

## Introducing Additional Low Emission Mobility Offers in a Well Connected Area: Challenges and Opportunities

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### 1 ABSTRACT

European cities and regions strive for energy efficiency to meet the Europe 2020 goals on climate change and energy sustainability. At present, the transport sector is one of the main sources of greenhouse gas emissions due to the dependence on fossil fuels. The switch to renewable energies together with improvements in energy efficiency often cause rebound effects (e.g. increased use as a result of the environmentally friendly image) and therefore only partially serves the objectives sought. Hence, making the current mobility behavior more sustainable is of major importance to tackle environmental challenges and secure a high standard of living in European cities and regions.

Many cities already offer a well-developed and efficient transport network for public and individual transport. Previous efforts concentrated on a shift from car to public transport to improve transport performance within the city, avoid congestion and reduce air pollution. Taking into account progressive urbanization, it is obvious that public transport will reach its limits without major improvements (new lines, decreases in intervals) which are slow and very expensive and hence cannot be the sole solution. Together with the increasing individualization of society, more flexibility is needed. Therefore, an additional pool of mobility options targeting these user requirements and needs has to be provided.

In the EU project “Smarter Together” CO<sub>2</sub> savings are targeted by implementing projects in the fields of energy, renovation and mobility in Lyon, Munich and Vienna. An essential part of the project is the introduction of additional low emission mobility options in the Viennese project area in the northwest of the 11th Viennese district covering 1.5 km<sup>2</sup>. The area is well linked to public transport and the general transportation network. Our research focusses on the potential of mobility behavior changes in such a wellconnected area in terms of the individual and public transport network, and on opportunities provided by additional services (e.g. sharing offers) and challenges in the implementation of these new services.

To develop successful new concepts, residents’ requirements and needs have to be taken into account. Hence, a survey was conducted to capture information on mobility behavior and available vehicles, attitudes of the residents towards certain transport modes and willingness to use active modes, e-mobility and sharing services. The survey, including roughly 1% of the area population (N=21,300; n=241), was conducted partially online and partially face-to-face to ensure participation among different groups. Based on the collected data, the potential for alternative low emission mobility options was captured in a multi-level survey analysis. The results disclosed challenges and opportunities related to current options concerning user friendliness and communication strategies of existing services along with crucial points for the implementation of additional options.

One of the results showed that sharing services are hardly known to the residents. The participants revealed that e-bikes are not yet considered as an appropriate form of transportation since their features and advantages are not known. Offering car- or e-bike sharing services therefore does not only require a location with certain characteristics but also campaigns targeting the lack of knowledge. Active mobility has a good standing, particularly cycling. Many residents want to cycle more, but the surrounding structure does not encourage them, e.g. due to missing public bike parking at shopping facilities, transport stations and transportation hubs. Public transport is already heavily used, but could be stronger linked to other types of transportation. This should be achieved by implementing a “mobility point” offering locally bundled mobility options and information. The “mobility point” links different (multimodal) mobility services and acts as a major component of ICT solutions. This relatively new concept leaves ample room for additional low emission mobility options within the area leading to greater support, services and satisfaction to the travelers and users.

Keywords: mobility behaviour, implementation of social services, low emission mobility, environment, ICT

## 2 PROBLEM STATEMENT

The Europe 2020 goals on climate change and energy sustainability targeting greenhouse gas emissions, energy from renewables and energy efficiency pose a particular challenge for cities and regions (European Commission 2015). To meet these goals, an holistic approach is needed that takes into account various components of the city that are expected to contribute to the achievement of the objectives.

