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E-Mobility: New Challenges for Urban and Transport Planning

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E-Mobility:
New Challenges for Urban and Transport Planning

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Abstract

Cities in Europe underlie strict emission limits by the European Union. The transport sector accounts for a large share of pollutants. E-Mobility combined with renewable energies can help reduce emissions and enhance the quality of life in cities. But to sustainably introduce e-mobility measures within the existing mobility system, cities have to shape the right circumstances.

Important questions address the establishment of the (green) charging infrastructure combined with the right marking and design of parking spaces as well as the generation of intermodal connecting points where people can change from one transport mode to another. Also electric bicycles and scooters need a better infrastructure as they have a big potential for reducing traffic and land consumption in urban areas.

Some cities are implementing e-mobility measures in their climate action plans or urban development strategies; others try to set legally binding regulations for real estate developers in land-use plans. The royal road has not been found up to the present moment. Also, a new constellation of stakeholders makes it harder to achieve short term goals. The most important thing is to work strategically on the transition of the energy and mobility system likewise.

The aim should be to develop a sustainable concept for the implementation of e-mobility at planning new building and conversion areas within existing structures. Intelligent mobility concepts have to be combined with innovative urban planning approaches. The paper will point out challenges and chances for cities which come along with the introduction of e-mobility and renewable energies. It will also show some exemplary approaches of cities in Germany and from abroad and discuss possible strategies.

Keywords: Charging Infrastructure, E-Mobility, Electric Vehicles, Mobility Behavior, Multimodal Transport Urban Planning, Transport Planning

Introduction

In order to achieve climate and energy policy goals a fundamental mobility change is necessary. Municipalities have the scope for action to accelerate this transition. Not only is the reduction of pollutants and greenhouse gases a major issue in this case but also the recovery of urban qualities which suffered from long term planning failures made in favor of cars.[1] Sustainable concepts in urban development, urban planning, and transport planning strive for covering all the various mobility needs while trying to increase the quality of life. Sustainably shaped e-mobility can be part of these concepts.

The promotion of sustainable transportation modes like walking, cycling, public transport, or car sharing is crucial for rearranging the urban transport system. An important measure to reduce individual car traffic is linking the different transport modes with each other. This offers a potential for connecting all kinds of electric vehicles. To provide intermodal services, appropriate infrastructure as well as information and booking platforms must be offered. These services should be designed as attractive as possible for costumers by using integrated ICT services. Cities can initiate, support, organize, influence, and control these processes.[2]

Public space in particular provides opportunities to influence urban mobility with appropriate offers and the deployment of infrastructure.[3] Relevant key points which are related to the topic e-mobility include parking spaces for cars and two-wheelers, charging infrastructure, intermodal mobility stations, and complementary mobility services. Additionally, the interaction between the transportation and electricity network is a major topic which is crucial for a simultaneous transition in energy and mobility.

In the following, varying types of municipal implementations will be exemplified and discussed. By using practical examples, it can be demonstrated which e-mobility measures are appropriate and necessary in order to meet the needs of consumers as well as to show how to integrate infrastructural solutions in urban development or how to involve different stakeholders. Finally, approaches will be outlined showing how municipalities can give measures a legally binding character and promote e-mobility in an appropriate and sustainable way.

The descriptions and findings in this paper are part of the PhD project of the author at the University of Kassel and the Frankfurt University of Applied Sciences, working on the integration of e-mobility into urban planning and street space design. Moreover, some survey results originate from a research project called “Socio-scientific and ecological research in the Model Region Electromobility Rhine-Main”, funded by the German Federal Ministry of Transport and Digital Infrastructure and coordinated by the National Organisation Hydrogen and Fuel Cell Technology.

[1] Jansen et. al. 2013: 57
[2] Beckmann 2014: 20f
[3] Canzler & Knie 2009: 28

Building Public Charging Infrastructure - A Municipal Task with Signal Effect

Different platforms and directories of charging points in Germany and Europe (e.g. lemnet.org, chargemap.com, plugsurfing.com) display that the highest density of the charging infrastructure is observed in metropolitan areas. These are also the regions with the largest number of currently registered electric vehicles. By discussing the long term issue whether charging infrastructure or electric vehicles need to be placed first (chicken-and-egg problem), it can only be speculated how these two variables affect each other. In general, there are two types that need to be distinguished – private and public charging points. While private charging points are usually on private ground at home or at the employer, public charging points are mostly relevant in cities where the majority of the population has no private parking space but nevertheless relies on a private vehicle (so called 'street lamp parker'). A special type of charging points are those in semi-public areas which can locally complement the existing supply (e.g. at supermarket parking lots).

