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Electric Mobility and Smart Mobility Concepts – restrained uptake in German Cities

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Summary

German municipalities must implement the overarching federal goals regarding the expansion of electric mobility, the reduction of local environmental pollution, compliance with climate protection regulations, etc. locally in highly regulated sectors such as public transport and energy. To achieve these overarching federal goals a substantial turnaround of the transport system ("Verkehrswende") is necessary. This concerns integrated urban and transport planning, flexible, strong, fast PT, non-motorized and flexible operating systems. What cities that significantly exceed the NO_2 limit values are planning in this respect has been set out in Green City Plans. An evaluation of the plans showed that by now city administrations mainly optimize the current system by electrification and digitalization. Especially small and middle size cities need to be empowered to establish a systemic approach with flexible and digital concepts.

Keywords: mobility system, mobility concepts, EV (electric vehicle), municipal government, sustainability

1 Transport and Climate Policies

1.1 From Paris to German Municipalities

With the international climate protection agreements in Paris in 2015, all signing countries agreed on a voluntary commitment to limit the global warming to 1.5 degrees Celsius. The European Union (EU) committed to reduce the greenhouse gas emissions by 40 % until 2030 (reference 1990). In 2008, the European member states agreed on the increase of the share of renewable energies up to 20 % of the total energy use (electricity, transport, heating and cooling) in the EU climate and energy pact 2020 [1].

In Germany the transport sector accounts for almost 18 % of the total greenhouse gas emissions. Thus, transport is the third largest polluter of emissions in Germany. And 96 % of the emissions from the transport sector result from road traffic [1].

Besides that, the annual survey of the European Environment Agency shows that compared to other European countries an above-average number of cities in Germany exceed the NO_2 limits of 40 µg/m^3, as shown in Figure 1 [2]. This underlines the immediate need of action Germany has to comply with on local level in order to achieve the required emission reduction.