Smart city projects that concentrate on energy, renovation and mobility are a tool to approach energy related challenges and tackle them from various angles. Incorporating transportation is an essential part since it is one of the main contributors to greenhouse gas emissions due to the prevalent dependence on fossil fuels. In 2015, the transportation sector was accountable for one quarter of the total EU-28 greenhouse gas emissions and despite various efforts, emissions increased by 0.7 % compared to the previous year (European Environment Agency 2016). To alter the current development, technological solutions as the sole action are not enough to increase efficiency (Binswanger 2001). Rebound effects as a sideeffects of the transition to renewable energy and energy efficient technology (e.g. increased use as a result of the environmental friendly image) contribute to a negativ development and underline the importance of behavioral aspects in transportation. To achieve goals of effectiveness, consistency and sufficiency (Linz 2004, Fischer/Grießhammer 2013, Buhl/Acosta 2016), the mobility behavior has to be recorded in the respective social and spatial contexts (Scheiner 2009, Dangschat 2013) and changed towards more environmentally-friendly mobility (Hunecke 2015, Dangschat 2016).

More sustainable mobility behavior helps tackling environmental challenges and serves a high standard of living in European cities and regions. Main obstacle to the pursued behavior are predominant everyday routines which make decisions easier, give (behavioral) security and increase the identification. The confrontation with new and complex things, such as change, requires a great deal of attention and concentration (Roth 2003). This can be unsettling and is therefore often avoided or rejected. From a social psychological perspective, routine activities are a prerequisite for dealing with complex social situations (coping strategies) (Risser/Chaloupka-Risser 2011, Wilde 2013). To overcome routines of unsustainable mobility is not the only challenge in the field of transport policy since settlement development or the existing technical transport system can be regarded as “constraints” in terms of altering transportation choices.

To foster environmentally-friendly mobility behavior, influencing factors have to be investigated not only targeting the existing infrastructure, mobility patterns and needs but also taking into account previous transport policies and their outcome. After a period of car-orientation, improving and promoting public transport was one of the main agendas for several years in order to avoid congestion and reduce air pollution. The result is a well-developed and efficient transport network for public and individual transport in many European cities. Current challenges such as progressive urbanization and increasing individualization of society pose new challenges for the transport system since they cannot be addressed by public transport solely.

Major improvements in public transport are slow and very expensive. They also often do not address the flexibility needed. An additional pool of mobility options targeting these user requirements and needs has to be provided. Additional low emission mobility offers therefore concentrate on sharing services and active modes (walking, cycling). The usage of sharing services is quite different from owning a vehicle and therefore needs rethinking of how we go from point A to point B. Active modes on the other hand are partially integrated in our daily routines but require self discipline. Thus, additional low emission mobility offers are needed to break old habits. This is particularly challenging in an area with good traffic connections and infrastructure, such as many areas near the city center of European cities and regions are, since residents already have convenient options to go places.

## 3 RESEARCH FRAMEWORK

The smart city project “Smarter Together” aims to increase energy efficiency and reduce CO<sub>2</sub> emissions in the fields energy, renovation and mobility in Lyon, Munich and Vienna. This is done by implementing light house projects in selected urban areas in these cities; the introduction of additional low emission mobility services as the most promising in the mobility domain for the city of Vienna.

### 3.1 Study area

The Viennese study area covers the northwest of the 11<sup>th</sup> district “Simmering” with a surface of 1.5 km<sup>2</sup> and 21,300 inhabitants. The area is well connected to the public transport (underground and one commuter train line as well as several tram lines) and the general transport network (there are several major roads as well as an exit from the city highway).

The existing structure prevents major rebuilding work in terms of infrastructure which is one reason for taking a more behavioral approach towards energy savings in the field of mobility. The introduction of additional low emission mobility as a light house project in this field offers not only opportunities but also poses challenges due to the existing structure and related usage patterns.

By now, additional low emission mobility services are mainly introduced in urban development areas and not in existing urban structure. Altering mobility behavior is challenging itself but even more in an area that is well-connected in terms of individual and public transport network. Our research therefore focusses on the potential of mobility behavior change in a well-connected area as well as the opportunities provided by additional services and challenges in the implementation of these new services.

