansion, standardization initiatives and alignment of legislation are being pursued (STRIA 2019; for more on criticism and perceptions, cf. Dangschat 2020b for Germany and Manders/Klaasen 2020 for the Netherlands). Cybersecurity and general questions concerning liability are the only two areas where a regulatory framework has so far been actively put into place (Taeihagh/Lim 2019).

Only if these new technologies succeed in helping to replace privately used cars – the 20th century's dominant mode of transportation – will they have made a meaningful contribution to the transport and mobility transformation. The development of connected and automated transport (CAT) should therefore be used to specifically tackle the ecological, social and economic challenges we face. It is thus not a matter of encouraging the disruptive development of CAVs, but of shaping, nurturing and overseeing a mobility transformation that is partly made possible by the connection and automation of transport.

In Europe, steps have already been taken to make this a reality. In 2019, the European Commission's Sustainable Urban Mobility Plans (SUMP; Wefering et al. 2013) were revised to accommodate advances in the connection and automation of transport (Backhaus et al. 2019). There are also plans and speculative designs that focus – albeit still very optimistically – on the use of "self-driving" cars in cities (see, for instance, Harrouk 2020, Ratti et al. 2020).

Transport engineers have developed concepts that explore sophisticated applications. For instance, there are already examples of network plans for automated mobility services (Madadi et al. 2019) that only use parts of the road network and are reminiscent of personal rapid transit (PRT) networks from the 1960s (McDonald 2012). There is currently a lack of integrated planning approaches for integrated settlement and mobility designs that highlight the ways in which connected and automated vehicles can help achieve a mobility transformation and the conditions needed for this to happen in specific transport and spatial scenarios, especially in rural areas.

The challenges faced here are considerable. It is improbable that one European city or region can single-handedly design a mobility system that is increasingly shaped by automation and connectivity. The web of responsibilities is simply too tangled; for instance, regulations for road traffic are set at the national rather than the local level. The tasks and issues are so complex that it is almost impossible to tackle them adequately with existing resources. If this new mobility system is to be developed in harmony with the current objectives of the mobility transformation, a comprehensive dialogue must take place at various transport policy levels and involve both new and established actors in (urban) mobility markets, institutions and administrative bodies. This is one of the key requirements set out by transformation researchers (Wittmayer/Hölscher 2017).

Following decades of voices repeatedly making the case for the integrated development of space and mobility, a change now needs to occur. Unregulated development that leads to additional traffic and thus takes up more land, produces more emissions and creates hazards – as cars have now done for the last hundred years – is a scenario that humanity can no longer afford at the start of the 21st century.

2. CURRENT DEVELOPMENTS IN CONNECTED AND AUTOMATED VEHICLES

At the beginning of the last decade, self-driving cars received a tremendous amount of attention in the media. This hype was driven by IT companies suddenly taking an interest in the mobility sector. As these actors were motivated by other business models, they were able to realize technological and organizational innovations, and thus further add to the excitement around this new technology. The mobility service providers that appeared during this period (Uber, Lyft, Bolt, etc.), numerous sharing companies offering bicycles and e-scooters as well as car-sharing services, which have been around slightly longer, are now commonplace in urban areas, especially larger cities. This wave of euphoria and uncertainty shaped expectations regarding connected and automated vehicles. But now even technology developers are taking a more sober approach: a revolutionary scenario whereby a single market actor is able to produce a fully automated driving system that can handle every situation as adeptly as a human is largely regarded as unlikely (cf. Beiker 2015, Shladover 2018, Mitteregger et al. 2022).

The many passages on sustainable mobility that featured in policy and strategy papers back then attest to the huge hopes that were pinned on the technology; now each line is considered to need careful review (for instance, STRIA 2019; Kirchengast et al. 2019: 58). The perceived positive effects, such as reclaiming parts of the streetscape by freeing up parking spaces, the reduction of vehicles by increasing the use of car or ride-sharing, improved traffic safety thanks to the superior cognitive abilities of machine learning, reduced energy consumption thanks to more efficient modes of driving as well as a broader scope for the use of Mobility as a Service (MaaS), are all currently the subject of debate (Dangschat 2019, 2020a; Dangschat/Stickler 2020; Soteropoulos et al. 2019; Mueller et al. 2020; Pangbourne et al. 2020).

Yet even today connected and automated vehicles largely exist only as concepts. That is why, given the current state of connected and automated vehicle development, a study such as this invariably includes several untested hypotheses. The theories that have been developed are outlined and examined in the following section.

2.1 EVOLUTION NOT REVOLUTION: AUTOMATED MOBILITY AND THE LONG LEVEL 4

Today's perception of the technological challenges inherent in the development of automated vehicles will likely mean a longer transitional phase. In other articles, we have coined the term "Long Level 4" to describe this phase. Here we mean "a gradual process [...] extending over several decades, during which CAVs will be deployed only in parts of the road network. During this transition period, conventional means of transport will continue to play an essential but increasingly specialized role" (Mitteregger et al. 2022: VIII).

As connected and automated vehicles are deployed as part of the Long Level 4, negative effects may become more visible and appear early in the process. This is primarily due to expectations that those areas of the road network that are already predominantly designed around cars will be more easily adaptable to CAV use (Shladover 2018; Mitteregger et al. 2022: 80–83; Soteropoulos et al. 2020). The roads that are expected to see CAV roll-out first are the result of a technological paradigm that has shaped urban development and transport policy since the 1950s. Such roads have been designed solely for use by motorized vehicles and their capacity is measured in vehicle throughput over a specific period (traffic density/volume) or speed limits (in km/h).

For this reason, it is expected that within the complex road networks of Europe's cities and regions, motorways and multi-lane trunk roads will see the first CAVs, followed by industrial roads and business routes. At low speeds, automated parking and services operating within a set boundary are conceivable. Until now, roads that serve as more than just transport routes, i.e. that are also used and revitalized as public spaces, have been too complex for CAV software, algorithm systems and sensors (Shladover 2016).

2.2 CONNECTED AND AUTOMATED VEHICLE APPLICATIONS

During this transition period, the fully automated vehicle is effectively fragmented into different highly automated applications that develop progressively and whose gradual deployment is contingent upon not only the developmental trajectory of the technology but the various complexities of the driving tasks and the infrastructural requirements (cf. ERTRAC 2019, Wachenfeld et al. 2015; Fig. 1). For this study, we examined five different highly automated vehicle applications, which were then used to guide discussions within the focus groups (see Table 1).

Table 1: Connected and automated transport system applications

Parking Assistant

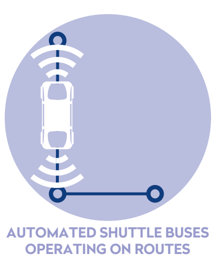
Parking assistants (or automated valet parking) enable automated vehicles to drive to and from a nearby or far-away parking space. These systems are mainly being discussed, and are most likely to be imminently rolled out, within the context of park-and-ride facilities (at airports and train stations). A system of this kind makes it possible for passengers to call or drop off a vehicle in a designated pick-up/drop-off area even before changing their mode of transportation (e.g. before leaving the train). Another place where this application could be used are large car parks for shopping centres or retail parks. This technology could also enhance car-sharing vehicles. There is also the potential to charge battery-powered electric vehicles.

Area assistant

Area assistants are designed for use within a limited, usually not publicly accessible area of land. There are some well-known applications that have been in place for just over a decade, including heavy goods vehicles in ports, in mines or automated reconnaissance vehicles that are used by military facilities to conduct security operations. Improved sensors enable new applications and access to new spaces: there are numerous companies that are either developing or already supplying mobile delivery and security robots for use in spaces within university campuses, theme parks, industrial estates, train stations and shopping centres. The most well known is the Waymo pilot scheme taking place in the suburbs of Phoenix, Arizona.

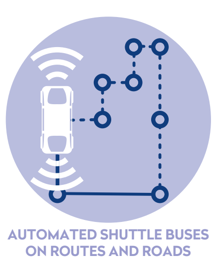
Motorway assistant

Motorway assistants are systems that take over driving tasks on motorways or other trunk roads. The development of motorway assistants is primarily being encouraged by vehicle manufacturers and can also be considered an active safety system. This application is not just limited to individual transport: it is also a viable option for HGVs, utility vehicles (e.g. for haulage) or long-distance buses. Specially designed lanes are frequently discussed, especially for HGVs, to further reduce demands on the driving technology.



Automated shuttle buses operating on routes

Automated driving systems on specially constructed routes have been in use for several decades. One such example is PRT systems at airports (e.g. Heathrow) or as a last-mile solution to enable access to offices (e.g. Rivium close to Rotterdam). There is very little to distinguish automated shuttles on routes from shuttles deployed on public roads. It can be assumed that automated shuttles, at least at present, only drive on selected, clearly defined and approved routes (and lanes) that are protected and designated as such, and that vehicles only call at specified stops. On such routes, vehicles are able to operate without a driver; however, similar to air travel, they are monitored from a control room by pilots and can be deactivated. There is thus some technical crossover with area assistants.



Automated shuttle buses on public roads

Automated shuttles are currently being tested predominantly by public transport companies (see Chap. 6 by Soteropoulos et al. in this volume). However, the vehicles are yet to operate without a safety driver. These automated vehicles are mainly being tested as a possible shuttle service for underground and tramlines and thus as a complementary public transport service, for instance in suburban areas. The potential to save personnel costs, as well as the more flexible range of applications, is believed to make this a more economical option.

Source: Mitteregger et al. (2022), Kyriakidis et al. (2019), Shladover (2018), Perret et al. (2017), Wachenfeld (2015)

3. SUSTAINABLE MOBILITY AND SETTLEMENT DEVELOPMENT IN RURAL AREAS

The objective being pursued by transport policymakers is clear: the climate crisis demands a radical transformation of mobility – and past failings mean change must be achieved within a short space of time. In the EU, the transport sector has so far failed to reduce greenhouse gas emissions. In fact, since 1990, emissions have been rising rapidly (with a sharp surge between 2005 and 2015); outlooks also remain bleak (IEA 2020). Yet the changes required to successfully bring about the necessary transformation have long been known. As early as the 1970s (cf. Schwedes 2017), researchers and activists were formulating versions of a strategy that can be summarized as follows:

- traffic must be avoided,
- a shift needs to occur away from individual transport options and towards more environmentally friendly forms of mobility (walking, cycling and public transport) or zero-emission vehicles,
- and, lastly, steps must be taken to improve the quality of streetscapes. In towns, roads must become much more effective as public spaces (for more on the differences between transforming drive, traffic and mobility, see Chap. 4 by Manderscheid in this volume).

3.1 CO_2 EMISSION REDUCTION TARGETS IN AUSTRIA'S TRANSPORT SECTOR

The path to achieving greater ecological sustainability in the transport sector is still largely defined through targets. The possible approaches to achieving this aim across the EU's member states, however, remain vague, if they have been sketched out at all. By 2030 the European Commission aims to have reduced greenhouse gas emissions by 55% compared to 1990 levels (European Commission 2020). And from 2050, Europe should be the world's first "climate-neutral continent", a goal that will be pursued with a budget of €1 trillion (European Commission 2019). The Commission is also striving for the EU's transport sector to stop all net greenhouse gas emissions by 2050, all while stressing the economic viability and positive social impacts of the overall mobility shift. The current targets being pursued by Austria's policymakers even go one step further: the country aims to be climate neutral by 2040 and thus "play a pioneering role in climate protection in Europe" (Austrian Government Programme 2020).

Such long-term aims have repeatedly been called for by transformation researchers. However, given the world's limited carbon budget, it remains doubtful whether the planet will have by then long surpassed the Paris Agreement's aim to limit global average warming to between 1.5 and 2 °C. At the current rate of emissions, the global budget to limit warming to 1.5 °C will be reached by around 2027; for an increase of 2 °C, the limit will be reached by 2045 (IPCC 2018).

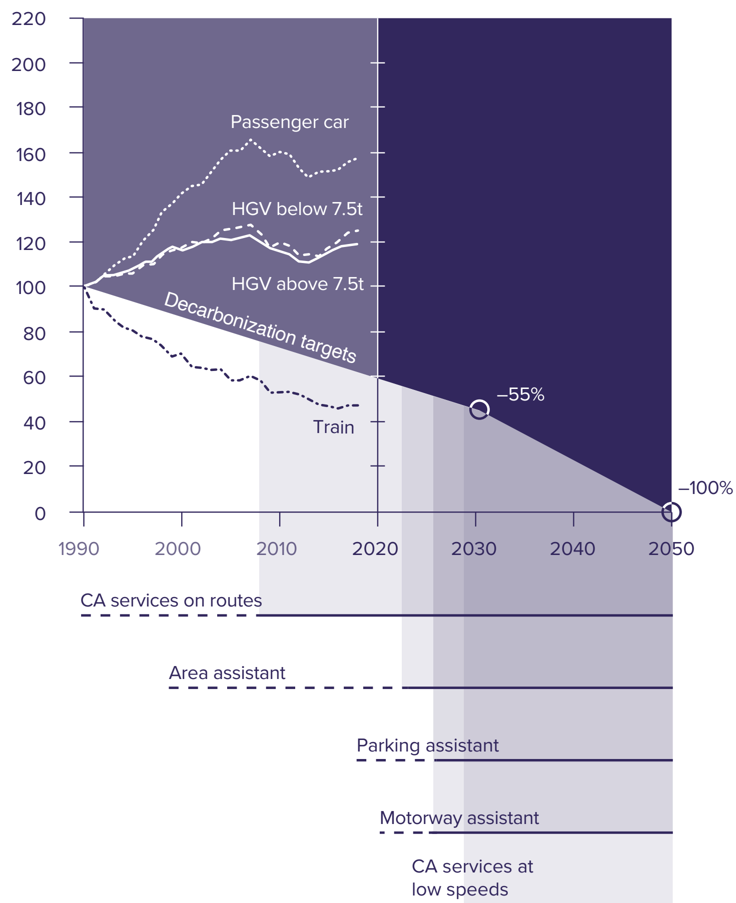
Roughly one quarter of Austria's greenhouse gas emissions are produced by the transport sector (Environment Agency Austria 2019). If we look at the greenhouse gases excluded from emissions trading schemes, transport is by far the largest contributor, making up 46% of emissions. Austria also exhibits a pattern seen at the wider EU level: while in recent years there have been visible reductions in all other sectors – from construction to agriculture – transport has in fact seen its emissions rise. Austria aims to reduce its annual transport sector CO_2 emissions by 7.2

million tonnes to 15.7 million tonnes by 2030 (at present, the figure stands at 22.9). Given that emissions have been rising in recent decades, this would mean that emissions must be reduced to 1991 levels (Kirchengast et al. 2019).

3.2 THE ROLE PLAYED BY CONNECTED AND AUTOMATED VEHICLES

Figure 1 compares the expected market availability of different CAV applications with the European Union's planned emission reductions. Here the theoretical availability of an application is being explicitly discussed and not its widespread use within society.