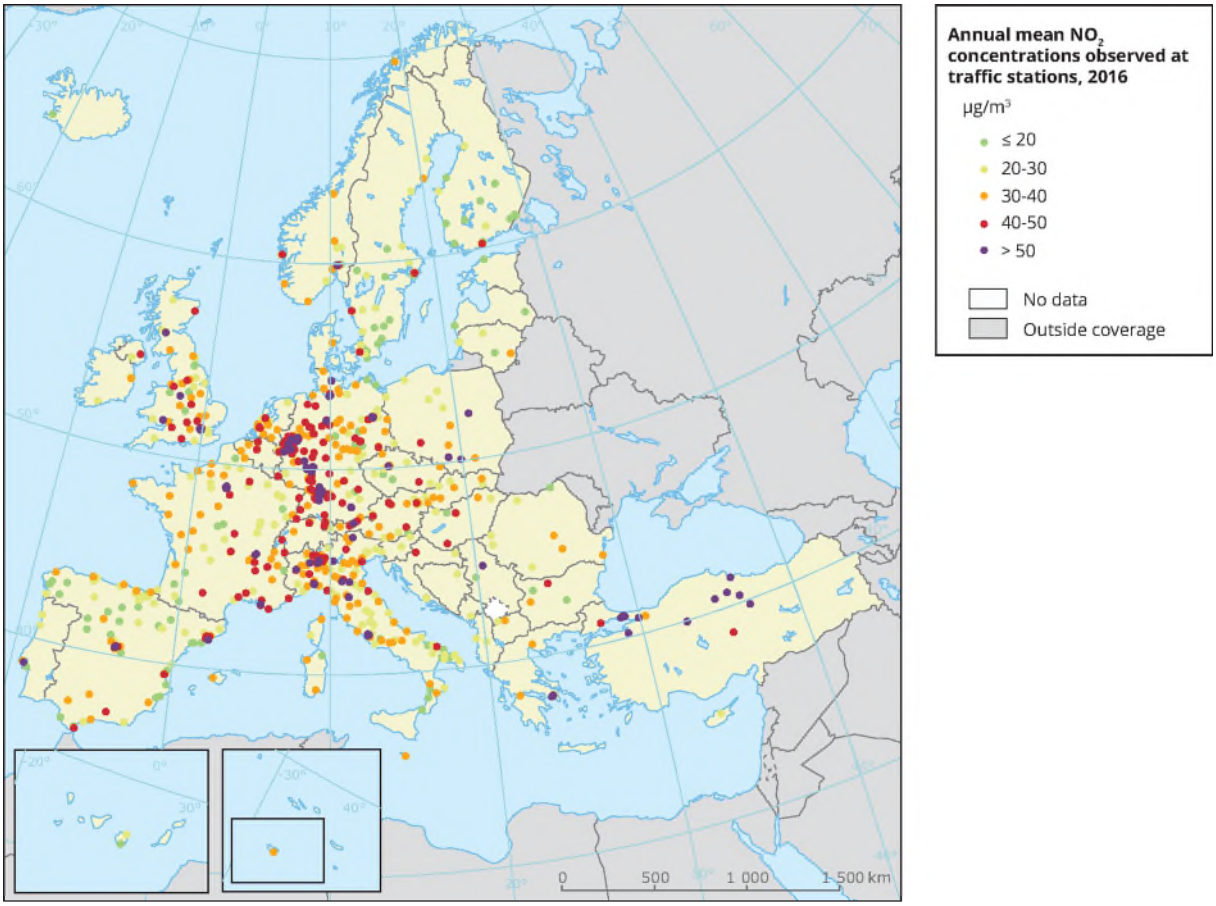


Figure 1: Annual mean NO_2 concentration observed at traffic stations, 2016 [2]

The German federal government has clear targets for climate protection and related issues such as electric mobility and energy efficiency. These overarching objectives must be subdivided into operational tasks that are implemented at local level. Due to the high sovereignty of municipal administration, federal policy can only exert limited influence on how the overarching goals are implemented locally. At the same time, there may be conflicts of interest between the federal level and local policies. For example, the Electric Mobility Act, which came into force in summer 2015, offers local authorities the opportunity to favour electric vehicles, e.g. by allowing them to use bus lanes. On the other hand, it is favourable for local authorities to give preference to public transport and to restrict motorized private transport. It is therefore unlikely that all the instruments provided in this Federal Act will be implemented on the municipal level [3, 4].

The federal government and the federal states also affect local activities by tendering funding for procurement and research & development. On the other hand, the institution KOINNO, which supports public bodies in introducing innovative procurement instruments, states that new technologies and innovative products are rarely used by public entities in Germany [5]. This is confirmed by the fact that only every second municipality feels prepared for the challenges of digitization [6]. On the other hand, more than half of the municipalities see the urgent need to implement new mobility concepts [7]. Electro mobility plays a key role here. As a recent survey of 540 German municipalities with 5,000 inhabitants or more shows, electric mobility is of great importance to two thirds of the municipalities [8].

1.2 Challenges in the Transport Sector

However, transport does not only stand for emissions that have to be reduced in line with climate protection targets. Mobility is one of the basic prerequisites for the functioning of urban areas. At the same time transport and urban infrastructure determine to a great extend future developments. E.g. in the years 1950 - 1960 car oriented urban planning dominated in German and other European cities. Urban planning

separated traffic modes and functionality of city districts and led to the construction of large traffic axes and gave priority to individual motorised transport[1]. Nowadays, the cities have to cope with this legacy. For this reason, the German federal government has established a transformation process within the framework of climate policy under the term “Verkehrswende”, which follows amongst others the principles of avoiding, relocating and improving efficiency in the transport sector [9].