The provision of additional low emission mobility services alone is not sufficient to bring about behavioral change. According to the behavioral model of Fietkau/Kessel (1981), behavior is determined as a combination of influencing factors with knowledge transfer and explained as a component which is “[...] indeed a necessary but often not sufficient condition for behavioral change” (Schlaffer et al. 2002:13). The attractiveness of behavioral opportunities and incentives for a certain behavior play an important role. In order to create such offers and incentives, an extensive knowledge of the needs, desires and preferences of the target group is required.

### 3.2 Research design

To cover the above-mentioned knowledge of the needs, requirements and preferences of the residents in the study area, it was decided to conduct a mobility survey. Since all mobility options should be available to the respondents, persons aged 18 years and above living or working in the study area were identified as target group. The aim of the survey was to find out about

- the current mobility behavior of the respondents,
- the current use of transport by the respondents,
- the availability of different modes for households and the ability of persons to use the mobility options available,
- the prevailing attitudes towards different forms of travel,
- preferences with regard to an extension of the services,
- willingness to use active forms of mobility and
- behavioral change since the last relocation.

The survey thus covered questions on demographic data, current mobility patterns and related predispositions (e.g. driver’s licence), the image of transport modes and the attitudes towards them, usage of alternative modes of transport and the willingness to change towards more sustainable transport modes in the future. It was carried out as a combination of face-to-face and online-survey.

### 3.3 Survey realization

Due to the geographically restricted area of investigation, some survey distribution channels had to be excluded from the start. Therefore, the main focus was on dissemination activities of the urban renewable office GB\*3/11, direct mail and the support from the adult education center VHS Simmering in combination with a minor compensation for the survey participants. Due to the commitment of the urban renewable office GB\*3/11, the residents were not only able to participate online in the survey but also had the opportunity to complete the questionnaire jointly with the multi-lingual staff of the GB\*3/11 at the local mall. This ensured that persons with little or no German skills as well as persons with no internet access could participate in the survey.

The survey was conducted in the period from August to December 2016. 482 persons participated in the survey but only half of the questionnaires were completely filled in and could be used for the analysis. Nonetheless, roughly 1% of the area population (N=21,300; n=241) provided complete datasets for the mobility survey.

99 fully completed questionnaires were provided by GB\*3/11, 21 were the result of a cooperation with the VHS Simmering and 121 completed questionnaires were obtained by the online survey. It is thus a hybrid-sample, which ensures the participation of different groups of persons in the survey as mentioned above.

### 3.4 Survey evaluation

To capture the potential for alternative low emission mobility options, a multi-level survey analysis was carried out. This methodology builds upon conventional mobility surveys complemented by additional survey items on the meanings of different modes of transport and stated preference mode choice questions. Clusters were formed using the current mobility behavior as an input. These clusters were further analyzed to estimate the potential of different modes of transport. In addition, respondents had to take mode decisions for several stated preference questions in typical situations in the area (e.g. shopping trips). To study the potential of sharing projects for electric vehicles, these modes were given as options in the stated preference questions. The results of the mode decisions were applied to estimate a mode choice model that included the new modes. Finally, associated meanings of the different modes were given and analyzed for the groups to get a deeper understanding of how the different modes are perceived. This in turn can help with improving targeted measures to promote the modes amongst different groups.

## 4 BASELINE

As already mentioned, the study area is well-connected in terms of public and private transport. To underline this statement, the basic infrastructure components and main findings from the survey in terms of accessibility and usage are summarized.



Fig. 1: Viennese study area in the 11<sup>th</sup> district.

#### 4.1 Available infrastructure in the study area

The study area offers a close meshed road network with parking space at public ground. Furthermore, it is bordered in the west by the highway A23 (see Fig. 1). High-ranking transport stations in this area cover metro (U3 stations Enkplatz and Simmering) and rapid rail transit (S80 station Simmering and S7 station Geiselbergstraße). The local public infrastructure consists of trams and buses (lines 6 and 69A alongside the Geiselbergstraße, line 71 alongside the Simmeringer Hauptstraße, line 15A alongside Grillgasse/Dommessgasse).