In the progress report of 2014 the German National Platform for Electromobility NPE recommended a set up of more publicly accessible charging infrastructure which should be easy to handle and orientated on the needs of the users.[1] All the interviewed experts within the PhD project of the author (municipalities, project developers, transportation operators, car sharing providers) agree that the provision of more charging infrastructure is essential to overcome the spatial range anxiety of consumers.

The charging infrastructure issue plays a major role for municipalities because they try to trigger a signal effect by providing attractive offers, as an expert confirmed: *"We said if we want the residents to use e-mobility more often, we need to take some preliminary steps. So this is also some kind of political message to show people that all this is not science fiction but actually real and possible."*[2]

That is the reason why persuasion is required since the attitude and mobility behavior of people should be guided in a certain direction. However, to reach a major change certain offers must be provided – starting with the installation of charging infrastructure.

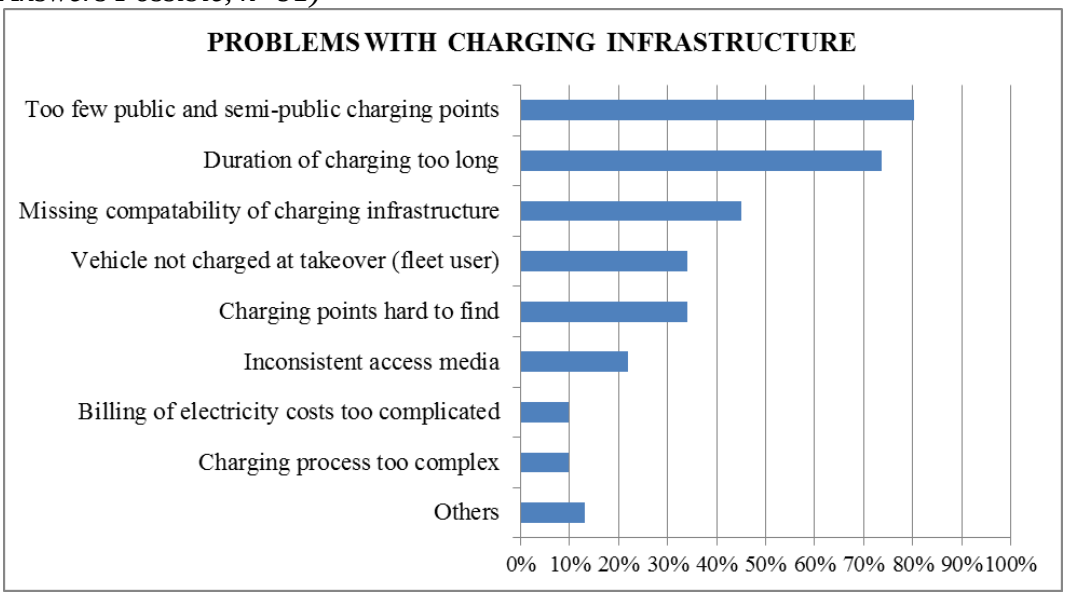
Users Ask for More Charging Points

Between 2013 and 2015, users of electric vehicles in the Rhine-Main area have participated in multi-stage acceptance surveys, conducted by the Frankfurt University of Applied Sciences[3]. The results of the quantitative surveys show how important charging infrastructure is for real users of electric vehicles. Long-term-users (with a minimum of six months periodic electric vehicle use) experienced the lack of charging infrastructure in public and semi-

[1] NPE 2014: 13
[2] Interview 1.1.7 with a municipal planner, translated into English
[3] For more information visit the website www.frankfurt-university.de/verkehr

public spaces as an important obstacle for the future use of electric vehicles. Figure 1 shows that four of five respondents say that there are not enough publicly accessible charging stations. For three quarters of the users the duration of charging is too long. Furthermore, nearly 36 % of the interviewed people complain that charging points are too difficult to find in public space.