In principle, transport has likewise negative impacts on the quality of life in cities, such as pollution, traffic, congestion, long time to cross the city (negative impact on work and life balance), high cost of public local transport services and so on [10]. Achieving a sustainable, inclusive and efficient mobility system for goods and people is the overall challenge to be dealt with in the Smart Mobility action field [11]. With the development of new technological innovations (in particular ICT), the concept of the Smart City was seen as a mean of achieving more efficient and sustainable cities. In these concepts Smart Mobility is one of the most promising topics, as it could produce high benefits for the quality of life of almost all the city stakeholders [10]. Taken all together, transport planning must be integrated into an overall urban planning that takes into account all behavioural aspects of mobility, which determine the sum of all personal choices about means of transport, place of residence, etc. and needs to pay attention on all modes equally.

The *sustainable cities mobility index* prepared by Arcadis provides an approach to quantify the state of a city's urban mobility environment considering all different requirements [12]. It takes into account the social and human implications of mobility systems, including quality of life (People), "green" factors such as energy, pollution and emissions (Planet), as well as the efficiency and reliability of a mobility system to promote economic growth (Profit). The indicators of this index show up the wide variety of determinants a sustainable mobility planning needs to take into account and cover several relevant criteria determine the modal choice. According to Arcadis, an effective transport system is one which can simultaneously address and improve its functioning for all stakeholders, while facilitating economic opportunity without compromising environmental concerns. To achieve a high index value, each of the sub-indices People, Planet and Profit must be strong. In the ranking of the 100 world’s leading cities, seven European cities are among the top 10 - including one German city. A differentiated view shows that there are no German cities to be found in the top 10 of the sub-indices People and Profit. However, German cities occupy the top three places in the top 10 of the sub-index Planet which includes indicators such as CO_2 emissions, air pollution, congestions, efforts to lower emissions, bicycle infrastructure, electric vehicle incentives and provision of green space. In total, however, only four German cities are among the top 100 cities. This creates a need for further measures to transfer the good approaches to green factors to other cities, while significantly improving the pillars People and Profit. The first means improving indicators such as road safety, access to transport services, modal split, digitisation of the transport system and PT duty time. The second means that factors such as the efficiency and reliability of a mobility system, in particular in terms of commuting time, traffic revenue in relation to the total cost and affordability of PT need to be improved.

For an improvement of transport in all areas, i.e. in the three indices of Arcardis People, Planet and Profit, German municipalities and cities must be empowered to expedite smart services as well as smart mobility concepts locally. This requires amongst others gaining confidence in working with innovative procurement instruments for public authorities [5].

1.3 Green City Plans, Germany

In 2016 ninety German cities exceeded the permissible annual EU threshold of Nitrogen Oxides (NO_x). Since NO_2 is mainly produced during combustion processes in plants and engines, transport accounts for a very large share. According to this, the EU Commission sued Germany as well as five other member states for air pollution in 2018 and the *Deutsche Umwelthilfe* has filed lawsuits against numerous cities for persistently high levels of NO_2 in the air. As a result, driving bans for emission-intensive diesel vehicles have been imposed by court in the recent past, e.g. in Hamburg and Stuttgart.

In 2017, the Federal Government launched the “Immediate Action Programme for Clean Air”. The objective is to achieve a rapid and sustained improvement of the air quality in those towns and cities in