Footpath connections are quite good whereas there is no uninterrupted cycling infrastructure within the study area. A continuous cycling connection can be found alongside the boundaries in the East and West. With only the one in the West being a separated bikeway, the one in the East an on-street cycle path next to parked cars. This cycle path links the area to the city center but does not serve the inner development. Public bicycle parking areas are very limited. Additional mobility options such as sharing services are only partially introduced so far. Bike sharing service providers concentrate on the city center and do not cover this territory; car sharing is available almost throughout the study area depending on the service provider.

#### 4.2 Accessibility and usage of transport modes

The findings from desk research on the transport infrastructure and spatial design are supported by the survey results.

88 % of the survey participants have a public transport stop nearby their residence (5-7 minutes walking distance). 77 % state that they have an annual ticket for public transport, which reflects their usage and is above the Viennese average of 51 % (Tomschy et al. 2016). Half of the respondents use public transportation every day (see Fig. 2). Only walking is a more prominent day-to-day mode of locomotion in this area.

The majority of the people surveyed said that they walk on their daily routes; this applies for about 60 % for both leisure trips and trips to work. These walks are often part of a longer trip that includes public transportation. Traveling to work, many walk less than 15 minutes. Longer footpaths are not that common among the participants of the survey and are often replaced by using public transport.

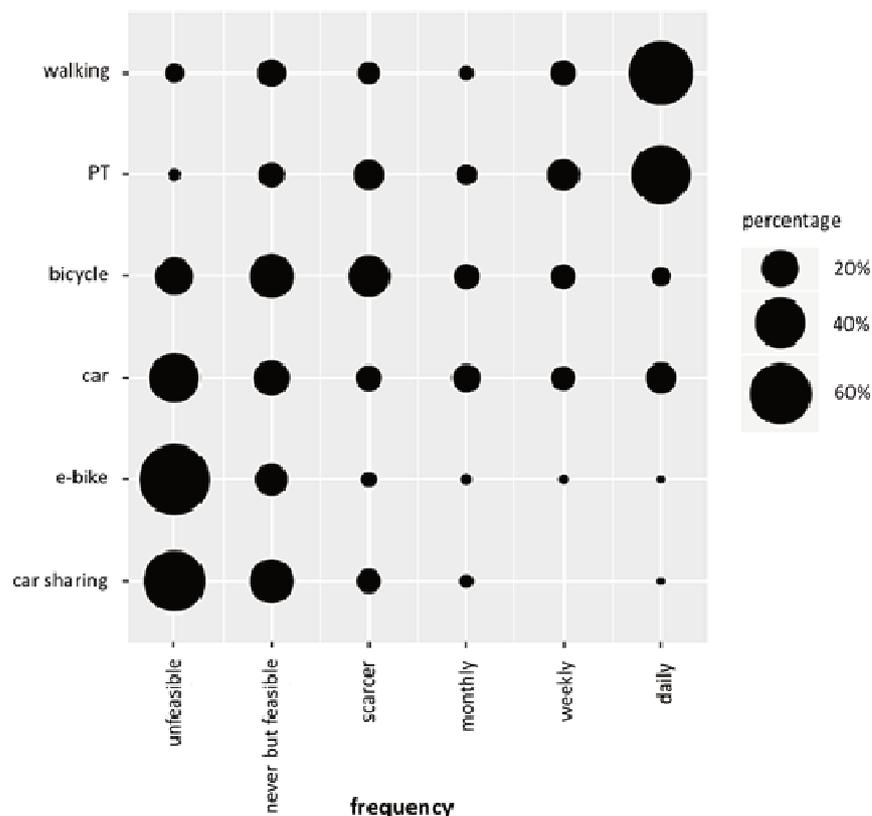


Fig. 2: Current usage of transport modes for the trip to work.