Figure 1: Necessary greenhouse gas reductions in the European Union's transport sector (Transport & Environment 2020) and the implementation of various CA services.



Source: the authors based on ERTRAC (2019), Kyriakidis et al. (2019) and Perret et al. (2017)

3.3 THE UNIQUE CHALLENGES OF RURAL SPACES

It is repeatedly stressed that the challenges of the transport and mobility transition will differ fundamentally in urban and rural areas (VCÖ 2016, Rudolph et al. 2017, Canzler et al. 2018). It is important to remember that this situation is, to a large extent, of governments' own making: in addition to the sectoral restructuring of economies in Europe and the associated social impacts, it is the transport and settlement policy decisions of recent decades that have led to the situation currently faced (Sieverts 2018). There is a lack of appealing alternatives to private cars in rural areas because public railways in these locations have been scaled back while the locality's further expansion is either tolerated by settlement policymakers or even intensified through incentives at local and national levels (e.g. by using the distribution of funds between the federal government, provinces and local authorities to encourage the rezoning of land designated for construction, encouraging owner-occupied homes and offering a commuter allowance). *Bahnstraßen* ("station roads") in extensive municipalities that no longer lead to working train stations bear witness to this development (see, for instance, Poysdorf in Lower Austria). Transforming transport in these locations, where an A-S-I strategy has only been pursued in recent years, has been made significantly more challenging.

The Verkehrsclub Österreich (VCÖ) has stated that 70% of the Austrian population live outside of large cities and that these areas are responsible for almost 80% of the greenhouse gas emissions produced by passenger mobility (cf. VCÖ 2019: 2). Thus the creation of alternative mobility options in suburban and rural areas is undoubtedly necessary for transport to be decarbonized.

4. APPROACHES TO AND THEORIES CONCERNING STRATEGIC PLANNING CONCEPTS IN FOUR AREA TYPES

In the following section, we outline strategic planning concepts developed in a transdisciplinary process and based on four selected area types. The aforementioned issues involved in bringing about a more sustainable mobility model in rural areas serve as a basis and have been consolidated into specific transport and spatial challenges in each area examined in our analysis. In focus groups, multistage development strategies were created to ensure the largest possible provision of public transport-type services across settlement zones in each area type in order to establish attractive alternatives to private cars. The planning concepts are integrated, i.e. transport issues are not only resolved with transport-based solutions. The innovative appeal of connected and automated mobility services is to be harnessed not to increase the acceptance of connected and automated vehicles but to boost the level of acceptance towards measures that will be necessary to bring about the transport and mobility transformation. This can be crucial, particularly in areas where people are heavily impacted by transport policy decisions made at the national level (e.g. an increase in fuel prices) due to a lack of real alternatives.

4.1 APPROACHING AND ADAPTING PLANNING CONCEPTS

Throughout the course of several workshops, specific areas around Vienna were selected and then further developed into prototypes identified by certain transport and spatial features. Once the areas had been chosen, the team examined current planning documents and strategy papers as well as obtained geographic and demographic information to paint an accurate picture of the current situation in each area type. Using the action plans from our previous study (Mitteregger et al. 2022: 141–158), we developed theories for the development potential of these areas. Both the assessment of the status quo in each space and its potential were discussed and reviewed in focus groups involving stakeholders from the municipalities, regions and the state of Lower Austria, as well as connected and automated mobility experts. The technical possibilities of connecting and automating transport during the time frame considered as part of the study were compiled and edited for the workshop with the help of existing literature (see Figs 2 and 3).

Figure 2: Work during focus groups with local experts in Vienna during the autumn of 2019.

Photos: Lena Hohenkamp

Building on the results of the focus groups (see list of participants in Fig. A1 in the Appendix), strategic planning concepts were defined, each including a multistage development process. These are presented as narratives in Section 5. Wherever possible and appropriate, the impact of the outlined planning stages was qualitatively and quantitatively evaluated. Due to restrictions imposed as a result of the Covid-19 pandemic in the spring and summer of 2020, the second stakeholder workshop had to be cancelled. The feedback provided by experts on a rough draft of this paper was incorporated into the final version.

Figure 3: Focus group discussions were aided by reference material compiled prior to the workshops

Photo: Lena Hohenkamp

4.2 SELECTING THE AREA TYPES AND CASE STUDY LOCATIONS

The typology put forward by Matthes and Gertz (2014) was used as a basis to categorize the chosen areas. This approach explicitly examines the extent to which residents in each location can complete everyday tasks without a car. The typology can also be easily applied to other studies and was developed using a broad empirical foundation (Table 2).

Table 2: Systematization, characteristics and hierarchy of case study area types

Hierarchy of transport reduction	Area type	Description (based on Matthes/Gertz 2014)	Case study
Less challenging	**Outskirts, suburban centre**	Suburban centres and outskirts are comparatively heterogeneous spaces. Designing everyday mobility to enable the lowest possible number of car journeys is possible to some degree, especially in combination with options for cycling, but driving remains dominant in these area types, partly due to a lack of car restrictions (e.g. there is no shortage of parking spaces).	Vienna South (area type A) Mistelbach (area type B)
↑	**Public transport axis**	Public transport axes differ from the periphery, particularly with regard to the accessibility of service centres and workplaces by public transport and bicycle. Designing everyday mobility without or with just one car per multi-person household is challenging but possible.	Ebreichsdorf (area type C)
Challenging	**Periphery**	The periphery is characterized by a very low density of settlements and workplaces, a lack of local amenities and poor public transport access to centres and workplaces. Here it is either very challenging or impossible to manage without a car on a daily basis.	Bad Schönau (area type D)

Source: the authors based on Matthes/Gertz (2014)

The selection was chosen based on themes and issues arising in a Long Level 4. Known transport and settlement policy problems were addressed (see Table 4). The aim was to develop different automated driving applications as alternatives to “automobility”. One key question formed the basis of analysis in each of the chosen area types (see Table 3).

Table 3: Area types, example areas and key questions addressed by the case study

Area type	Question	Case study
Outskirts (area type A)	How can the mobility transformation be realized in industrial zones and business centres located on the outskirts of towns and cities while simultaneously ensuring their commercial growth?	**Vienna South**
Suburban centre (area type B)	What development options can be made available for suburban centres that could become dormitory towns as a result of automated driving on motorways?	**Mistelbach**
Public transport axis (area type C)	What functions can last-mile automated mobility services fulfil along large-capacity regional public transport axes?	**Ebreichsdorf**
Periphery (area type D)	Can automated mobility services improve the mobility options open to the residents of peripheral spaces and enable the relocation of traffic?	**Bad Schönau**

Source: the authors

The following table lists the typical problems that characterize the various spaces. The challenges included in the table are the result of our analysis of the chosen municipalities/areas (see Table 4 on the next page). This information was then used to develop theories for potentially desirable connected and automated vehicle applications that are consistent with the aim of transforming mobility. This overview thus also shows that certain connected and automated transport use cases (see Table 1) should be given priority when faced with certain problems.

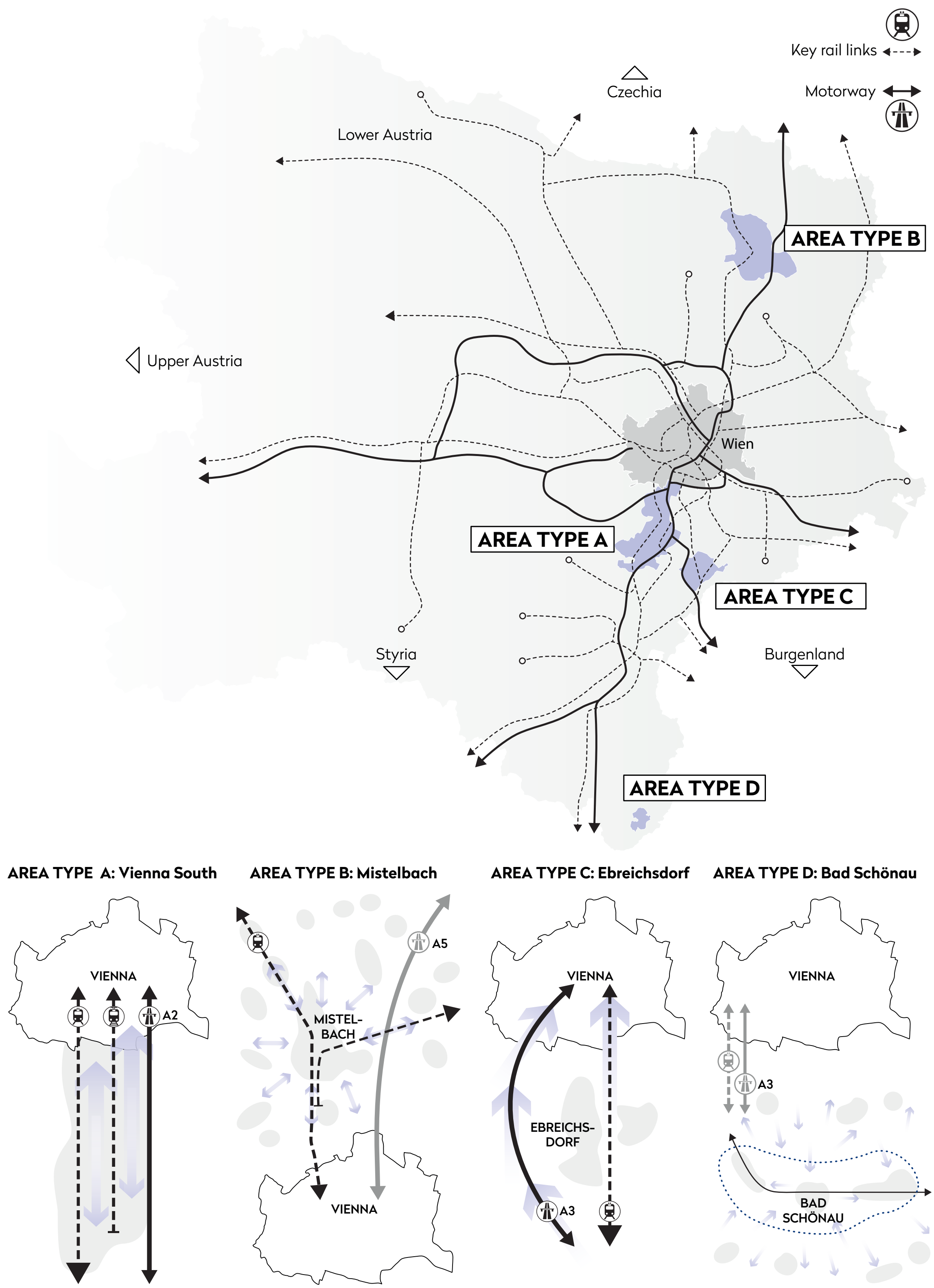
Table 4: Area types, challenges and theories on development potential involving the application of connected and automated driving systems

Case study (type of area)	Challenges characterizing the area	Theory on the development potential with Level 4 applications
Vienna South (outskirts)	• Dynamic industrial area with excessive land use • Transit area (traffic flows around large cities) • High level of traffic and pollution • Congestion and stress on infrastructure	Area and/or motorway assistants create relevant criteria to encourage businesses to relocate to the area and influence new forms of commercial mobility management. These spaces are important testing grounds. Developments here can be groundbreaking.
Mistelbach (suburban centre)	• Strain on existing housing stock • Lack of public transport links between the surrounding municipalities/urban districts and key functions located in the centre • Rising commuter traffic towards Vienna since the completion of a motorway • Urban sprawl in residential areas and business sites	The use of automated shuttles can improve public transport access to centrally located functions. Specific route planning and the careful repurposing of existing infrastructures would be necessary to make this happen.
Ebreichsdorf (public transport axis)	• Strain on existing housing stock • Creating transport links between the train station and the surrounding town and village centres (train station outside of the city centre) • Commuter traffic to Vienna • Disused railway line	Spatial features specific to the locality (in this case, a disused railway line) can become the pavements and cycle paths, or CAV access routes, of tomorrow and enable connected and automated services on specific routes. In this context, connected and automated services could also be used to help boost local development.
Bad Schönau (periphery)	• Insufficient and/or non-existent public transport access, especially for scattered settlements • High dependency on private cars	Connected and automated shuttles could be used in synergy with tourist sites to optimize accessibility.

Source: the authors

To respond to the question concerning area type A, a section within the ribbon development to the south of Vienna encompassing eleven municipalities was chosen. For area B, Mistelbach, a district capital to the north of Vienna, was examined. To answer our question concerning area type C, researchers looked at Ebreichsdorf, where a new train station offering an excellent transport link to Vienna is being built. Finally, researchers analysed Bad Schönau, a small municipality on the border between Lower Austria, Burgenland and Styria, to respond to the query posed for area type D (Fig. 4).

Figure 4: Location of the four area types within the Vienna/Lower Austria metropolitan region, including main transport links



Source: the authors

In the following section, the strategic development concepts created during the research project are presented as narratives. The concepts are considered in detail and the various stages of each transformation are discussed. Specific areas for action in various specialist fields of urban policy and planning are subsequently developed.

5. FUTURE CONCEPTS FOR INTEGRATED MOBILITY AND SETTLEMENT DEVELOPMENT

5.1 VIENNA SOUTH (AREA TYPE A)

The name "Vienna South" is used to encompass the ribbon development located to the south of the city, which is closely linked to the capital both in terms of its locality and functions. The area is directly to the south of Austria's capital and covers 11 municipalities in the districts of Baden and Mödling. A green space, the Vienna Woods (Wienerwald), can be found to the west of the area. To the east, the area borders a cultural landscape that is mostly undeveloped. The municipal boundary with Bad Vöslau was chosen as the area's southern border (see Fig. 5).