Figure 1. *Problems that Occur while Charging for Long-Term-Users (Multiple Answers Possible, n=91)*



Especially the provider of a free-floating car sharing system sees the extensive supply of charging facilities as indispensable for a functioning operation with electric vehicles. He sees the responsibility to ensure an adequate establishment of infrastructure at the local authorities, who should work together with public utilities and energy suppliers. *'Because you certainly cannot ask the car sharing providers to build the charging network themselves as well.'* [1]

It is said that it is the municipalities who want to promote environmentally friendly transport. This in turn requires political will and decision-making processes due to various interests and land-use conflicts in public space. For example, keeping parking spaces at charging points free for electric vehicle users is controversially discussed but absolutely necessary for free-floating car sharing providers. That is different from the situation for station-based car sharing services – they usually have their own private spaces. However, in this case it could be considered to release some of the charging infrastructure also for private use.

For electric two-wheelers there are different circumstances as well. Studies with a focus on pedelecs (pedal electric cycles) show that public charging infrastructure is not as crucial for private users because the battery is usually portable.[2] It can be easily taken out of the bike and plugged into a socket at

[1] Interview 4.7 with a car sharing provider, translated into English
[2] Schäfer, P. and Schmidt, K. 2011: 78

home or the workplace. Nevertheless, charging facilities for electric bicycles are considered as being important for convincing people with range anxieties and increasing the general acceptance of e-mobility.

Approaches of Municipalities are Varying

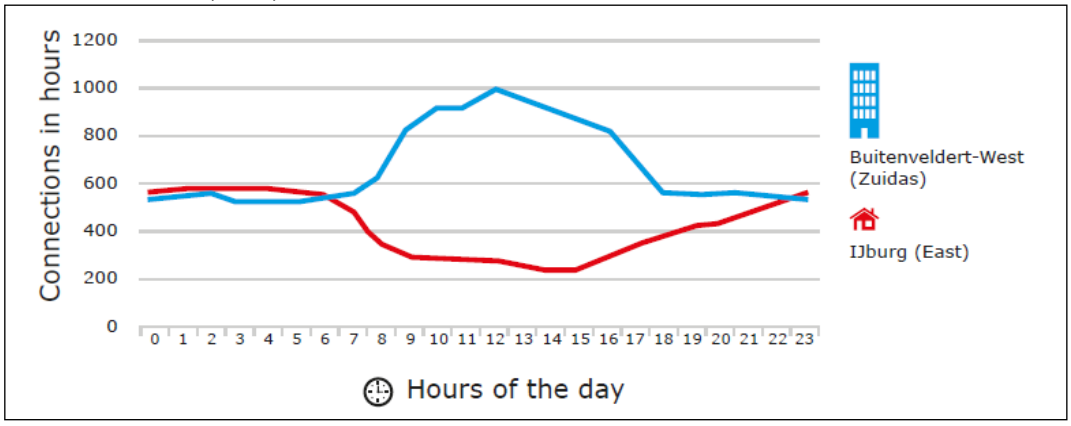
There are various concepts used to install the charging infrastructure for electric vehicles. In some cities the supply of charging stations was allocated even before standardizations and legal regulations were available (e.g. Oslo), while other municipalities seek for a gradual development of different charging techniques (e.g. Hamburg), and still others pursuit a complex procurement procedure for a unified expansion of charging infrastructure (e.g. Berlin). The demand is determined by various methods – with settlement structure approaches like in Dortmund or specific target group procedures like in Berlin where the short term demand is primarily orientated on the dissemination of electric car sharing.

Amsterdam calls itself the city with the highest density of charging infrastructure in Europe and started with a fully demand-oriented approach in 2012. Nearly 11,000 electric vehicle owners used the 1,150 public charging points in 2014, which were installed by the municipality. An average of approximately 200,000 kWh of energy was charged per month.[1] City residents can apply for the construction of a public charging station in their living area. The municipality, together with a selected energy provider and the network operator, then checks the preconditions (spatial and structural circumstances, existing charging points in the nearby area and their occupancy, available electricity connections, etc.) before the application can be approved.

The development and operation of charging infrastructure is not a successful business model in any city yet. In order to approach a monetary profit, specific behaviors of various user groups must be considered for charging stations as well as the different needs of these groups. An example from Amsterdam shows the variations between charging points in a residential area in which most charging procedures occur during night time (‘pillow charging’), and in an industrial area where charging points are most frequently used during day time (‘business loaders’), see Figure 2. Thus, charging points in a mixed-use zone could be used complementarily from both residents and businesses, and ensure an optimal capacity utilization.