In Vienna, 47 % of the population has a driver's licence (Tomschy et al. 2016). Compared to the Viennese population, driver's licences are more widespread in the study area. 75 % have a driver's licence for a car and 19 % for a motorcycle. Even though two thirds of the survey participants have a driver's licence, only 59 % live in a household with one or more cars and 9% with one or more motorcycles or mopeds. 12 % have one car per household, 46 % have two cars and 41 % have no car at all. This means that most households are either oriented towards car or towards environmental friendly transport modes.

Owning a car is convenient in this part of Vienna. 51 % of the participants have a private parking space, 28 % have access to a public garage and 60 % can use public space for parking.

15 % of the respondents stated that they have a car sharing membership, which does not automatically equal the usage. 9 % actually use car sharing while 60 % state that they are not able to use car sharing for trips to work or leisure trips. The mobility patterns of the survey participants show that some use car sharing on a monthly basis with more frequent use on the trip to work. Those people who travel multimodal tend to use frequent car sharing offers compared to everyday drivers that are less likely to do so.

81 % of the respondents stated that they live in a household with at least one bicycle and 4 % live in a household with at least one e-bike. This result is rather good compared to an average Viennese household (Tomschy et al. 2016). Asked about the existing infrastructure on their everyday routes, 51 % indicate that they have access to cycle paths or bicycle-friendly roads. 59 % can use a storage space in their apartment building but only 21 % have a public bicycle parking space in their residential area.

Even though bike sharing is currently not available in the study area, 9 % of the respondents state that they use bike sharing. Therefore, they most likely use it in the city center that is the operation area of the Citybike provider and not in their residential area.

### **4.3 Concept of a mobility point**

As already mentioned, the aim of the project in the field of mobility is a reduction of CO<sub>2</sub> emissions from fossil fuels by increasing the usage of alternative options through vehicle supply, promotion of services, awareness raising and consequently mobility behavior change. Desk research and the survey results revealed that public transport is already heavily used, but there is potential to connect it stronger to other types of transport and foster multimodal mobility lifestyles. This can be achieved by implementing a "mobility point" offering locally bundled mobility options and information.

The "mobility point" is a link for different (multimodal) mobility services and acts as a major component of ICT solutions. As it is a relatively new concept, the implementation varies from one country to another regarding offered services and information for users. Additional low emission mobility options can cover various sharing services (e-bike, cargo bike, bike, e-car, car), public transportation, taxis, bicycle storage and car parking spaces and even packaging boxes at one location or within a specific radius. The different services provided can be used via one booking platform which makes it easier and leads to greater support, service and satisfaction to the travelers and users.

The survey was performed to reveal the main aspects regarding the portfolio of services, the site selection and other criteria that have to be considered to ensure its practical use.

## **5 POTENTIAL OF ADDITIONAL LOW EMISSION MOBILITY OPTIONS**

The current usage and attitude towards low emission mobility options have to be taken into account to provide not only the right service but also place it at the right location and design it in an appealing way. The survey revealed that cycling and sharing services are not at their best regarding publicity and as a result acceptance and should therefore be investigated in detail. The survey results offer the opportunity to capture different aspects regarding these modes of transport which are reflected in the following section.

### **5.1 (e-)Bike offers**

Even though only a few survey participants cycle on a regular basis, 41 % of the respondents stated that they would like to cycle more often (see Fig. 3). Preferred trip purposes for cycling are doing groceries (87 %), traveling to work (41 %) and accessing the nearest public transport stop (22 %).

Whereas cycling is regarded as very attractive and many respondents feel the desire to travel more frequently by bike, the e-bike is classified as much more unattractive. Both are regarded as environmental friendly and

leisure vehicles but the e-bike is perceived as the “lazy version” of a bicycle and rated as a little less independent (due to the rechargeable battery). Particularly in households with lower incomes, e-bikes are regarded as unnecessary luxury. The bicycle on the other hand is perceived as more conventional than the e-bike and hardly associated with luxury, laziness and high income.