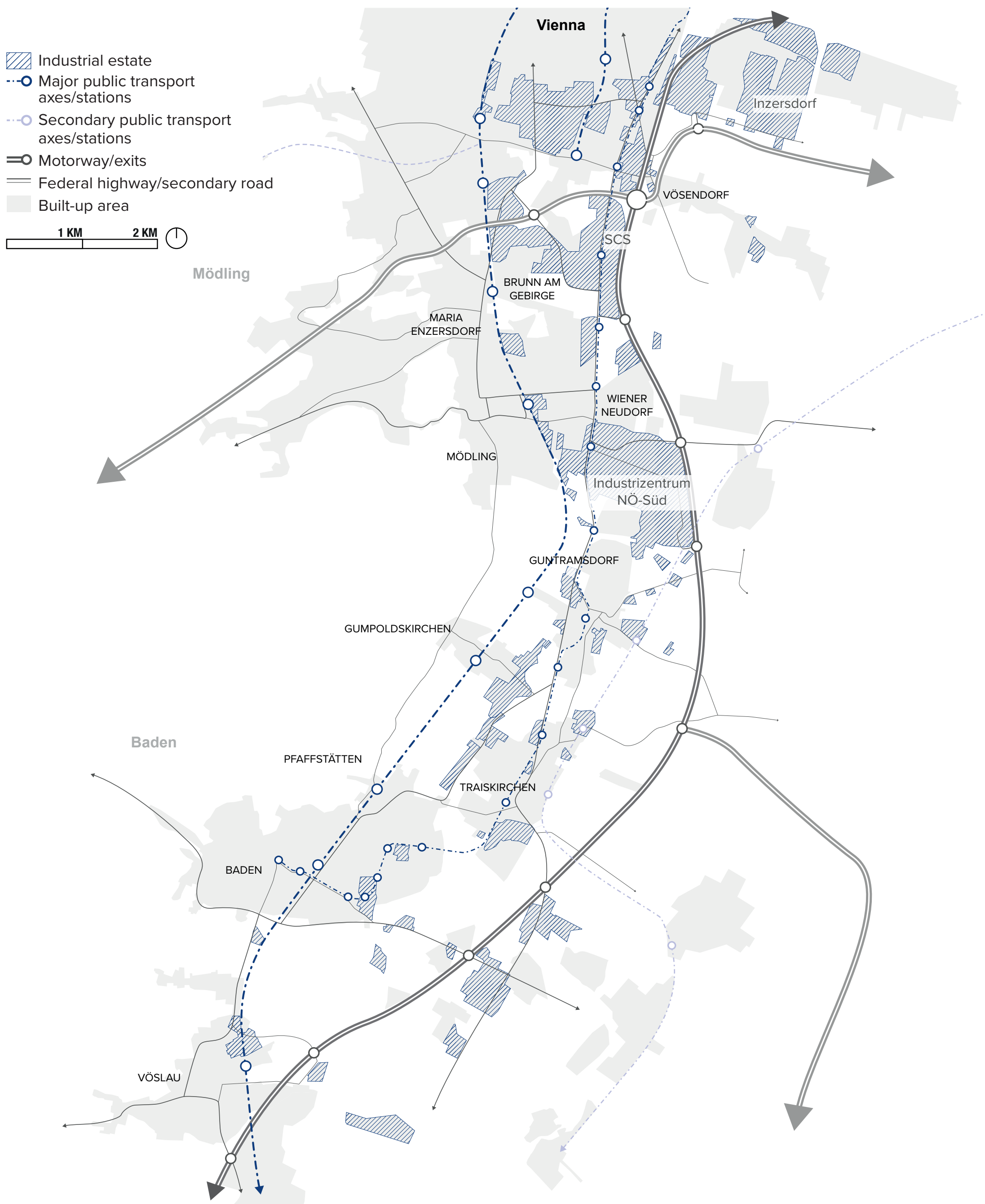
Given its proximity to Vienna, the availability of space and the area's good transport links, Vienna South is one of Austria's most dynamic economic zones. Housing in the historical town centres, and particularly on the slopes close to the Wienerwald, is in high demand. A controlled and coordinated settlement development of this ribbon zone is the key challenge for land use planners. Local regional planning and transport organizations are currently tackling this (these are Stadt-Umland-Management, Planungsgemeinschaft Ost and Verkehrsverbund Ost-Region); however, they have limited scope for action.

Vienna South is also a transnational transit space and part of the Trans-European Transport Network (TEN-T). Traffic flows from the surrounding area largely head towards the Austrian capital. The A2 Südautobahn (South Motorway) is a central transport axis in the east of Austria that runs towards Styria and onwards to Carinthia, Slovenia and Italy to the south and towards Bratislava and Brno to the north. The Südbahn (Southern Railway) links Vienna to Graz (where passengers can travel on to Ljubljana, Zagreb and the port city of Rijeka) or Klagenfurt and Villach (with connections to northern Italy and the port city of Trieste) in the south (and is currently being extended in two locations). The capital also has rail links to Brno and Prague in the north. Furthermore, the area is structured around a third transport link: a branch line ("Badner Bahn") connects central Vienna to the district capital of Baden.

Challenges
In this area type, the importance of historical centres has dwindled. Vienna South is home to Shopping City Süd (SCS), Austria's largest shopping centre (comprising 192,500 square metres of selling space and employing 5,000 staff), and Austria's top-performing commercial site in the shape of the Lower Austria–south industrial hub (IZ NÖ-Süd), which also has 11,000 employees. In addition to vehicles transiting through the area, these sites generate considerable volumes of traffic. Online shopping is noticeably putting pressure on brick-and-mortar retail (even big-name stores). Desperate attempts are being made to find opportunities for development. Efforts are also underway to secure the future of commercial sites such as the IZ NÖ-Süd, which

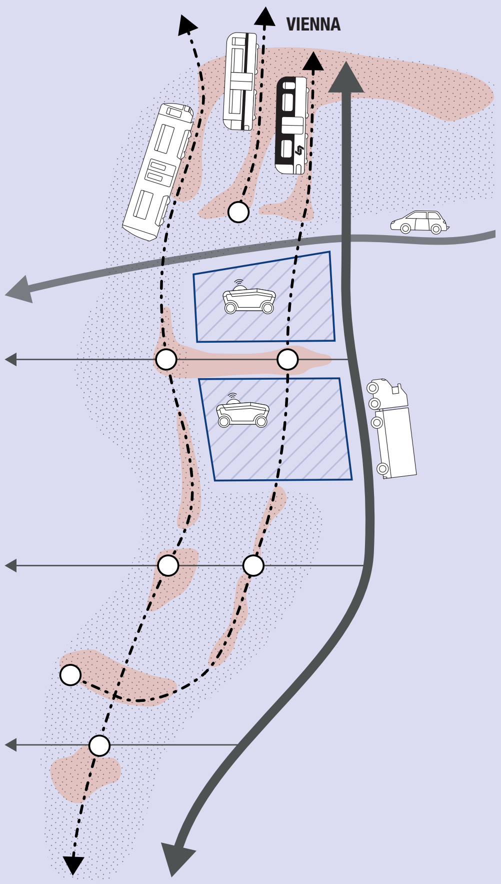
has two road links to the A2 as well as its own on-site depot. Competition between these locations has increased significantly and new logistics chains mean competitors are now abroad as well as at home. The change underway is demonstrated by the growing significance of site factors once considered “soft” (design quality, culinary offering) and, above all, public transport accessibility (cf. IHK 2020; GVA Mödling 2016; Görgl et al. 2017; Statistik Austria 2017, 2019; SUM 2020).

Figure 5: Structural plan of Vienna South with a particular focus on the area surrounding the IZ NÖ-Süd industrial site



Source: the authors

TRANSFORMATION STAGE 1
ON-SITE MOBILITY PLATFORM



The first transformation stage will see IZ NÖ-Süd become a test site for automated mobility. The project will be run by businesses operating on the site as a public-private partnership with the support of public operators (from the province of Lower Austria) and actors from the mobility sector. The aim of this first phase is to meet the different logistic's needs of the businesses on site. Some of the roads on the IZ NÖ-Süd site will be specifically adapted to form a network suitable for automated mobility services (Fig. A3 in the appendix).

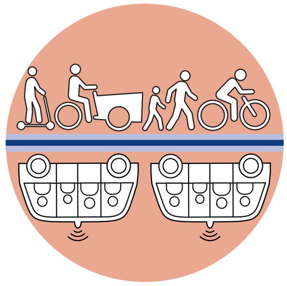
The roads developed for the area assistants will also be adapted for use by pedestrians and cyclists. Pavements and cycling lanes will be separated from the rest of the road and feature an attractive design. The operators of IZ NÖ-Süd will work together with local stakeholders to ensure the location's future. Land at the site's transport links (A2 motorway: Wiener Neudorf exit; IZ NÖ-Süd exit to the Badner Bahn: stops at Griesfeld, Neu Guntramsdorf and at the site's depot) will be secured.

1 PRINCIPLES OF THE VIENNA SOUTH TRANSFORMATION

CA APPLICATION

SITE ASSISTANT

MOBILITY

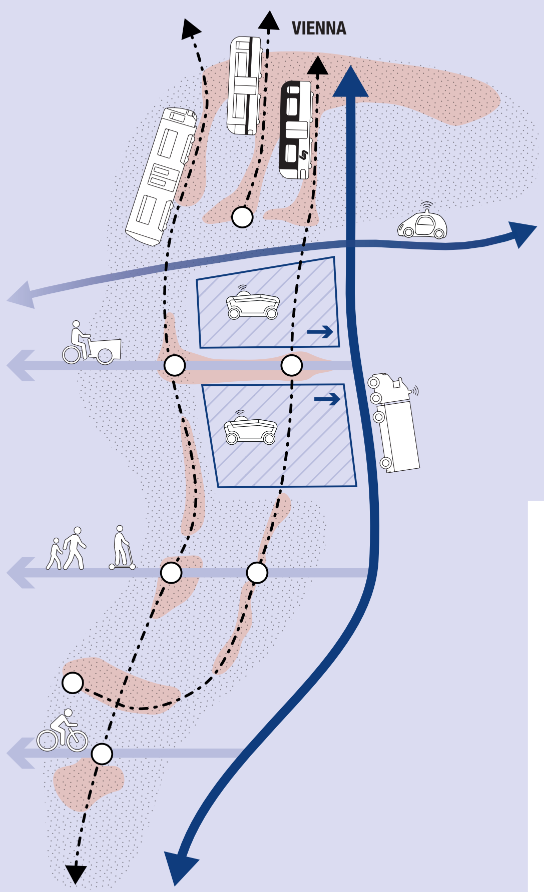


CA SERVICES GO HAND IN HAND WITH SOFT MOBILITY

MOBILITY

LINK CA SERVICES TO OTHER SECTORS

TRANSFORMATION STAGE 2
DESIGNING INTERFACES



The interfaces at the outskirts of the site will now be developed into mobility hubs. It will become possible to offer attractive services, even for workers on site. CA shuttles now transport passengers from the Badner Bahn's stops. An area assistant can now be implemented across the whole of the IZ NÖ-Süd site. Passenger transport will primarily be provided by two automated bus lines that cross the IZ NÖ-Süd site and stop at the mobility hubs (Fig. A3; the existing road network's suitability for automated vehicles was considered, Fig. A2).

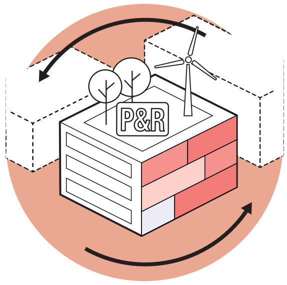
A visible transformation will be underway: more green spaces appear alongside pavements and cycle paths and on old car parks. The site thus becomes more appealing for other sectors. After this phase is complete, the motorway can also be used by automated vehicles. The on-site mobility platform now also enables synergies on the motorway that lead to greater efficiency and less traffic congestion. Companies rethink their approach and instead of offering employees company cars, they provide flexible mobility. The mobility hubs located at motorway junctions are used, similar to port areas, as goods handling spaces and are key interchanges for passenger transport.

2 PRINCIPLES OF THE VIENNA SOUTH TRANSFORMATION

CA APPLICATION

SITE ASSISTANT

MOBILITY



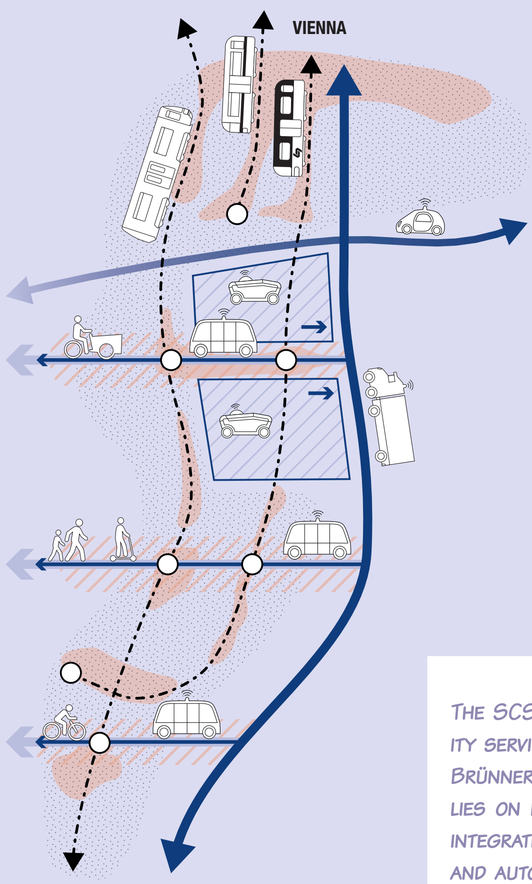
ADAPTABLE MOBILITY HUBS DESIGNED FOR URBAN SPACES

SPACE

CAR-FRIENDLY SITES CLOSE TO THE MOTORWAY BECOME PRIME SITES

TRANSFORMATION STAGE 3

A MOBILITY PLATFORM IS LAUNCHED AND INTEGRATED INTO THE VIENNA SOUTH RIBBON DEVELOPMENT

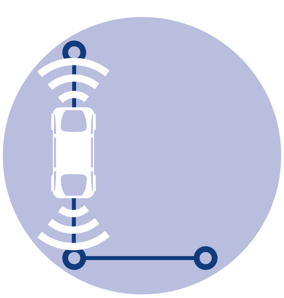


EXPERIENCES GAINED MAKE IT POSSIBLE TO INTEGRATE THE SITE INTO ITS SURROUNDING AREA. IT IS ALSO POSSIBLE TO REDUCE CAR DEPENDENCY IN OTHER LOCATIONS ALONG THE MOTORWAY. REGIONAL TRANSFORMATION OBJECTIVES ARE DEVELOPED JOINTLY WITH THE MUNICIPALITIES IN THE AREA. THE MOBILITY PLATFORM IS TRANSFORMED INTO A PUBLIC INFRASTRUCTURE SERVICE PROVIDER. THE AIM IS TO DEVELOP A REGION WITH CLEARLY ARTICULATED PLANNING GOALS AND IN WHICH A COMPLEX SPATIAL EXPERIENCE CAN BE CAREFULLY DESIGNED.

THE SCS WILL ALSO BE ACCESSIBLE VIA AUTOMATED MOBILITY SERVICES, AS WILL SMALLER BUSINESS SITES ALONG THE BRÜNNER STRASSE AND TRIESTER STRASSE. THE FOCUS NOW LIES ON LINKING PARALLEL LARGE-CAPACITY ROUTES VIA AN INTEGRATED LOCAL TRANSPORT NETWORK (ACTIVE MOBILITY AND AUTOMATED SHUTTLES ARE BEING JOINTLY DEVELOPED). SPACES RECLAIMED FROM PARKED CARS ARE THEN UTILIZED IN A RANGE OF WAYS BY REDESIGNING BROWNFIELD SITES.