[1] City of Amsterdam 2015

Figure 2. *Example for Charging Processes in a Residential Area (Red) and Industrial Area (Blue)*[1]



Currently, public charging infrastructure is often financed by different funding pools and pilot projects. Sometimes municipalities are the main investor, sometimes it is the energy supplier. Also, the ownership structures and operater models of charging stations differ significantly – from monopolistic conditions with a free choice of the charging point location, technology, and operation model, to a mix of operators with determined conditions by the municipality and specific operating agreements.

Access to Charging Infrastructure and Reserved Parking Spaces are Relevant for Users

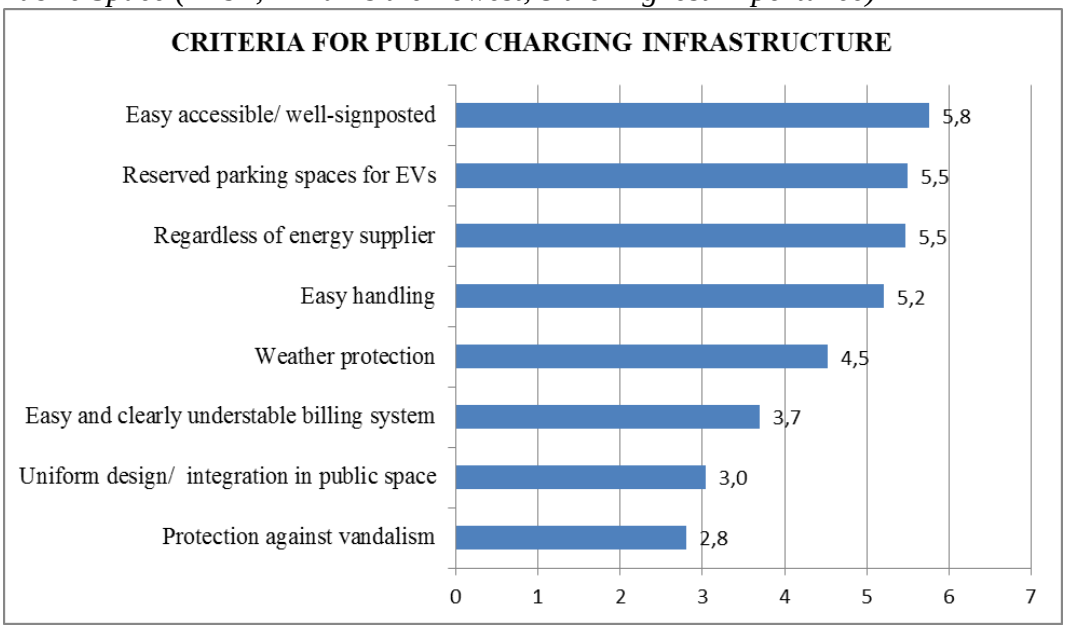
Essential for an easy handling and a functioning operation in all examined cities is a non-discriminating access to public charging points – so you can charge your car at every charging point regardless of the provider. Nevertheless, the reality shows a different picture. As reported by an expert hardly any of the publicly accessible charging point in his city is non-discriminating *'because there are always some particular club models behind it'*.[2]

The results of the quantitative surveys can confirm this view. 45 % of the long-term users complain about the missing compatibility of the charging infrastructure in public space (see Figure 1). Asking about which criteria a public charging point would need to fulfill, the majority of the respondents mentioned a good accessibility in combination with good signage (see Figure 3). About 57 % of the users stated that an easy access is one of the three most important criteria for a public charging point. Furthermore, the reservation of parking spaces for electric vehicles plays an important role as well as the non-discriminatory access to the charging infrastructure. Other essential elements are an easy handling of charging stations and an adequate weather protection.

[1] City of Amsterdam 2015
[2] Interview 1.1.3 with a municipal planner, translated into English

The problem with misplaced cars (fossil cars in front of a charging point) was hardly ever mentioned from users or experts.