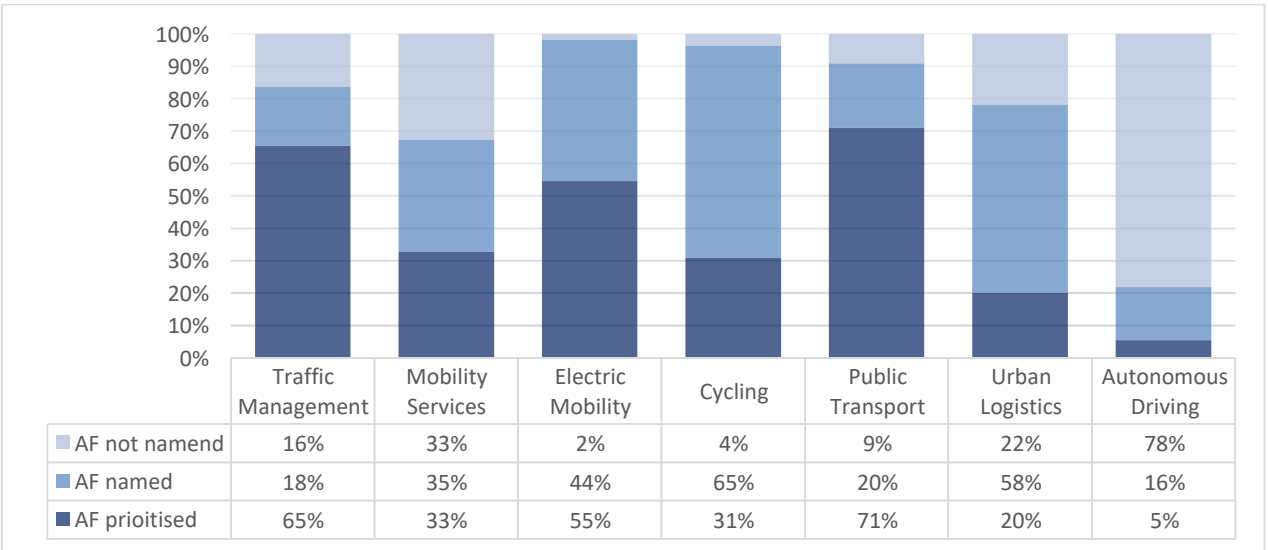
[1] See: S. Wilhelm, *Elektromobilität in deutschen Kommunen - Eine Bestandsaufnahme*, 2019

which the annual average air quality threshold for NO_2 is exceeded. The prerequisites for receiving specific funding from the Action Programme are so-called Green City Plans (GCPs). The aim of these GCPs is to help local authorities address the issue of sustainable urban mobility in a long-term and strategic way. The submission of comprehensive strategic concepts should show how the concerned municipalities intend to reduce nitrogen oxide pollution in the short, medium and long term and shape sustainable mobility in their regions in the future [13].

Accordingly, the GCPs contain the concepts and ideas of the German cities and municipalities on how their local transport systems will address and improve its functioning for all stakeholders simultaneously in future while facilitating economic opportunity without compromising environmental concerns. In order to find out which measures are being taken or planned by the cities most affected by high NO_2 emissions, all 55 publicly accessible GCPs were evaluated. First of all, the concrete problem situation of each city was identified and the various fields of action were gathered. It turned out that there are a total of seven fields of action to which almost all measures can be assigned: Traffic management / digitalization, public transport (PT), electric mobility, cycling, urban logistics, mobility services and autonomous driving. Thereby, the first five topics were expected to be dealt with if the municipalities received funds from the Federal Ministry of Transport for the preparation of the GCPs. Secondly, all GCPs were analysed to determine in which of the seven fields of action the respective city had planned measures and which fields of action were prioritized, e.g. by assessment of the measures or emphasizing in the text. Finally, a more in-depth qualitative analysis of the main topics electric mobility, public transport, mobility concepts as well as an analysis related to city size was carried out.

2 German Cities focus mainly on same Action Fields

The evaluation of all GCPs shows that more than 80 % of the cities envisage measures in the fields of action traffic management, electric mobility, cycling and public transport. In just under 80 % of all GCPs, measures in the area of Urban Logistics are mentioned. Measures concerning Mobility Services are mentioned in almost 70 % of the plans. Approximately every fifth plan mentions measures in the field of autonomous driving. Figure 2 shows the occurrences of measures in the seven action fields that were identified by analysing 55 GCPs. In the figure, the occurrences are shown differentiated according to prioritised naming, simple naming or not named.