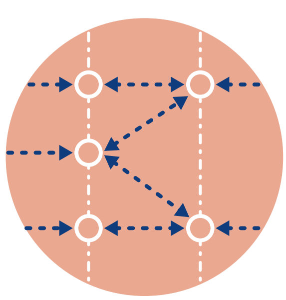
3 PRINCIPLES OF THE VIENNA SOUTH TRANSFORMATION

CA APPLICATION



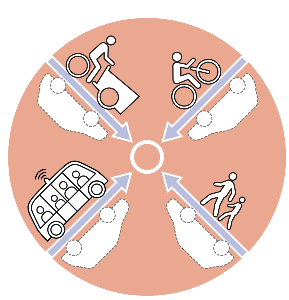
CA SHUTTLE BUS

MOBILITY



CLOSE GAPS BETWEEN TRANSPORT AXES WITH CA SERVICES

MOBILITY



UPGRADE FEEDER ROADS FOR CAV

Development strategy: a clear-cut course

Area types such as Vienna South should be among the first to witness the roll-out of connected and automated vehicles and to show visible signs of how effective the mobility transformation can be. Such sites can be found close to large cities everywhere and are chosen by businesses that are dependent on innovative logistics and are thus constantly moving towards more automation and connectivity. The following planning stages proceed on the assumption that these areas will serve as pioneers and thus play a key role in the transformation of the mobility system.

Discussion and reflection

Vienna South faces considerable volumes of traffic. This is largely a result of commercially successful sites such as IZ NÖ-Süd and the SCS that play a significant role both locally and nationally. These locations will, however, invariably and inevitably be transformed. A new host of characteristics are coming to the fore. Area types such as Vienna South could be the next niche zones from which connected and automated driving takes hold. These locations are thus highly relevant as role models and pilot schemes. The transformation of these areas, either brought about spontaneously or initiated in a targeted manner, will set the course for developments to come. If opportunities to build a transport system around greater sustainability are missed here, all further attempts to do so will face a much steeper uphill climb.

At present, there are hardly any pedestrians or cyclists at these sites. These streetscapes are also barely used as spaces for relaxation (for instance, by workers on their lunch breaks). These areas thus provide an opportunity to test the waters when it comes to new forms of mobility without putting undue strain on the surrounding area. Areas such as Vienna South could also give rise to a public freight transport network or an integrated public transport network for passengers and goods. The valuable experiences of users and operators could be collected. Shifting or pooling types of transport in this way (to avoid unnecessary journeys) can be an important step towards ensuring the competitiveness of these locations while also initiating a sustainable transformation.

5.2 MISTELBACH (AREA TYPE B)

Mistelbach is the capital of a district with the same name and is situated in the north-east of the Weinviertel, Austria's largest winegrowing region. The municipality comprises ten small towns, with five forming the functional centre. The Laaer Ostbahn (S-Bahn lines 2 and 7) provides a direct public transport link to Vienna. In 2015 an additional transport link was created in the east of the city: the A5 motorway is connected via a bypass.

In recent years Mistelbach has grown due to its good transport links and high reserves of building plots. With the targeted redevelopment of brownfield sites, the city aims to consolidate its existing compact and historical buildings. Overall, the settlement structure is developing towards the east in the direction of the motorway (e.g. business park, shopping centre; see Fig. 6).

Challenges

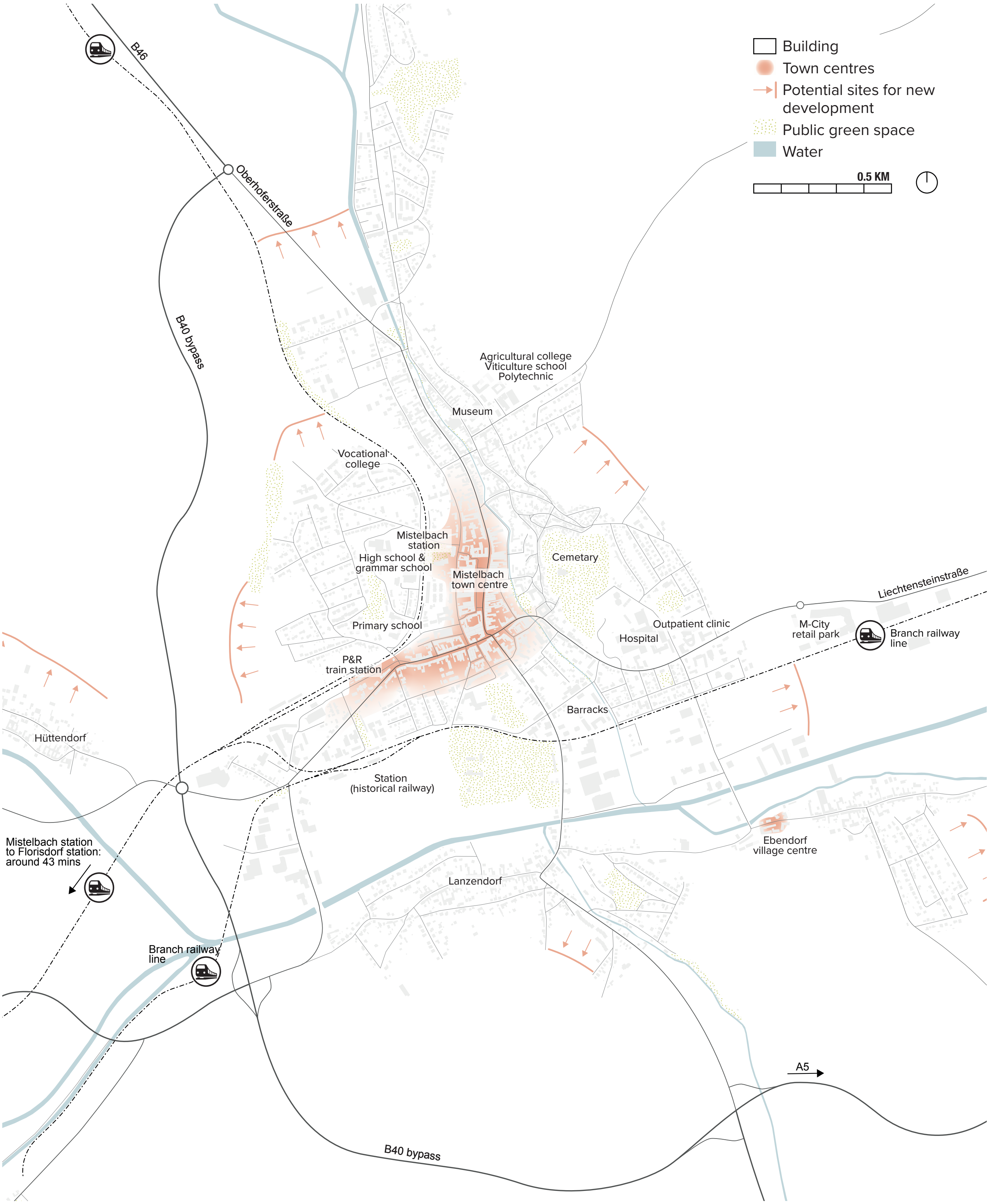
As a centre, Mistelbach fulfils key regional functions for a commuter belt with around 120,000 residents. The town provides shopping, service and administrative functions (for example, it is home to the district court, the regional hospital, and primary and secondary schools). Trains serving the S-Bahn line north of Mistelbach/Zaya station also operate at high frequency, making them attractive for many commuters (trains call at the town's second station, Mistelbach Stadt, less frequently). A branch line runs to the south of the Mistelbach/Zaya train station that once connected Mistelbach with a second district capital, Gänserndorf. Today this line is only used for goods transport and as a historical railway.

The regional bus network is unable to compete with individual transport. Although all key local municipalities are served, the frequency and timing of services are not convenient. Mistelbach's role as a regional centre will be undermined by a new motorway. Since the new junction was opened, commuter numbers (particularly to Vienna) have been rising (Stadt Mistelbach 2014; Statistik Austria 2017, 2019; Görgl et al. 2017).

Development strategy: two key criteria

There is a considerable risk that greater automation along the motorway will mean Mistelbach ceases to function as a regional centre and increasingly becomes a peripheral dormitory town with no specific function. In the case of Mistelbach, avoiding transport means strengthening its position as a centre to avoid as many long journeys to Vienna as possible. To make this a reality, this will involve, on the one hand, connecting the town's key functions and, on the other, improving the region's public transport network.

Figure 6: Structural plan of Mistelbach (Lower Austria)



Source: the authors

TRANSFORMATION STAGE 1

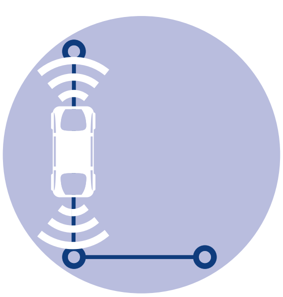
THE FIRST STEP TOWARDS AUTOMATED URBAN TRANSPORT IN MISTELBACH

The first aim of the transformation is to improve the intermodal accessibility of Mistelbach's key functions. An initial line for an automated shuttle, which will run from Mistelbach/Zaya station towards the south along the settlement boundary, is to be developed as a pilot project. This will link a sports and leisure centre, an industrial estate and, lastly, Mistelbach-Gänserndorf regional hospital. Pavements and cycle paths will also be added and/or expanded along the route. The line's terminuses will offer connections to the regional bus network.

To advance the development of the regional public transport network, a search is conducted to find potential sites in and around Mistelbach for an automated shuttle line. This will focus on the train line running towards Gänserndorf but primarily also roads in the town centres that can be made accessible by lowering the permitted speed limit (Fig. A4).

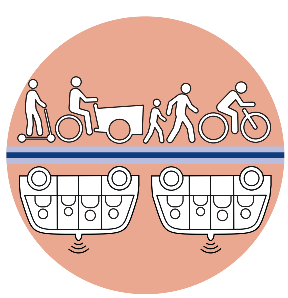
1 PRINCIPLES OF THE MISTELBACH TRANSFORMATION

CA APPLICATION



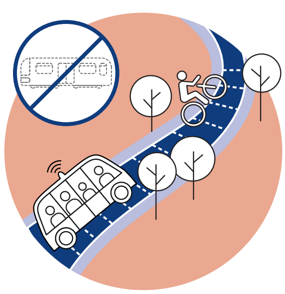
AUTOMATED SHUTTLE BUSES

MOBILITY



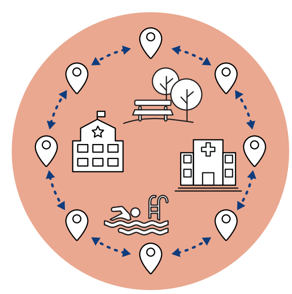
CA SERVICES GO HAND IN HAND WITH SOFT MOBILITY

MOBILITY



BRANCH LINES ARE THE CAV ROUTES OF TOMORROW

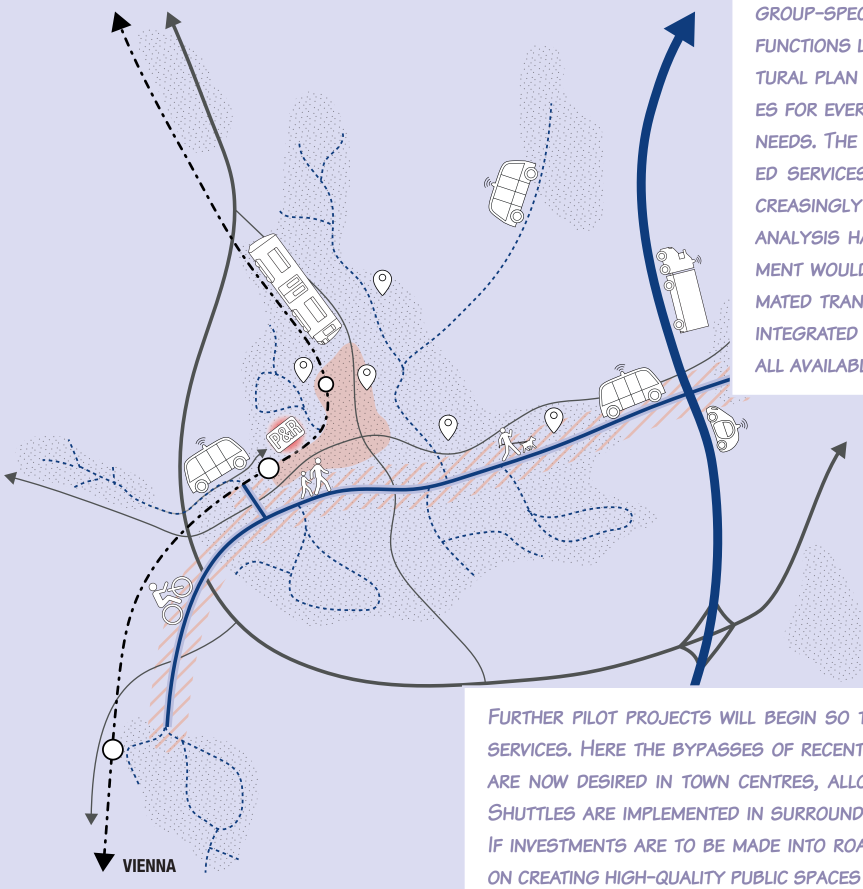
MOBILITY



LINES MUST LINK CENTRAL FUNCTIONS

TRANSFORMATION STAGE 2
FROM PILOT PROJECT TO TARGET GROUP-SPECIFIC EVERYDAY MOBILITY

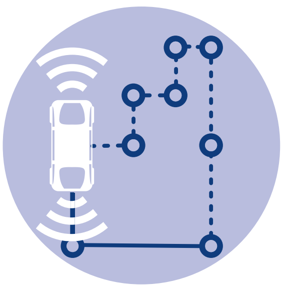
Once experience has been gained via the pilot project and a comprehensive analysis of the infrastructure for potential routes has been conducted, target group-specific services will be developed to access functions located centrally (in Mistelbach, see structural plan in Fig. 6). The aim is to create public services for everyday mobility to cover a range of different needs. The first step entails the expansion of automated services at off-peak times for commuters and increasingly for young people too. The infrastructural analysis has shown that high infrastructural investment would be needed to establish an extensive automated transport network. Work will then begin on an integrated mobility platform that can be used to access all available services.



Further pilot projects will begin so that many residents can experience the new services. Here the bypasses of recent decades come in useful. Lower speed limits are now desired in town centres, allowing a new type of mobility to be trialled. Shuttles are implemented in surrounding municipalities following a rotation plan. If investments are to be made into road infrastructure, then the focus should be on creating high-quality public spaces in town centres. A growing number of functions are linked within Mistelbach's urban zone. The focus is now on the mobility of the town's school pupils and the elderly. The first integrated mobility hubs are created at the train station and the regional hospital.