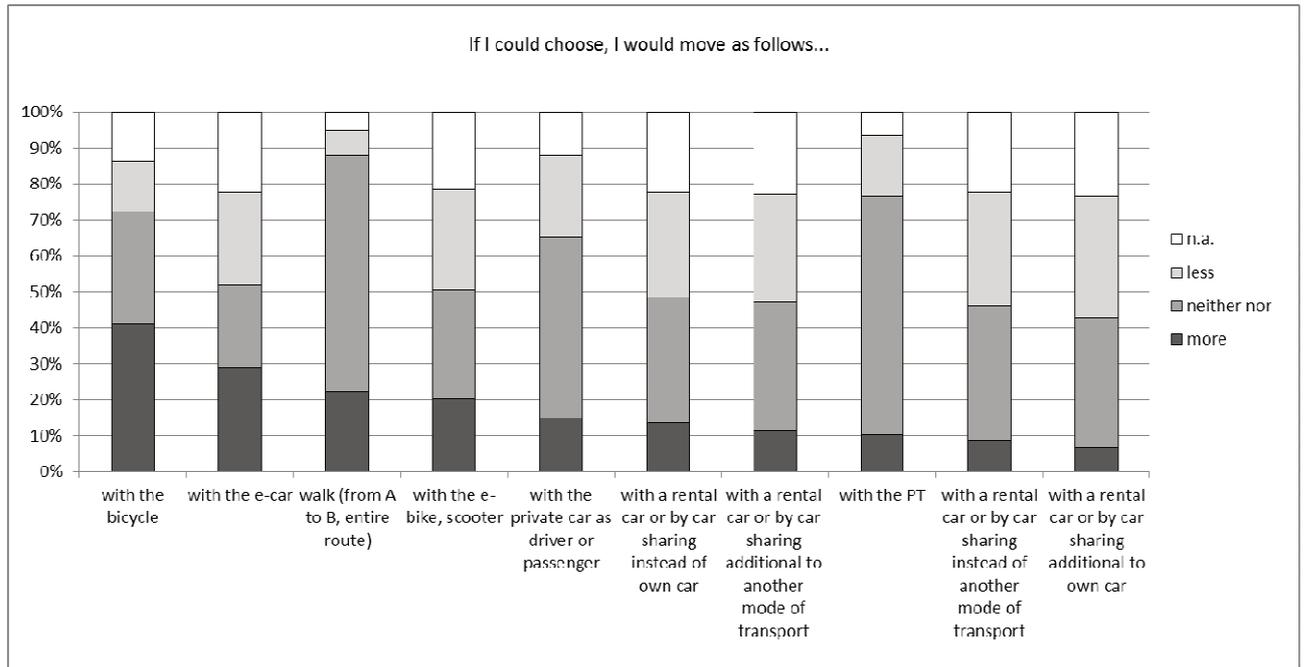


Fig. 3: Preferences for different mobility options.

The availability of private bicycles suggests that an upgrade to e-bikes is automatically associated with additional costs due to the investment needed. Interviews in a different project in Vienna called „flexiTrike“ (FFG 2017) revealed that people are not adequately informed about bike sharing options and related costs. The majority of the interviewees did not know bike sharing from the provider Citybike is free of charge for one hour. This should be taken into account interpreting the survey results. Current reservations to e-bike sharing can therefore arise from the fact that (a) it is regarded as unnecessary for those who already have a bicycle at their disposal, (b) e-bikes are associated with additional costs and (c) the study area is relatively flat and the additional drive therefore does not seem necessary at first not taking into account the transport of goods on the e-bike. The survey shows that the benefits of e-bikes are not obvious to the residents and that they tend to ignore the fact that it can be a useful means of transportation for loads or less athletic people.