	Traffic Management	Mobility Services	Electric Mobility	Cycling	Public Transport	Urban Logistics	Autonomous Driving
AF not namend	16%	33%	2%	4%	9%	22%	78%
AF named	18%	35%	44%	65%	20%	58%	16%
AF prioitised	65%	33%	55%	31%	71%	20%	5%

Figure 2: Seven identified Action Fields (AF) and the occurrences of measures in these Action Fields. A differentiation is made as to whether measures are prioritised, mentioned at all or not mentioned. Total number of analysed Green City Plans: 55

In 18 % of all GCPs measures in the action field traffic management are mentioned whereas in 65 % of all plans those measures are prioritised. Parking guidance systems as well as intelligent traffic lights and traffic management systems for the purpose of improving the flow of traffic are the most commonly named actions. Measures in the action field Mobility Services are mentioned in 35 % of all GCPs and prioritised in a further third of all plans. The spectrum ranges from needs-based ride-sharing systems, which supplement public transport in off-peak times, to multimodal hubs, which are intended to connect all modes of transport. Almost every master plan mentions measures relating to the electrification of modes of transport, the action field Electric Mobility. In just over half of them (55 %), measures in this field of action are prioritised. The focus is on the electrification of bus fleets and / or municipal vehicle fleets as well as the expansion of the charging infrastructure. Almost every master plan mentions measures in the action field cycling. However, in less than one third of all plans those measures are prioritised. In nearly all cases, the focus is on improving the basic conditions for cycling, such as the overhaul and / or expansion of cycle paths. In 20 % of all GCPs measures in the action field public transport are mentioned whereas those measures are prioritised in 71 % of all plans. The main focus is on the conversion of diesel buses to low-emission or locally emission-free drives as well as on upgrading the infrastructure and expanding the offering. Measures in the action field Urban Logistics are mentioned in 58 % of all GCPs. In 20 % of all plans, measures are prioritised. These are mostly measures for the flexible and environmentally friendly design of inner-city distribution traffic, e.g. last mile logistics. In 16 % of all GCPs measures in the action field Autonomous Driving are mentioned whereas in 5 % of all plans those measures are prioritised. In this field of action, approaches for autonomous shuttles are listed, which are primarily intended to supplement public transport.

2.1 Action Fields – A closer look

In the following part the results of the qualitative analysis of the action fields electric mobility, public transport and mobility concepts are presented, as these topics are three of the most important focus areas to achieve a switch to sustainable urban transport and mobility.

2.1.1 Electric Mobility – Focus on Fleet Electrification and Infrastructure Provision

As shown in Figure 3, almost all GCPs include the promotion of electric mobility as a locally emission-free alternative to vehicles powered by a combustion engine. It can be clearly seen that cities with 250-500k inhabitants prioritize this action field most often.