2 PRINCIPLES OF THE MISTELBACH TRANSFORMATION

CA APPLICATION

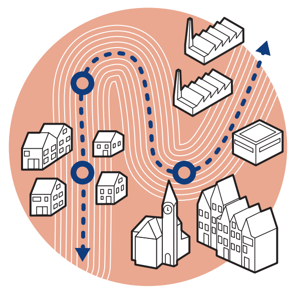


AUTOMATED SHUTTLE BUSES

MOBILITY

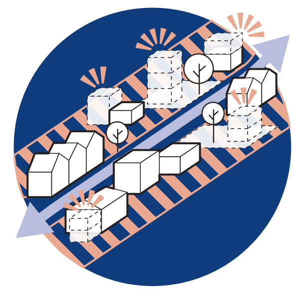
LINK CA SERVICES TO OTHER SECTORS

MOBILITY



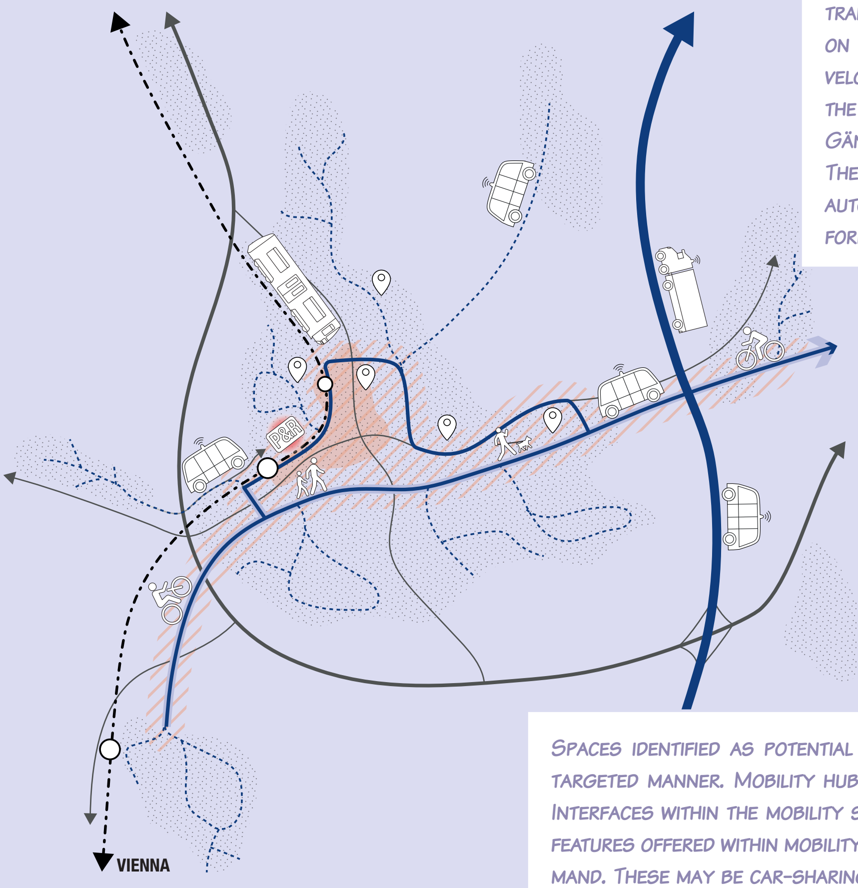
LINE PLANNING SENSITIVE TO ADJACENT ACTIVITIES

SPACE



CA SERVICE CATCHMENT AREAS WITH HIGH DEVELOPMENT POTENTIAL

TRANSFORMATION STAGE 3
REGIONAL TRANSIT IN MISTELBACH

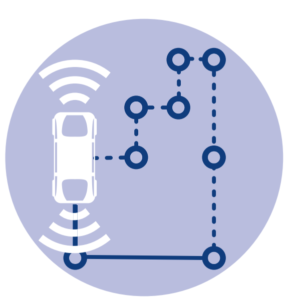


A REGIONAL DEVELOPMENT CONCEPT IS CREATED. THE MUNICIPALITIES NOT ONLY DEVELOP A JOINT PUBLIC TRANSPORT SERVICE BUT PLEDGE TO ALSO EMBARK ON A RADICAL LAND POLICY. THIS INVOLVES THE DEVELOPMENT OF AUTOMATED SERVICES RUNNING ON THE MOTORWAY TO PROVIDE EXPRESS ROUTES TO GÄNSERNDORF, LAA AN DER THAYA AND HOLLABRUNN. THE ENHANCED TECHNOLOGICAL POSSIBILITIES OF AUTOMATED DRIVING SYSTEMS NOW MAKE IT MORE AFFORDABLE TO DESIGN SUCH ROUTES.

SPACES IDENTIFIED AS POTENTIAL SITES ARE PRIORITIZED AND DEVELOPED IN A TARGETED MANNER. MOBILITY HUBS ARE INTEGRATED INTO EXISTING FUNCTIONS. INTERFACES WITHIN THE MOBILITY SYSTEM HELP BOOST CENTRAL LOCATIONS. THE FEATURES OFFERED WITHIN MOBILITY HUBS WILL DEPEND ON THE LOCATION AND DEMAND. THESE MAY BE CAR-SHARING SERVICES FOR LEISURE MOBILITY, ESPECIALLY AT WEEKENDS, AS WELL AS E-SCOOTER AND BICYCLE HIRE.

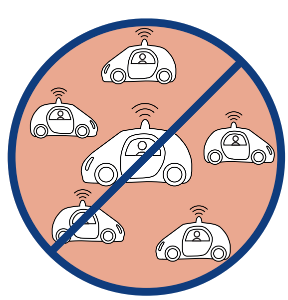
3 PRINCIPLES OF THE MISTELBACH TRANSFORMATION

CA APPLICATION



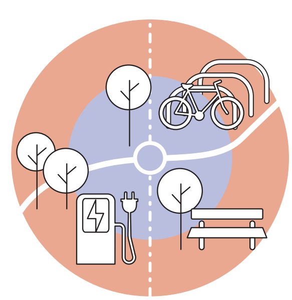
AUTOMATED SHUTTLE BUSES ON ROUTES AND ROADS

MOBILITY



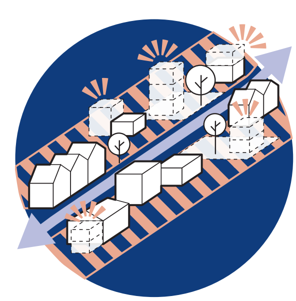
CA SERVICES ONLY IN CERTAIN AREAS

MOBILITY



PUBLIC TRANSPORT HUB AREAS SHOWCASE SERVICES

SPACE



CA SERVICE CATCHMENT AREAS WITH HIGH DEVELOPMENT POTENTIAL

Discussion and reflection

Automated driving on a motorway could put immense strain on a regional centre such as Mistelbach. If more affordable, comfortable journeys are possible on large-capacity roads, smaller retail entities, leisure facilities and other establishments will have to contend with greater competition. Mistelbach's expansive commuter belt will likely hinder the large-scale roll-out of automated vehicles in the longer term. The pathway proposed in this paper is focused on allowing as many people as possible to experience mobility in a new way. If there is a sense that everyday journeys to important functions in Mistelbach can be easily completed without a car, this would be a crucial step. This case study once again demonstrates just how vital it is to generate intensive cooperation between a highly diverse range of actors.

5.3 EBREICHSDORF (AREA TYPE C)

The town of Ebreichsdorf is located in the district of Baden roughly 25 kilometres to the south of Vienna. The municipality comprises four small towns (Fig. 7). Mobility in this area is largely concentrated on routes towards Vienna: 80% of the working population commutes, with 50% travelling to the Austrian capital. Ebreichsdorf has two main regional transport links to Vienna: the A3 southeast motorway and the Pottendorfer S-Bahn line. The Pottendorfer line, which offers travellers a link to Austria's eastern railway line towards Hungary, passes through Unterwaltersdorf; however, passenger transport has been suspended on this line. Ebreichsdorf's city bus network connects the town with the other cadastral communities of Schranawand, Unterwaltersdorf and Wegelsdorf.

Challenges

As it is situated close to Vienna and has good transport links to other parts of the country, the region is an attractive location for companies from all sectors. Ebreichsdorf is home to four large and several small industrial estates. The area's economy is structured around small- and medium-sized craft and industrial companies, as well as service providers. Business traffic sometimes passes through the centre of towns and localities.

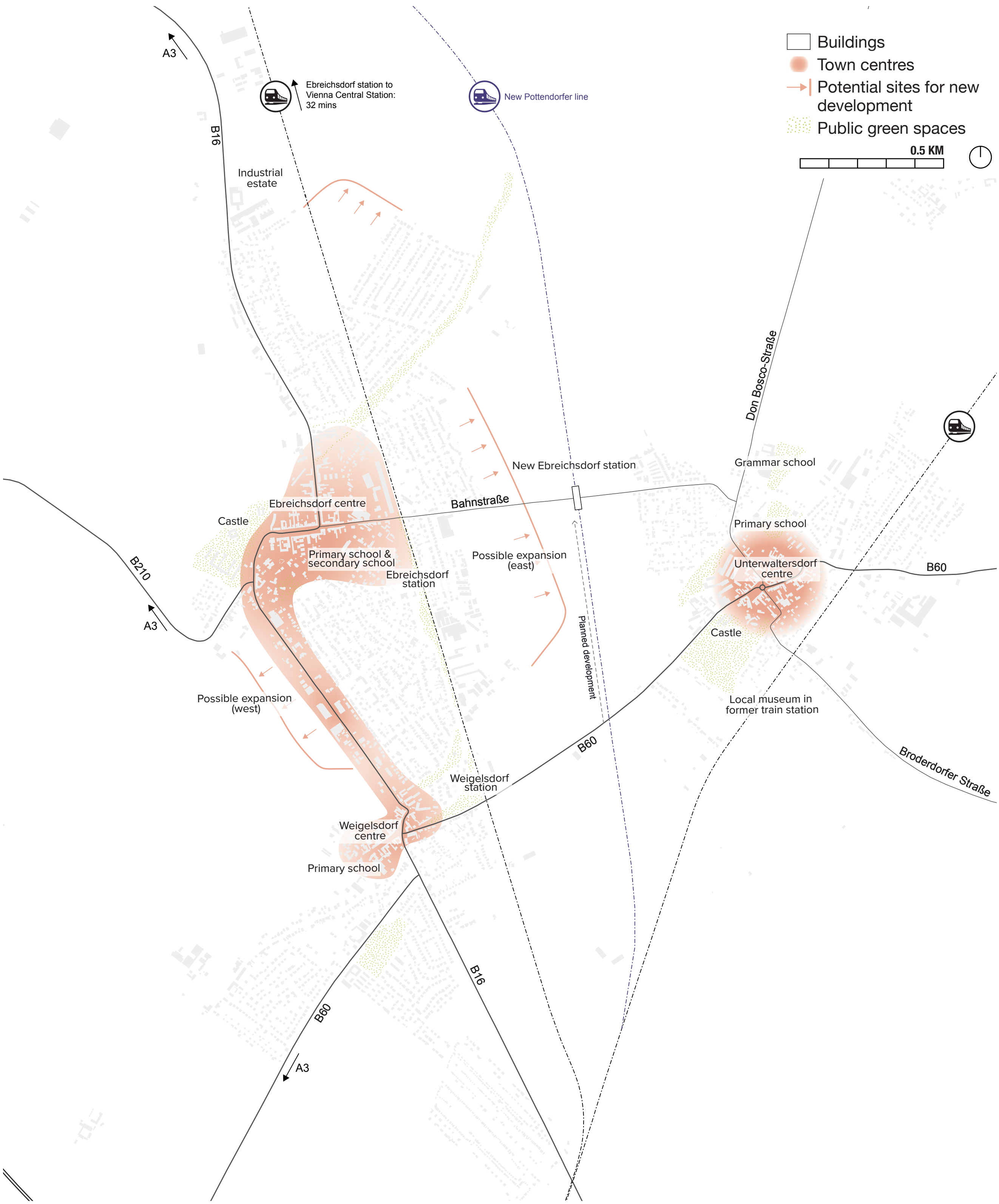
Ebreichsdorf is also a popular residential town. For years, its population has grown at a faster than average pace for Lower Austria. Settlements in the area largely comprise single-family homes. What little dense housing there is tends to be concentrated around the town centre and along the B16 road to Vienna. Key services are located here, including for residents living in the area around Ebreichsdorf. Along with the expansion of the Pottendorfer line, there are plans for the specific development of Ebreichsdorf. As a satellite town close to Vienna, some of the projected urban growth is to be realized close to public transport links (Görgl et al. 2017; Stadtgemeinde Ebreichsdorf 2014; Statistik Austria 2017, 2019).

Development strategy: Strengthening the development of existing structures with lively streets

In Ebreichsdorf, the first stage of the transformation has already begun. The Pottendorfer line is currently being expanded and should be finished by 2023. A large section will run on a new line roughly one kilometre further east. As part of this, Ebreichsdorf train station will be moved from its current central location to a greenfield site, which will also improve the link between the Pottendorfer line and Unterwaltersdorf. The former train station and rail line running through Ebreichsdorf will be closed down. Once it has been decommissioned, this railway line will have major potential for other uses.

The expansion and construction of the train line aims to accelerate growth and elevate Ebreichsdorf to a central hub in the area south of Vienna. The Ebreichsdorf Smart City project has also looked at different ways to integrate the new train station and future settlement development by drawing up a range of potential scenarios. This urban planning decision will initially mean a loss in public transport access for Ebreichsdorf town centre (the considerable drop in services is shown in Fig. A5 between transformation stages 0 and 1).