Figure 3. *Average Ranking of Important Criteria for Charging Infrastructure in Public Space (n=94, 1 Marks the Lowest, 8 the Highest Importance)*



Intermodal Services as a Key Factor for Changing Mobility Behavior

The installation of the charging infrastructure itself does not automatically lead to a fundamental change in mobility. All activities must be embedded in comprehensive mobility concepts. Intermodal facilities and services where people can change from one transport mode to another can strengthen the already started rethinking of people. *‚The mobility behavior is changing, more and more people waive an own car; more people are willing to open up for new mobility types which have nothing in common with property or ownership […] of vehicles.‘* It is important, *to connect different mobility services to make it easy for people not owning a car to use various mobility forms that are suitable for their needs.’*[1]

Intermodal mobility stations and mobility cards, for example, are used primarily as complementary offers to public transport. In the future, e-mobility in terms of electric bicycles, scooters, and cars may become a crucial element for areas and times where public transport is not working properly or turns unattractive. Therefore, mobility needs can be treated environmentally friendly even during marginal times and in rural areas. An expert furthermore speaks of a new attractive urbanity by combining appropriate infrastructure projects with innovative mobility services, that would lead to a high living quality in cities.

[1] Interview 1.4.1 with a public transport company, translated into English

The electric two-wheelers particularly provide a potential for municipalities. The use of electric bicycles and cargo bikes offers possibilities to handle the traffic in a purposeful, space saving, low-noise and emission-free way. Although these vehicles are still relatively expensive to purchase, savings can be achieved while using them instead of a motorized vehicles – personally in financial terms as well as for cities in terms of living quality. Good use cases for electric cycling are rental systems. They have the advantage that e-mobility can be used and tested easily, without having to invest in an unknown technology in the right away.

Finally, synergies between digitalization and infrastructure should be created. Digitalization can be seen as a success driver for intermodal services. Smartphone apps with intermodal platforms and tariff information help to connect different route sections easily. Nevertheless, since the infrastructure can be seen as the visualization of the connected public space, it is also one of the most important components of various projects. A representative survey among the inhabitants of the German city Offenbach has shown that the highly visible and central location of the mobility station in Offenbach was significant for its awareness level and use. Due to the station, most of the people in Offenbach are aware of e-mobility and a considerable part of the respondents are even interested in a short to medium term use of electric vehicles.[1]

In general, the use and improvement (and possibly reutilization) as well as the connectivity of the existing infrastructure through attractive services is an important component of a future sustainable transport system. From the urban design and environmental consideration it is very favorable to optimize existing systems and not to use new areas. In addition, it is important to accomplish a high quality of stay while people are changing transport modes, so waiting time will be experienced as a pleasant time.

Scope for Establishing a Legal Basis

The installation of charging infrastructure in public space requires a special use permit in Germany.[2] Municipalities can determine mandatory requirements for the technology, accessibility, and the design of the charging stations. With urban development contracts and changes in municipal parking space regulations it is even possible to promote the implementation of e-mobility on private ground – that way it becomes binding in a limited range. For example, mandatory obligations are set up in private agreements for new building sites and conversion areas to supply cable conduits or already entirely completed charging infrastructure. At a construction area in the HafenCity in Hamburg the required number of parking spaces per residential unit was determined to a maximum of 0.4 (usually 0.8 or higher), and the investors were encouraged to provide one third of all parking spaces with a charging facility.

[1] Schubert and Lanzendorf 2014: 25
[2] BMVI 2014: 11

Some municipalities already go one step further and adapt their general parking space regulations towards new mobility trends and demands. An excerpt from the parking space regulation of the city of Offenbach says (Section 315a, Paragraph 5): *"Regularly at least 20 parking spaces for the projects are required, a minimum of 25 % of these spaces shall have a power supply for charging electric vehicles."*[1] Moreover, a proven mobility concept is a reason for reducing the parking space supply. This does not only include parking and charging facilities for electric cars and bicycles, but also job tickets and car sharing concepts. Bremen integrated this option into their parking space regulation as well. In addition to the existing possibilities of a normal parking space supply or a financial compensation for reduced parking capacities, there is now the alternative to remove the obligation of providing parking spaces by implementing a mobility management scheme. In Berlin and Hamburg the parking regulations for the whole city were removed entirely.

In case of development plans and preparatory land-use plans there have not been many attempts to integrate e-mobility measures yet. Here, municipalities have to rely on helping activities from the federal government and federal states to create clear legal bases. A common way presently is to have guidelines for investors, developers, and residents which are considered to be suitable and less complicated to promote appropriate activities concerning sustainable mobility. Although they contain no obligatory measures, it calls attention towards possibilities, basic requirements, and ways of implementation.