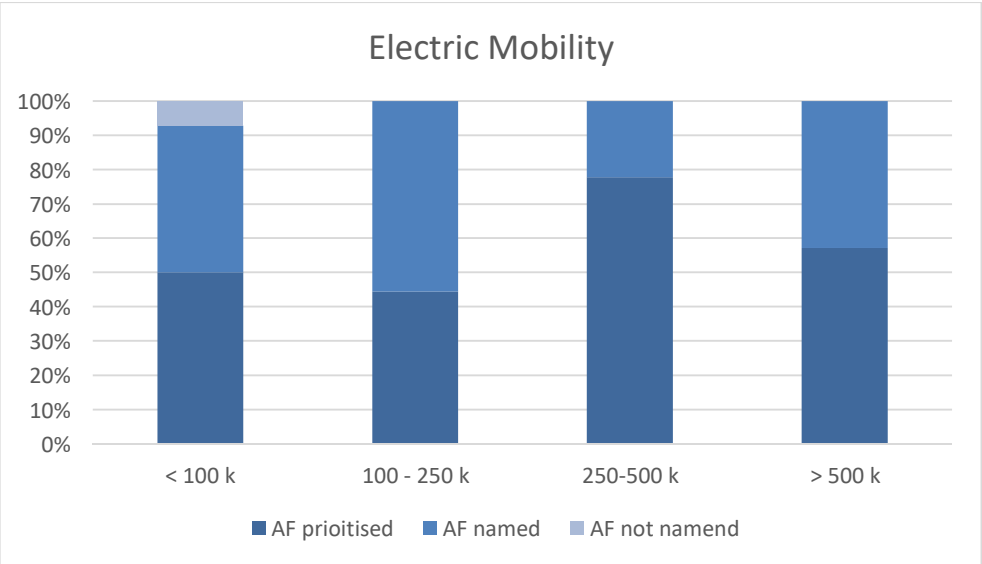


Figure 3: Action Field (AF) Electric Mobility. A differentiation is made as to whether measures are prioritised, mentioned at all or not mentioned. Total number of analysed Green City Plans: 55

In the GCPs most often the electrification of either local buses or municipal fleets, or both is stated. The most important measures mentioned are electrification of vehicles and building up infrastructure, in particular charging infrastructure (including low cost charging infrastructure). Many cities map out to electrify their bus fleets, some cities plan to shift fuels from diesel e.g. to gas or hydrogen. Likewise, a lot of cities start electrification of their municipal fleets. Some cities, among them Freiburg, address the electrification of local sharing-, ride hailing- and cab fleets (e.g. CleverShuttle, traditional station based or free floating car sharing) and two-wheelers. The city of Hamburg stands out by the integrated approach to include electric mobility directly while planning district developments. Wiesbaden states that the city wants to develop as a pilot and showcase city for electric mobility. As a kind of casual manner the city of Essen plans to establish counseling centers for electric mobility.

2.1.2 Public Transport – Focus on low-emission Busses and flexible Services

Improving public transport is a priority for around 70% of all cities, as illustrated in Figure 4. While some cities with less than 100k or more than 500k inhabitants do not plan measures in this field, almost all cities with between 100k and 500k inhabitants plan measures.

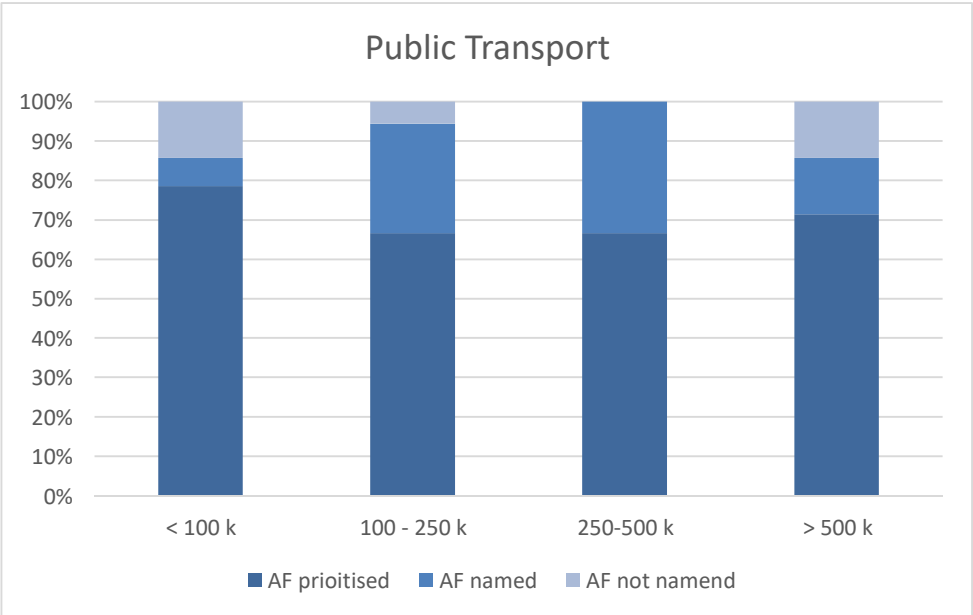


Figure 4, Action Field (AF) Public Transport. A differentiation is made as to whether measures are prioritised, mentioned at all or not mentioned. Total number of analysed Green City Plans: 55

The main focus in this field of action is on the conversion of diesel buses to low-emission buses by gas, hydrogen, hybrids or locally emission-free drives by electric busses as well as on upgrading the infrastructure and expanding the offering. The second priority is to improve the quality and quantity of PT. The cities are planning to expand their PT systems, especially on the outskirts and during off-peak hours by introducing ride sharing, ride heeling or shuttle busses.