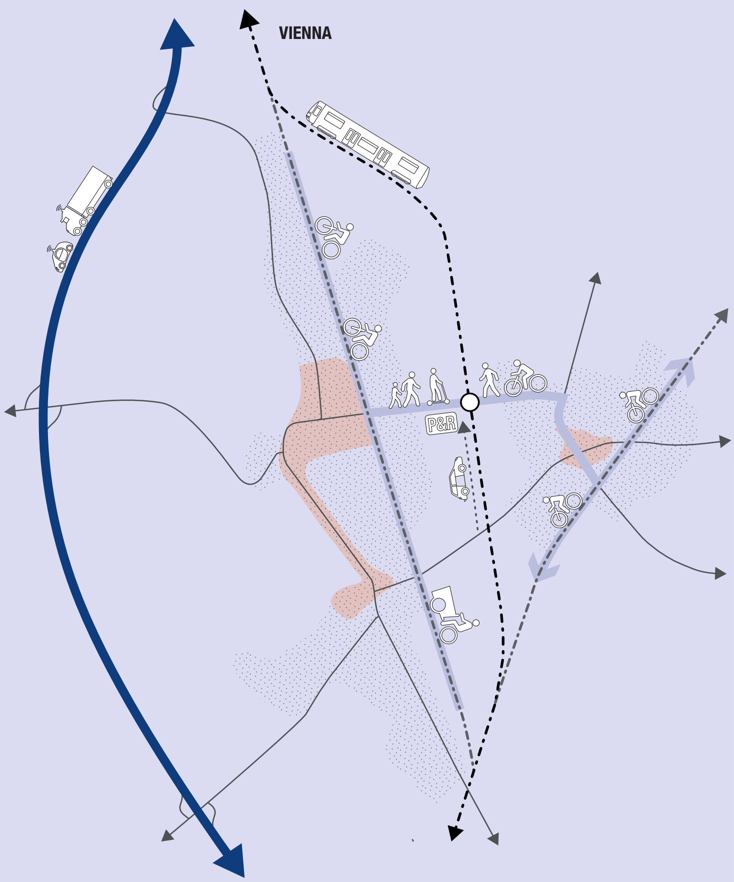
Figure 7: Structural plan of Ebreichsdorf (incl. new train station)



Source: the authors

TRANSFORMATION STAGE 0

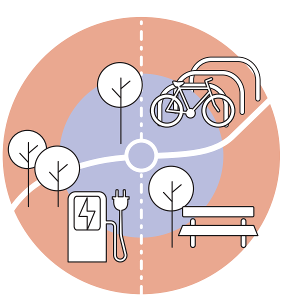
PREPARATION WHILE THE NEW STATION IS BUILT



THE NEW STATION IS BEING BUILT TO SERVE AN AREA WITH A RADIUS OF ROUGHLY 25 KILOMETRES. A PARK-AND-RIDE SITE IS CURRENTLY STILL NECESSARY BUT WILL BE DESIGNED SO THAT IT CAN BE REMOVED AT A LATER DATE. IT WILL PLAY A ROLE DURING THE ENTIRE TRANSFORMATION PROCESS BUT ITS FUNCTION WILL CONSTANTLY BE CHANGING. THE FRONT OF THE TRAIN STATION WILL MAINLY BE DESIGNED AROUND THE NEEDS OF THOSE USING ACTIVE FORMS OF MOBILITY. THIS CONCERNS THE PROXIMITY OF PARKING SPACES (OR E-BIKE CHARGING STATIONS) TO THE PLATFORM, THE ROUTE BETWEEN THE TWO AND THE ATTRACTIVE DESIGN OF APPROACH ROADS FOR CYCLISTS AND PEDESTRIANS, WHICH WILL FEATURE AN ABUNDANCE OF LIGHTING AS WELL AS GREENERY TO OFFER PROTECTION FROM THE ELEMENTS. PAVEMENTS AND CYCLE PATHS WILL BE BUILT ON A SEPARATE LANE.

0 PRINCIPLES OF THE EBREICHSDORF TRANSFORMATION

MOBILITY

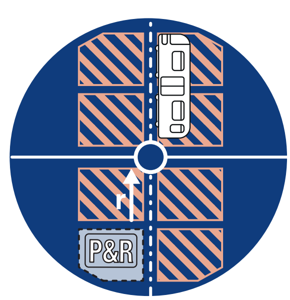


PUBLIC TRANSPORT HUB AREAS SHOWCASE SERVICES

MOBILITY

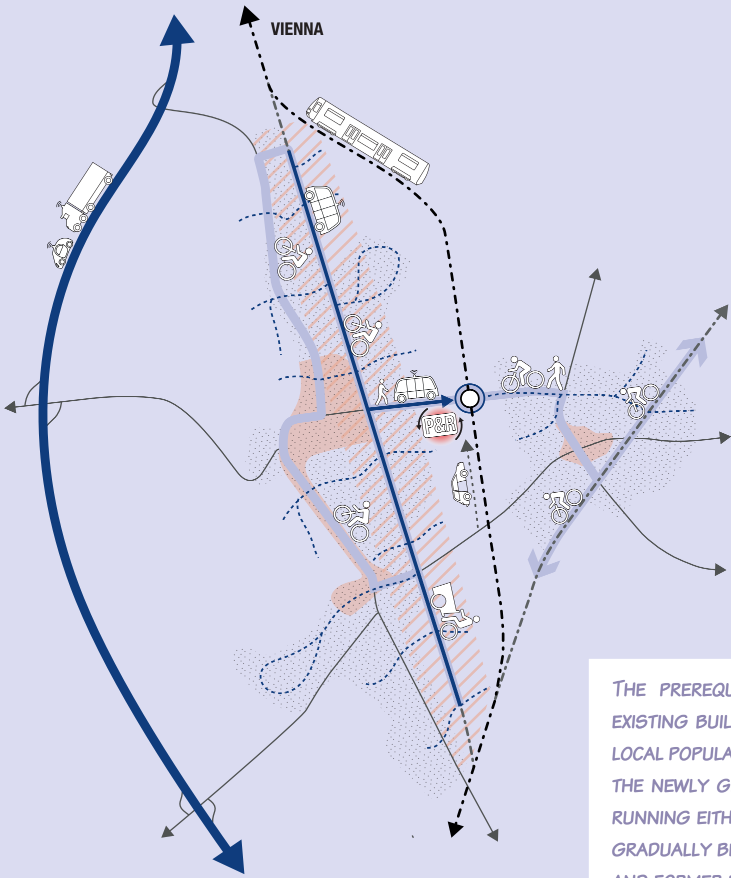
CLEAR PRIORITIZATION OF SOFT LOCAL MOBILITY AT PUBLIC TRANSPORT HUBS

SPACE



SECURE AREAS AROUND PUBLIC TRANSPORT HUBS FOR FURTHER DEVELOPMENT

TRANSFORMATION STAGE 1
THE FIRST INTEGRATED CA ROUTE IS BUILT

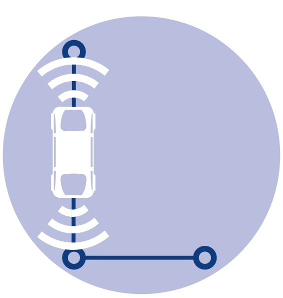


Transformation stage 1 will see the use of automated shuttles made possible through targeted infrastructure development, and infrastructural requirements for active forms of mobility will also be improved. CA shuttles will start operating on the approach road from the Ebreichsdorf area to the new station. Close to the old station, the access road will cross the disused railway line, which traverses the entire Ebreichsdorf residential area from north to south. There will also be integrated development on the route to allow active mobility and CA shuttles. In the town itself, microhubs will be built along the access road and the old railway line that serve as bridges connecting previously separated residential areas to the west and east of the railway.

The prerequisites for the targeted development of existing buildings are thus in place: together with the local population, concepts will be created detailing how the newly generated potential can be used. The roads running either side of the old railway embankment will gradually be turned into a linear park. Selected vacant and former parking spaces along the Rechte Bahnzeile road will be secured for future development.

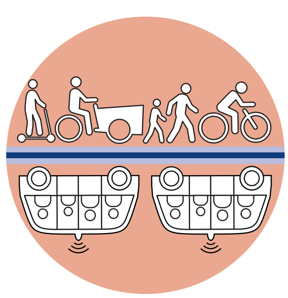
1 PRINCIPLES OF THE EBREICHSDORF TRANSFORMATION

CA APPLICATION



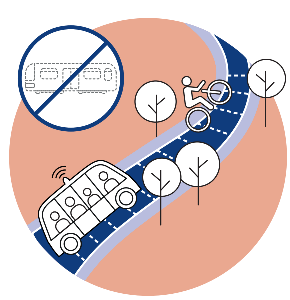
AUTOMATED SHUTTLE BUSES OPERATING ON ROUTES

MOBILITY



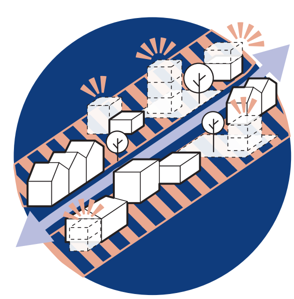
CA SERVICES GO HAND IN HAND WITH SOFT MOBILITY

MOBILITY



BRANCH LINES ARE THE CAV ROUTES OF TOMORROW

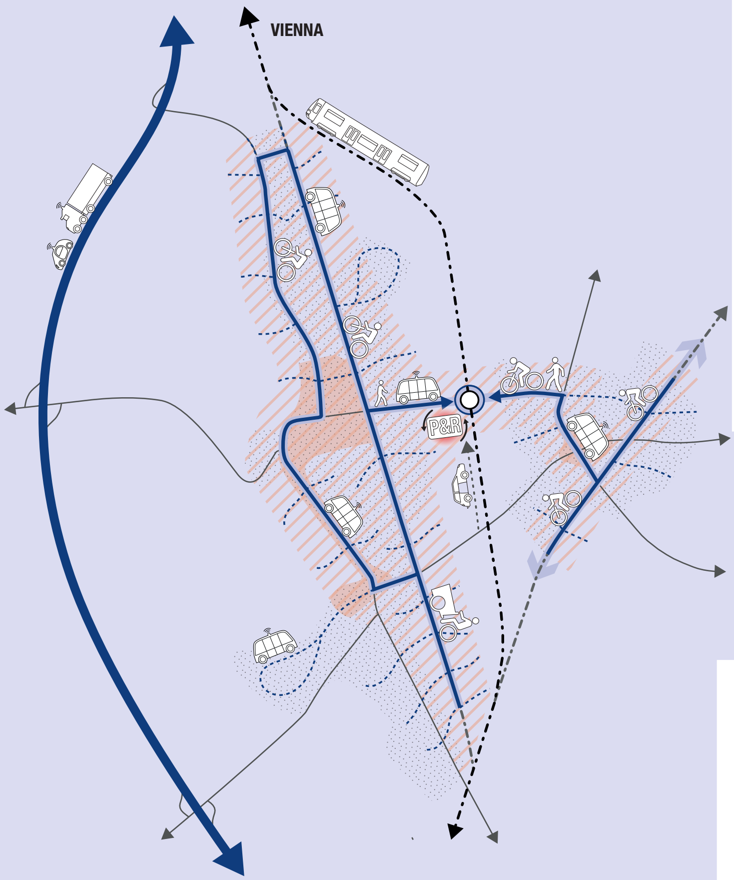
SPACE



CA SERVICE CATCHMENT AREAS WITH HIGH DEVELOPMENT POTENTIAL

TRANSFORMATION STAGE 2

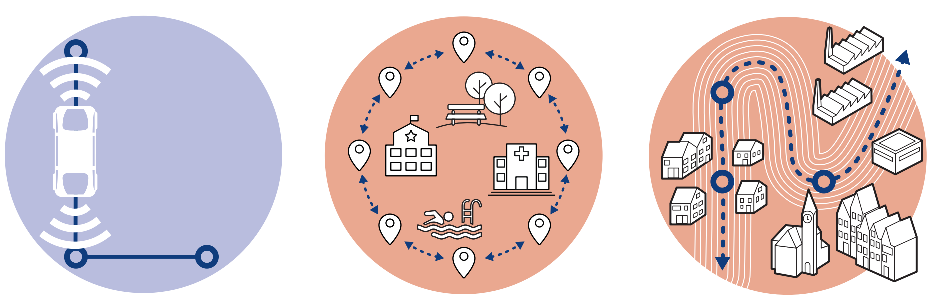
FROM PASSENGER MOBILITY TO INTEGRATED LOCAL TRANSPORT



Ongoing technological developments and municipalities' experiences of running CA shuttles will give rise to new opportunities to boost existing centres and sites via improved transport links. CA shuttles will take over a large part of the city bus network, which will then only serve peripheral urban areas. An evaluation of the existing road network's suitability will be used to plan routes. This will allow the frequency and timing of services to be vastly improved. Once the CA shuttle is operating on Ebreichsdorf's main square, space here will also be reclaimed from cars and allocated to active forms of mobility. High-quality public space will also be created.

During this stage of the expansion, the system will shift from simply transporting passengers (i.e. enabling commuter traffic) to a local public transport and active mobility network for people and goods. Local operators will benefit from being able to offer their customers mobility services. A participatory process will be used to turn existing concepts for local development planning into a polycentric vision that integrates all the cadastral municipalities.

2 PRINCIPLES OF THE EBREICHSDORF TRANSFORMATION

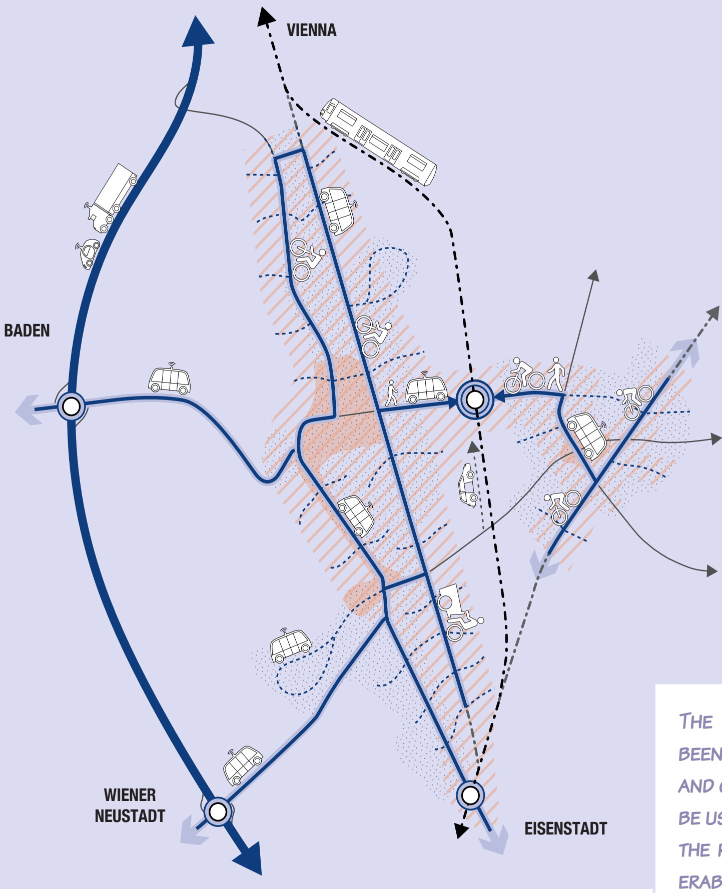


AUTOMATED SHUTTLE BUSES OPERATING ON ROUTES

LINES MUST LINK CENTRAL FUNCTIONS

LINE PLANNING SENSITIVE TO ADJACENT ACTIVITIES

TRANSFORMATION STAGE 3
A REGIONAL CONCEPT

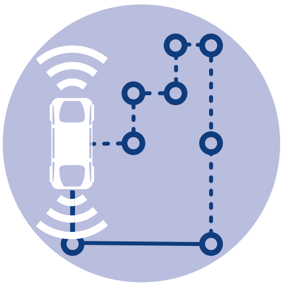


The CA shuttle network will be further expanded and serve almost all of the residential area, similar to the former city bus network but with a much improved service. Peripheral sites will have access to a CA ring-and-ride taxi service. An intricate, integrated local transport network for active mobility and CA shuttles is now a reality. It will be used for shopping and leisure journeys made by tourists, school-children and commuters as well as by local businesses. Unlike cars, automated vehicles only run in certain parts of the road network.