Flexible Long Term Planning for a Dynamic Market

The strategic direction and operationalization of e-mobility activities in a city appear to be influenced by the organization or department where the subject e-mobility is located. Municipalities in which e-mobility is considered as part of urban development follow a holistic approach including environmental objectives, satisfaction of mobility needs, and urban living quality. If e-mobility is an issue for business development commissions or in newly established agencies, the focus usually is on the procurement of vehicles and economic networking. Municipal utilities with the responsibility for e-mobility measures often prioritize the installation of the charging infrastructure while transportation companies try to generate mobility concepts without keeping urban development or energy-related issues in mind. Since holistic mobility concepts and e-mobility always involve the use of public space, several disciplines need to be included as well as numerous stakeholders. At the same time this means *"that such processes which do not only have one party concerned […] simply takes longer."* But *"if you want to have an integrated plan in the end, it has to take place where planning is done in an integrated way."*[2]

[1] City of Offenbach 2013: 4, translated into English
[2] Interview 1.1.3 with a municipal planner, translated into English

Principally, the experts agree that sustainable planning can only be done in the long term and ideally not only on a local level. One expert suggests to *"set goals together with other municipalities. These goals should be not too short-dated – better 5 or 10 years in the future"*.[1] Due to the dynamic development in the field of e-mobility, it is nevertheless necessary to be able to respond quickly and flexibly to occurring changes and new trends. This is, especially when it comes to the supply of infrastructure, not easy but should be considered during the planning process anyhow. *"The market is changing and you do not know exactly HOW it is going to change. This means that everything you do must be done in a way that is adjustable later."*[2]

What seems to be important as well is the exchange of experiences between municipalities. Due to the young age of the topic e-mobility many cities still have too little experience in knowing which measures are useful to keep mobility sustainable in the long term. An expert admits that, *"sometimes the problem could be that we often work haphazardly because there simply hasn't been any standardized processes, structures, or products yet."*[3]

Conclusions

The determination of limit values regarding pollutants and greenhouse gas emissions as well as claims for reducing noise and land use consumption are reasons for cities to take action in terms of creating mobility alternatives and traffic regimentations. Cities and municipalities are significant parties with their experience and scope for action regarding political and social change processes. That is the reason why they are important drivers and multipliers for both electric vehicles and multimodal mobility concepts. On the one hand they can contribute to make new mobility concepts visible and accessible. On the other hand they can set incentives for environmentally friendly mobility patterns by means of targeted measures. Altogether, it can lead to the necessary mobility transition.

Moreover, a rethink and related change of mobility behavior of people can affect the quality of life in cities and regions when pollutants and noise emissions will be reduced in the long run and areas used for traffic will be reclaimed for other functions. To reach this goal, a city should support local mobility by foot, bike, public transport, and car sharing on the one hand. With the help of appropriate planning tools and a clear legal framework e-mobility applications and services have to be integrated into intermodal and multimodal concepts on the other hand.

Municipalities should support a mobility transition with all available means. The resource 'public space' offers many chances but responsibilities as well. It appears that a wide establishment of charging infrastructure decreases the psychological obstacles for using an electric car. If cities want to promote a high usage of electric vehicles they should act early. The example of

[1] Interview 1.3.5 with a municipal planner
[2] Interview 1.4.1 with a public transport company, translated into English
[3] Interview 1.4.6 with a mobility research company, translated into English

Amsterdam has shown that targeted incentives combined with a demand-orientated deployment of charging infrastructure can be successful, especially when the municipality, energy provider, and other stakeholders work together.

To increase the attractiveness of electric vehicles, clarities and liabilities have to be accomplished. Many uncertainties arise because the entry into e-mobility means to change routinized behavior and valid criteria concerning vehicle purchasing. For inhabitants and companies of a city it should be clear that the establishment of e-mobility is a long term decision. This includes the integration of e-mobility and the inherent infrastructure into policies, planning tools, regulations, municipal and regional action plans.

However, it should never stand by itself but should always be embedded into the entire transport system. Especially when it comes to planning new residential areas or the transformation of conversion areas sharing concepts with electric vehicles (cars as well as two-wheelers) should be considered, as it can be a possibility to reduce the amount of private cars. Likewise, corresponding infrastructure (storages and shelters, charging stations, cycle highways) for electric two-wheelers should be thought of. They offer a major potential for substituting trips by motorized private transport.

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