2.1.3 Mobility Concepts – Playing a Minor and Complementary Role

Nearly 80 % of the cities mention innovative mobility concepts in their GCPs, as shown in Figure 5. Basically, mobility concepts play a minor and mainly complementary role in most GCPs. Mobility concepts are seen as a supportive part of the transport system mainly by smaller and middle rage cities.

Most of the cities revive the idea of **multimodal hubs** (German wording: “mobility station”) and Park and Ride Stations (P&R). P&R infrastructure should be expanded spatially regarding the amount of opportunities to switch between individual to collective transport modes. P&R Systems also should be

developed regarding the amount of transport modes which should be connected as well as supported by digital information systems. Quite often, installations of charging infrastructure for electric cars and e-bikes are mentioned as well as the offer of bike sharing systems. The same development could be seen for multimodal hubs, which mainly should connect PT with sharing systems, collective on demand services and cycling.

The implementation Mobility as a Service (**MaaS**) and **digital multimodal platforms** is currently under discussion in Germany. Within the GCPs these concepts are rarely mentioned, mainly from cities in which services already exist which will be developed and brought to a new level. E.g. in Aachen where an online service called “mobility broker” is intended to provide operational vehicle sharing and cost-sharing model for electric mobility.

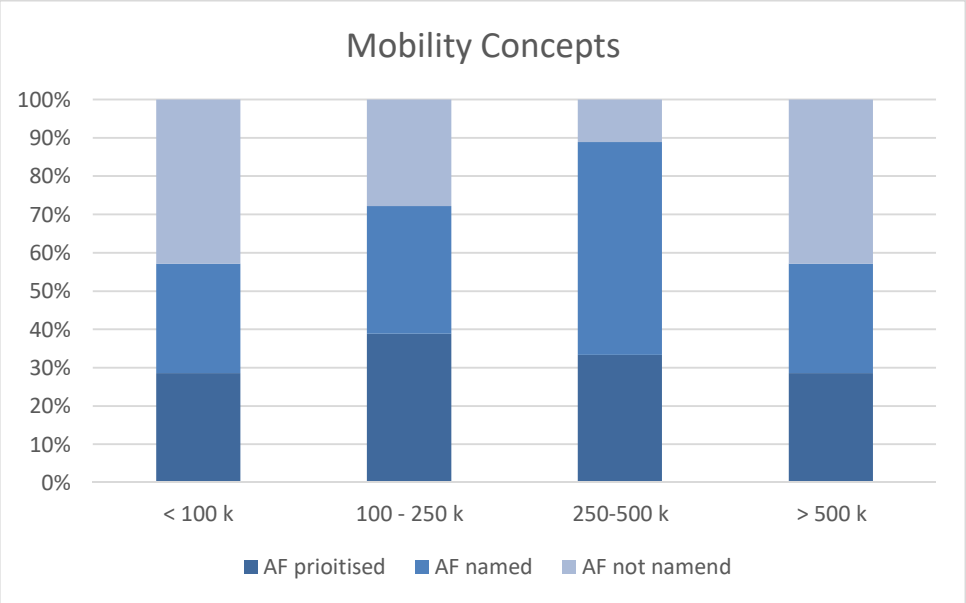


Figure 5, Action Field (AF) Mobility Concepts. A differentiation is made as to whether measures are prioritised, mentioned at all or not mentioned. Total number of analysed Green City Plans: 55

A lot of cities stated the aim to reduce car ownership by offering smart **car sharing system**. In most of the German cities different kinds of car sharing services can be found. Thus existing car sharing systems will mainly be digitally and spatially connected to other modes, will be expanded and will be electrified to be more attractive. Only a few cities state the aim to build up a new car sharing system itself. These city approaches on sharing concepts culminate in common vehicle fleets for municipal use as well as mobility management for municipalities and public institutions.