The park-and-ride site at the train station has now been almost fully repurposed. It now hosts business and office spaces; a range of sharing services can also be used. The next step is the polycentric development of the region, which will help relieve some of the considerable traffic flows towards Vienna. For this purpose, a joint regional development concept will be drawn up with Baden, Wiener Neustadt and Eisenstadt.

3 PRINCIPLES OF THE EBREICHSDORF TRANSFORMATION

CA APPLICATION

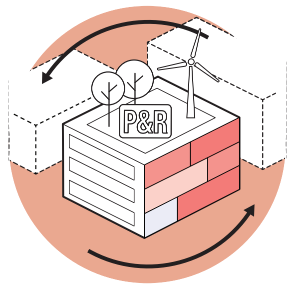


AUTOMATED SHUTTLE BUSES ON ROUTES AND ROADS

MOBILITY

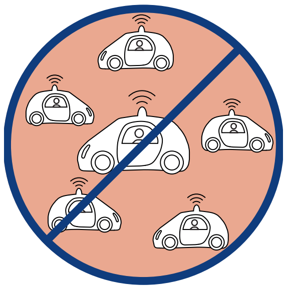
LINK CA SERVICES TO OTHER SECTORS

MOBILITY



ADAPTABLE MOBILITY HUBS DESIGNED FOR URBAN SPACES

MOBILITY



CA SERVICES ONLY IN CERTAIN AREAS

Discussion and reflection

Ebreichsdorf is already a municipality comprehensively engaged in shaping its future. The strategic planning narratives presented in this paper demonstrate the multitude of options that exist to reduce car dependency. Figure A5 (see Appendix) shows the shift in areas accessible by public transport during the various phases of this transformation. Furthermore, at the end of the process we have set out here, large areas of the municipality (including the cadastral communities) will have access to a network of high-quality streetscapes that are inviting spaces for walking and cycling and served by automated shuttles.

We can once again see that comprehensive cooperation is essential for the success of a transformation process of this kind as well as the ability to transfer the model to other areas. The technology behind automated shuttles is demystified and becomes one of many building blocks. Above all, committed action needs to be taken by a range of actors, the local population must be involved early on and, most notably, the shared view must be held that the pressures caused by the climate crisis represent this century's biggest challenge in terms of mobility and settlement development.

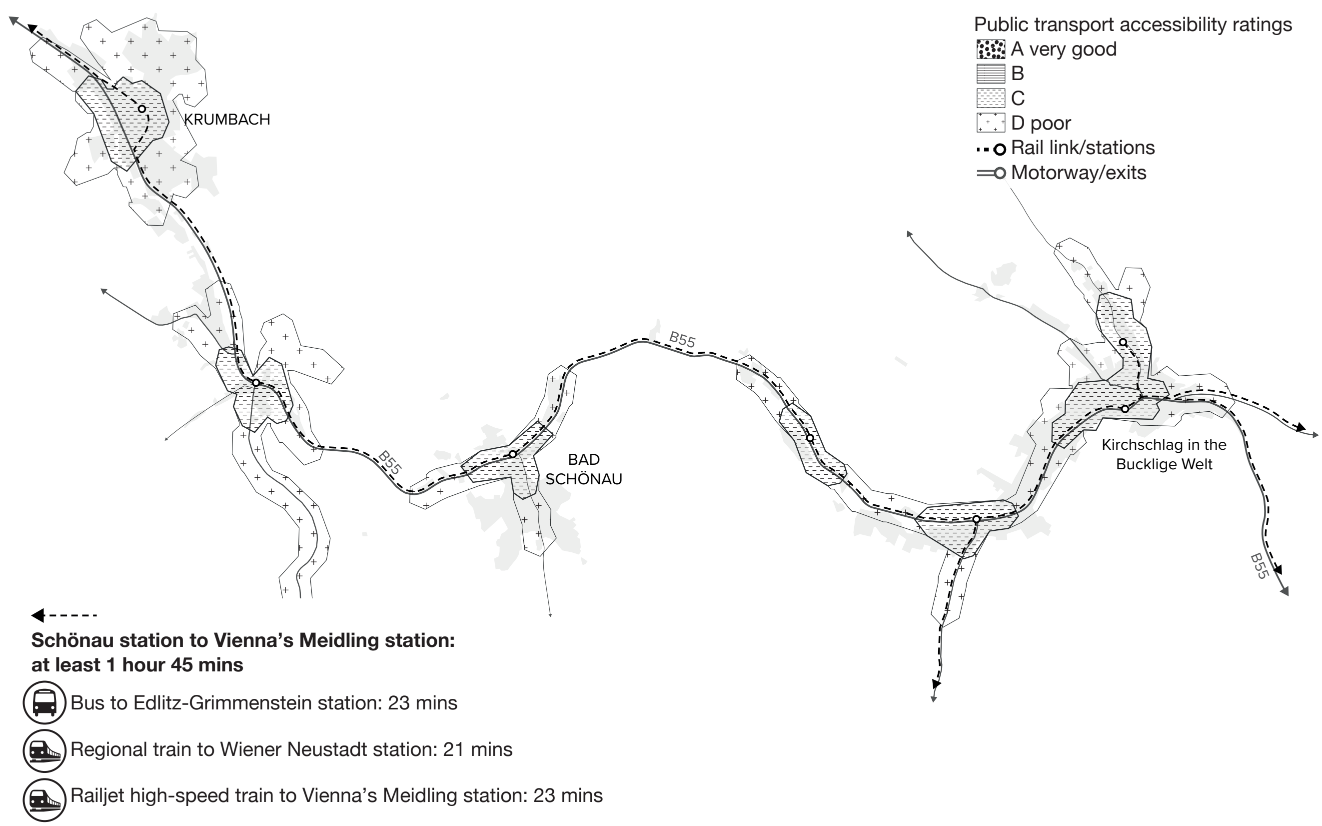
5.4 BAD SCHÖNAU (AREA TYPE D)

Bad Schönau is a small spa town in the south-eastern part of the Industrieviertel, a historically industrial region of Lower Austria that borders Burgenland and Styria. The dispersed municipality comprises seven villages, only two of which currently have more than 50 inhabitants. With just under 500 inhabitants, Bad Schönau is by far the largest. The few central functions that exist are located in Bad Schönau. Residents often travel outside of the municipality to nearby localities such as Krumbach and Kirchschlag to use local amenities as well as welfare and educational institutions.

There is no public transport service that covers the whole region. Vienna can be reached by car in roughly one hour. Residents in the region are thus highly dependent on motorized private transport. Regional buses only run along the B55 federal highway. One of the stations of the Aspangbahn train line can be reached by bus in roughly 20 to 40 minutes. However, these stations do not offer a frequent service (see Fig. 8). With tourism in mind, Austria's Bucklige Welt region is looking to develop services for e-bikes.

As a spa town, tourism is the dominant industry in the region. Several healthcare facilities are located at the outskirts of the municipality. The majority of jobs in Bad Schönau are either directly or indirectly reliant on tourism. The high number of overnight stays (over 200,000 per year, 550 per day) slightly surpasses the number of residents. Population growth in the municipality has been stagnant for a number of years and is now starting to fall in some areas (Kurgemeinde Bad Schönau 2020; Statistik Austria 2017, 2019).

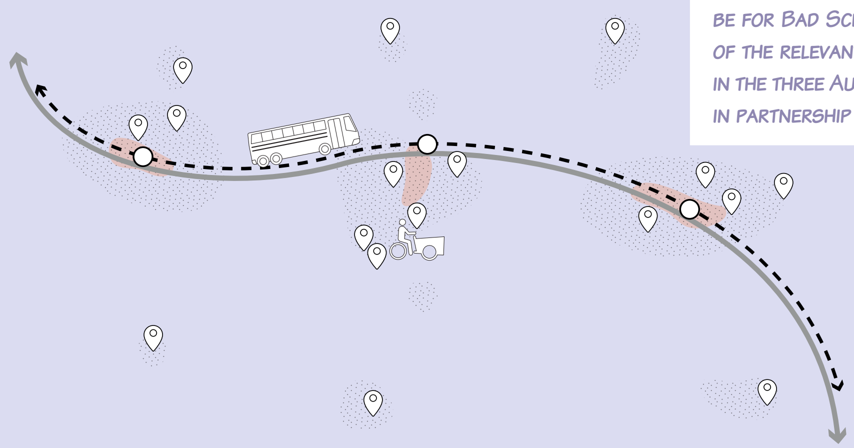
Figure 8: Public transport accessibility in and around Bad Schönau



Graphic: Michael Gidam and Lucia Paulhart

TRANSFORMATION STAGE 1
MOBILITY IN THE "SHARED BUCKLIGE WELT REGION"

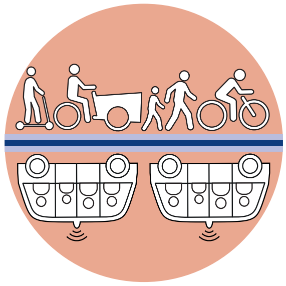
During the first phase of transformation, it is not transport automation but connectivity that plays a role in this area type. Ongoing efforts within the context of the shared Bucklige Welt region to boost connectivity continue while the objective remains to integrate the various transport services on offer into a single platform. This mobility platform would not only be for Bad Schönau but cover the entire region. Many of the relevant transport and spatial planning actors in the three Austrian states involved have been working in partnership to make this a reality.



While other areas are already testing automated vehicles, Bad Schönau is focused on helping children and young people become familiar with alternatives to individual transport. The automated shuttle's potential as a marketing tool for tourism in the area has been recognized and efforts are being made to launch a project that would take advantage of this opportunity.

1 PRINCIPLES OF THE BAD SCHÖNAU TRANSFORMATION

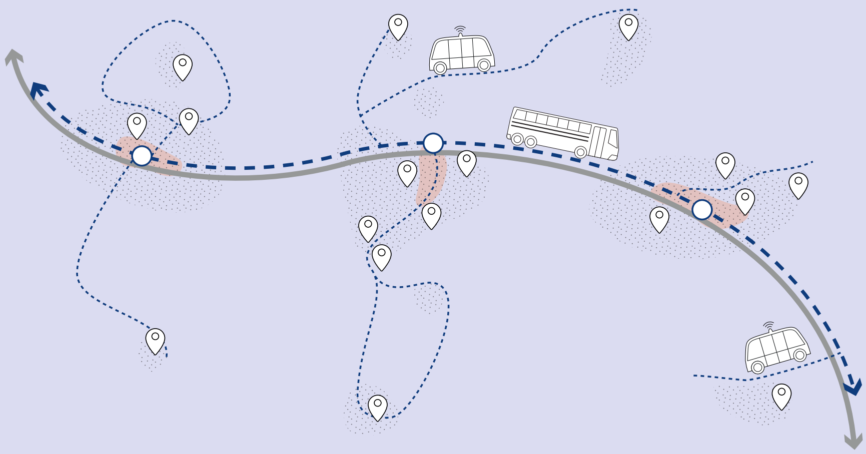
MOBILITY



CA SERVICES GO HAND IN HAND WITH SOFT MOBILITY

TRANSFORMATION STAGE 2
AUTOMATED TOURIST MOBILITY

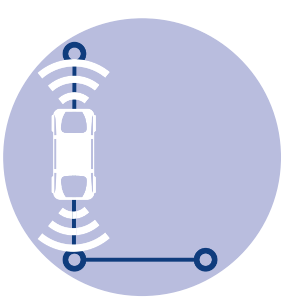
A mobility concept is developed together with other municipalities in the Bucklige Welt. An initial automated mobility project is launched in Bad Schönau: a dial-a-bus service will run between health resorts and other tourist sites in the town centre. Tailor-made services will also be developed for specific tourist segments.



Cycling will continue to remain popular on the quiet roads in the Bucklige Welt but will now be joined by shuttles, e.g. carrying passengers to restaurants located away from the town. There will also be improved links to the Aspangbahn, which will see more frequent (at this point, non-automated) services along the area's secondary road.

2 PRINCIPLES OF THE BAD SCHÖNAU TRANSFORMATION

CA APPLICATION

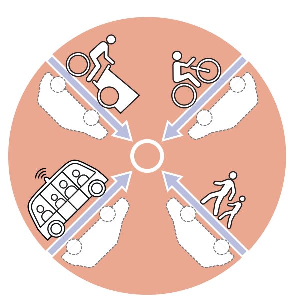


AUTOMATED SHUTTLE BUSES OPERATING ON ROUTES

MOBILITY

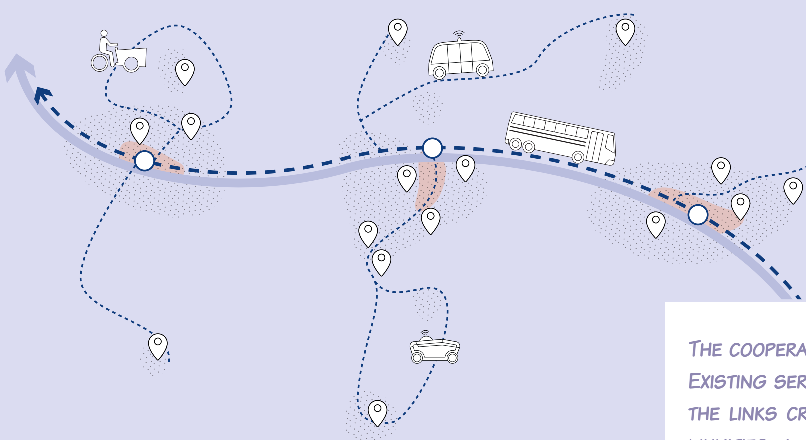
LINK CA SERVICES TO OTHER SECTORS

MOBILITY



UPGRADE FEEDER ROADS FOR CAV

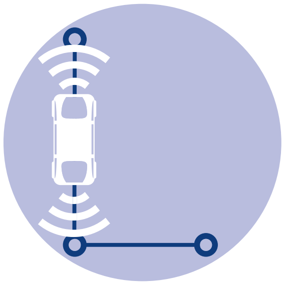
TRANSFORMATION STAGE 3
CONNECTION TO REGIO-TRANSIT WIENER NEUSTADT



The cooperation between regions is developed further. Existing services and initiatives are merged. Similar to the links created for Mistelbach's surrounding communities, a transport link is established between Bad Schönau and the regional centre of Wiener Neustadt. As well as tourists in the region, the improved accessibility now also increasingly benefits local residents. The regions' mobility platforms are merged to form a single system that can be used for all conceivable journeys. To counteract the increased accessibility of remote residential areas, a rigorous land policy will be implemented.