To supplement public transport in off-peak times and peripheral areas many cities mention **on demand services**. These offers are mainly collective ride sharing systems or ride hailing systems. Often these offers should be provided with electric vehicles.

Autonomous vehicles are part of a future mobility vision as of substantiated planning. This technology as well as related potential services is rarely discussed in the GCPs. Only very few cities mentioned autonomous shuttles.

3 No System Change in German Cities yet

Cycling and urban logistics are listed mainly in all GCPs but both action fields are not particularly highlighted. The measures mentioned in these action fields are essentially the same and have been developed at a low level. To enhance cycling in the cities, basic measures such as construction of cycling

infrastructure (in some cities cycling highways), strengthen the use of e-bikes and integrating cycling and cycling sharing systems into multimodal mobility hubs are necessary. It is the right step to make cycling more safe and fast. As the measures are rarely highlighted in the GCPs, we couldn't identify to what extent the infrastructure will be expanded compared to the other modes. Overarching measures to reduce traffic problems caused by commercial transport are rarely to be found in the GCPs. At most, concepts as inner city logistic hubs, shift to e-bikes and other lightweight electric vehicles on the last mile are mentioned but not specifically worked out.

Mobility concepts such as sharing, ride hailing, multimodal services, platforms etc. (prioritized and only mentioned) are becoming more important in the GCPs as the size of urban living spaces increases. However, this does not apply to the cities with more than 500k inhabitants. Overall, the GCPs of cities with up to 500k inhabitants show in a relatively uniform focus on the action fields. The plans of cities with more than 500k inhabitants are slightly heterogeneous. It gives the impression that the sets of measures and the prioritization are designed to be significantly more diverse than those in cities with a smaller population.

Overall, the GCPs show an optimization of the actual situation, triggered by electrification and digitization. If cities acted decisively, environmentally friendly means of transport such as cycling, collective transport and mobility services would be pursued much more consistently. In order to initiate real change, strong alternatives to motorised private transport and the consistent equality of all means of transport are necessary. Electrification and digitization are essential but equivalent components in the overall system without priority. Positive highlight is that bus priority at traffic lights for a strong and fast PT is often mentioned in the GCPs. But, the overall picture of the GCPs don't show a consistent abandonment of the car oriented urban planning.

What do we learn about the German GCPs related to climate protection, environmentally friendly transport development and the mobility turnaround ("Verkehrswende")? The GCPs are very similar in their contents. The plans contain good approaches, which could be more elaborated regarding the interlinkage between the components of the transport system like PT, collective services, private cars, non-motorized modes as well as addressing more of the determine criteria of modal choice such as the ones Arcadis included into the three pillars People, Planet and Profit into the sustainable cities mobility index rating. The plans primarily optimize the status quo; disruptive measures to adjust the car oriented urban planning are not envisaged. The system as a whole is not questioned in the GCPs. In order to initiate a sustainable change in transport the measures formulated in the GCPs need to be supplemented by consistent restrictions on motorized private transport, requirements on commercial transport and allocate appropriate urban space to non-motorized, public and collective transport. There are already first approaches in other countries, e.g. the bike-friendly city planning in The Netherlands or the bonus-malus-System related to the vehicle emissions in France. Considering the fact, that only half of the German municipalities feel prepared for the challenges of digitization but see the urgent need to implement new mobility concepts, they (esp. small and middle size cities) need to be empowered to implement flexible and digital concepts and to establish a new systemic transport system.

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Mr. Vorholt recived the B.Sc. degree in engineering physics, the M.Sc. degree in biomimetrics and the PhD degree in engineering. He is currently a Senior Expert at TÜV Rheinland Consulting GmbH. In the research management division, he supports the implementation of funding programs, surveys transport related topics and analyses the impact of federal funding of electric mobility on behalf of the Ministry of Transport and the Ministery of Economics.