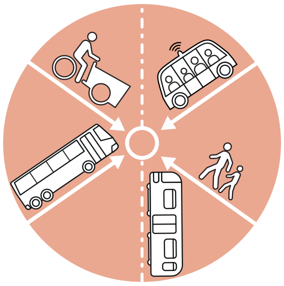
3 PRINCIPLES OF THE BAD SCHÖNAU TRANSFORMATION

CA APPLICATION



AUTOMATED SHUTTLE BUSES OPERATING ON ROUTES

MOBILITY



SAFEGUARD ACCESS TO WIDER PUBLIC TRANSPORT HUBS

MOBILITY

LINES MUST LINK CENTRAL FUNCTIONS

SPACE

CA SERVICE CATCHMENT AREAS WITH HIGH DEVELOPMENT POTENTIAL

Discussion and reflection

The example of Bad Schönau, with its 500 residents, raises the question of where and at what stage it is wise to implement automated mobility services. This has only partly been answered with the acknowledgement that the first transformation stage could be implemented without any automation, but this may not necessarily be the case for other, larger tourist centres. In fact, the opposite may be true. This is because potential users, who visit for leisure or during holidays, tend to prefer new experiences, and this interest in the unfamiliar could also be used to boost automated driving within the context of transforming mobility. Local recreational activities are now far more popular as a result of the Covid-19 pandemic, which is why this approach could become more relevant, not only in terms of tourism but also, at a later stage, to improve the mobility options for populations living in similarly peripheral areas.

6. CONCLUSION

This explorative case study has shown that connected and automated vehicles – if they are to be instrumental in bringing about a mobility transformation – do not always have to be implemented according to the same rules or a general set of principles; instead, it is vital to understand the backdrop to, and motivating factors behind, the technology's application. This requires a bottom-up approach to the implementation of connected and automated vehicles. If these vehicles can be rolled out in a manner that addresses local problems and challenges, this will also increase the probability that the mobility system will be transformed sustainably.

The narratives playing out in the various area types and during the stages of transformation demonstrate that ambitious planning processes are required if a transformation towards a service-oriented, sustainable mobility model is ultimately to succeed in a wide range of spatial contexts. Our analyses give examples of specific planning requirements that will be essential in various transport and spatial scenarios.

Such a transformation requires the necessary patience to prepare and set in motion the desired change based on the technological requirements and (local) acceptance. Even if, for instance, automated commercial/internal mobility management or tourist mobility services initially appear to have hardly any quantifiable transformational effect, they could provide an opportunity to gain initial experience with service-oriented automated transport and thus form the basis for the wider application of such services as part of everyday mobility. Ultimately, our exploratory analysis of each of the four area types has resulted in a final transformational stage that is designed around a holistic mobility system and connected and automated vehicles that can be meaningfully implemented into the existing mobility offering (MaaS). At the end of this transdisciplinary process, we can pinpoint the following dynamics that are shared by all area types:

- Transformation stage 1: Problem-oriented, target group-specific and spatially confined pilot projects allow initial experiences with CAT to be gained.
- Transformation stage 2: CAT projects are met with widespread support and acceptance for the respective activity. As the technology continues to improve, services become more entrenched and spread to other areas and are also applied in other fields.
- Transformation stage 3: The services appeal to a wider range of target groups and can be expanded to serve new catchment areas. They integrate existing mobility systems such as public transport, active mobility and sharing services.

The initial steps to bring about each stage of these development plans are made in the respective area types by various groups of actors (large-scale industry and trade, the municipalities, the regions and the tourism industry). However, an intensive cooperation with policy planning actors will be required at least by transformation stage 3. This collaboration should ideally take place as early as possible. Preparations can be made for measures, such as the integration of a range of mobility services and/or providers into a single fare system and the creation of a shared mobility platform, without the need to wait for developments in vehicle technology.

All four case studies outlined here demonstrate that CAT cannot be seen as the silver bullet that can resolve every issue. Contrary to initial expectations, the technology will only have a positive effect in some areas. If CAT is to contribute to the transport/mobility transformation, automated mobility services must then be meaningfully combined with other public transport services as well as active forms of mobility. Finally, it is hoped that this case study will encourage the necessary plans (processes, decisions, analyses to identify potential for action) to be undertaken in a range of spatial contexts today. CAT will not be capable of initiating an ecologically sustainable transport and mobility revolution all by itself. Bringing major change to transportation seems to be an almost impossible task, especially in rural areas. Only if there is a shared interest among a wide range of actors to develop CAT not as an end in itself but as part of a high-quality public transport system that meaningfully complements active forms of mobility and optimally integrates a range of transport services, does there remain a pathway to revolutionizing transport. In this context, local actors should also be given greater and more comprehensive powers to develop new forms of cooperation with regard to new mobility and take subsequent steps together and decisively

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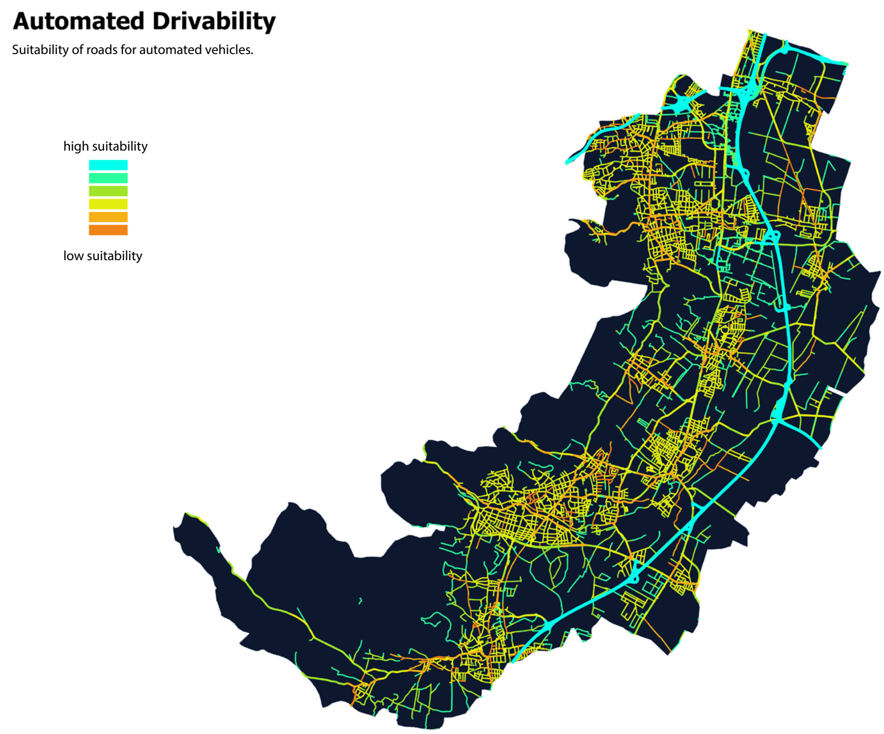
APPENDIX

Figure A1: Participants in the focus groups

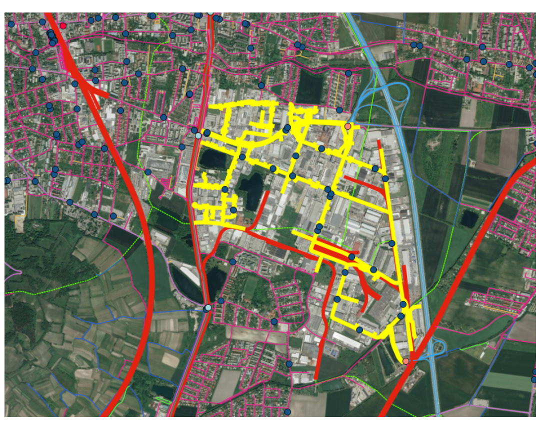
Daniela Allmeier	TU Wien, future.lab Research Center and Research Unit of Local Planning
Ian Banerjee	TU Wien, future.lab Research Center and Center of Sociology
Martin Berger	TU Wien, Transport System Planning Research Unit (MOVE)
Willem Brinkert	Zukunftsorte Munderfing
Emilia Bruck	TU Wien, future.lab Research Center and Research Unit of Local Planning
Jens S. Dangschat	TU Wien, Center for Sociology
Oliver Danninger	Lower Austrian State Parliament, head of regional planning and transport
Britta Fuchs	NÖ regional, Industrieviertel mobility management
Michael Gidam	TU Wien, Transport System Planning Research Unit (MOVE)
Peter Görgl	University of Vienna, spatial research and spatial planning
Erwin Hoffmann	Municipality of Mistelbach, department of planning and building inspection
Heinrich Humer	Municipality of Ebreichsdorf, local council, future working group
Mathias Mitteregger	TU Wien, future.lab Research Center
Marleen Roubik	Austrian Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology
Martin Russ	AustriaTech, managing director
Rudolf Scheuvens	TU Wien, future.lab Research Center and Research Unit of Local Planning
Aggelos Soteropoulos	TU Wien, future.lab Research Center and Research Unit of Transportation System Planning (MOVE)
Andrea Stickler	TU Wien, future.lab Research Center and Center of Sociology
Johann Stixenberger	Zukunftsorte Waidhofen
Lucia Paulhart	TU Wien, future.lab Research Center
Renate Zuckerstätter-Semela	SUM-Nord, manager

Figure A2: Suitability of existing roads in Vienna South (area type A)

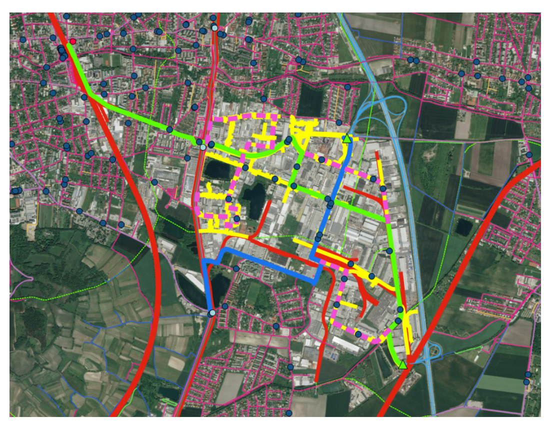


Graphic: Aggelos Soteropoulos

Figure A3: Line network for automated services in IZ NÖ-Süd (area type A)



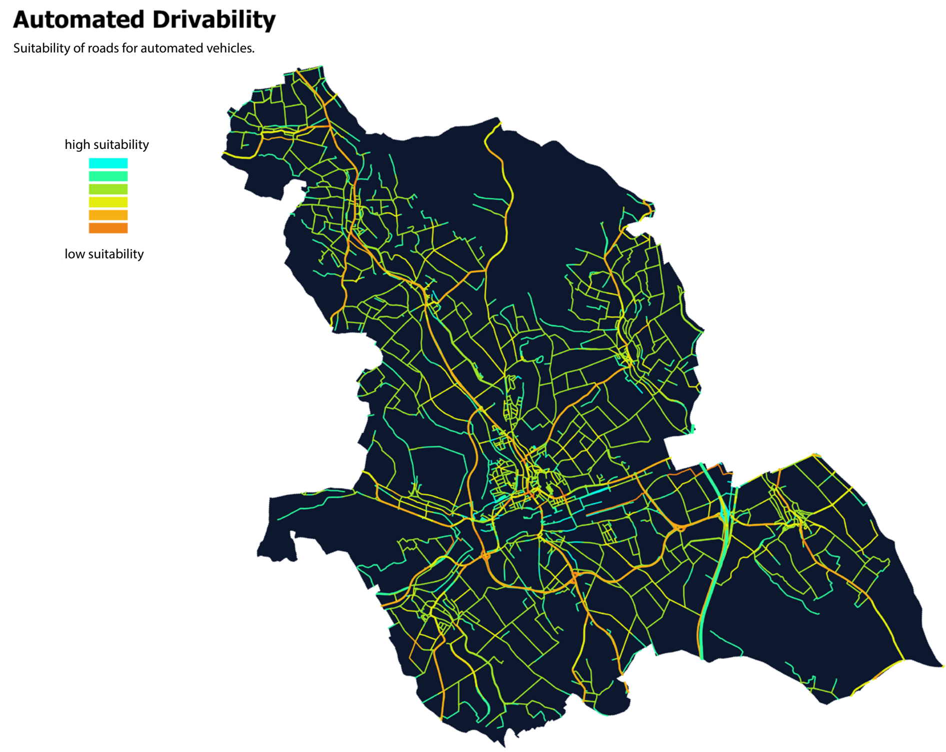
Area assistant line network in transformation stage 1



Expansion by opening express lines (shown in green and blue) between the interfaces in transformation stage 2

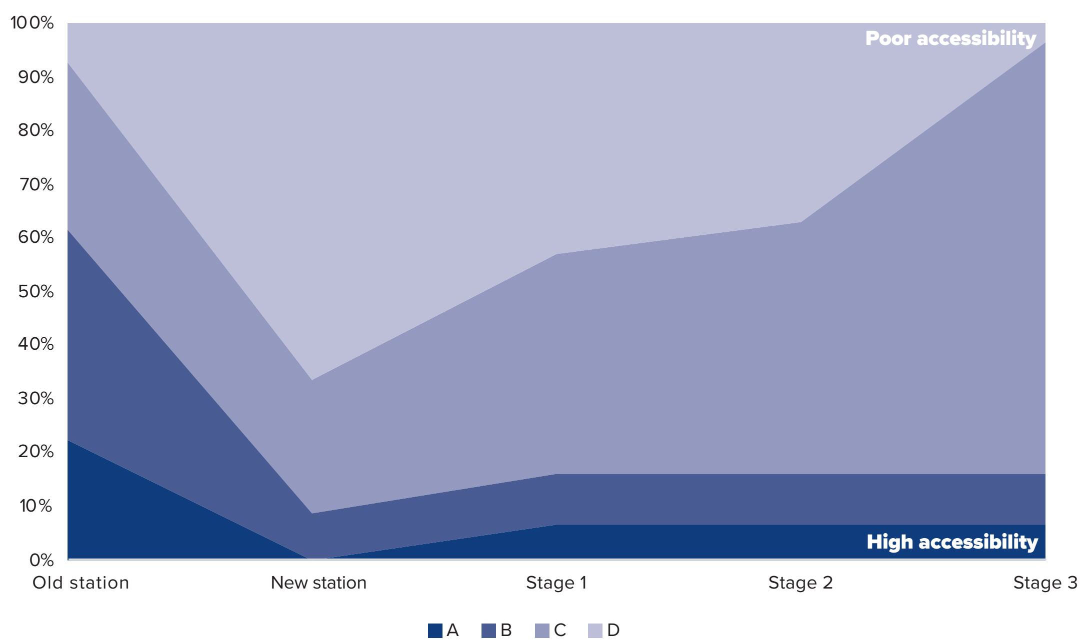
Graphic: Stefan Bindreiter

Figure A4: Suitability of existing roads in the Mistelbach region (area type B)



Graphic: Aggelos Soteropoulos

Figure A5: Changes in public transport accessibility in Ebreichsdorf (area type C) during the transformation stages



Source: the authors