While travel times of cars and public transport have no significant influence on the choice of means of transport, travel times of active modes have a negative effect on this choice. The travel times by bike and foot are assessed as approximately the same. Overall, the evaluation of the stated preference questions shows that people would use an e-bike sharing system at a cost of 1 Euro per trip if a time saving of approximately 6 minutes can be achieved. This highlights once more the importance of the location of such a service. If a detour of several minutes has to be accepted to reach the service provider, the likelihood of this 6 minute time saving is reduced and thus the probability of the use of the bike sharing system. It is therefore all the more important to achieve an optimal positioning of the sharing service to ensure useful connections and to offer a service with additional benefit e.g. e-cargo bikes for the transport of larger goods.

## 5.2 (e-)Car offers

Three quarters of those surveyed have a driver's licence but only half of them live in a household with access to a car. Although the majority of the residents could use car sharing, there are concerns regarding the concept. Asked about their preferences, 14 % would like to use car sharing more often instead of their own car. 11 % would like to use it on a regular basis in addition to other modes of transport. Therefore, their current use and preferences towards (e-)car sharing show that many people do not regard it as a desirable form of mobility which they intend to use in the future (see Fig. 3).

There are several reasons why (e-)car sharing is perceived that way: (a) little experience with car sharing which therefore cannot be assessed, (b) no need for several cars per household, (c) access or availability is currently difficult, (d) advantages are not known and inhabitants are thus not sufficiently informed.

By means of stated preference questions it could also be found that the travel time with e-car sharing has no significant influence on the choice as transport mode. The choice is heavily linked to the cost of public transport and walking distance as the alternative. Taking into account rather short foothpaths to public transport stops and the significant cost savings using public transport, attractive e-car sharing depends on a good distribution of the vehicles within the area. Car sharing or e-car sharing is especially interesting in areas which are not well-connected to the public transport network or for journeys that lead into such an area.

## **6 CHALLENGES AND OPPORTUNITIES IN THE IMPLEMENTATION**

Apart from the potential described, the implementation of different mobility options involves challenges and opportunities on the matter of reaching the target groups through additional services. Important aspects from the view of the users of different modes of transport are pointed out to raise awareness for prerequisites of mobility behavior change.

### **6.1 Car users**

Currently, a car is available in about every second household in the study area. Households with two cars are extremely heavily represented, which means that high dependency in everyday life can be attested. Due to the high car-affinity of these people, other transportation options are hardly considered by them, especially since parking space is not a scarce good in the study area. Interventions targeting the travel to work show therefore only limited potential. Leisure and other paths are far more promising and could have potential for minor behavioral changes.

In general, it appears difficult to persuade this group to use the car less often without a corresponding image change in the area. The unlimited parking space does support car usage and there are hardly any reasons not to use the car besides environmental and financial aspects. In this respect, people with lower incomes may be easier to win over by cost-effective alternatives; additionally, arguments like higher efficiency or shorter travel times can have some potential to encourage this target group to use alternatives for specific trips.

### **6.2 Public transport users**

The well-elaborated public transport in the study area can be regarded as hindering in terms of the introduction of additional low emission mobility options. The only notable weakness is the tram connection from East to West which is overcrowded during rush hour and can not be replaced or increased easily. Walking is rather unattractive along the main road (connection Hauffgasse to Enkplatz). The attractive bicycle infrastructure along the road „Am Kanal“ is not connected to high-ranking transport stations in a convenient way. Although the distance would be quite appealing, in particular anxious people and persons with children hardly use bicycle lanes next to busy streets and would need structurally separated bicycle paths. The highly-frequented tram line however provides the opportunity to introduce additional low emission mobility options successfully if these conditions are taken into account.

Apart from that, cycling is already regarded as acceptable mode of transport and can increase its attractiveness by providing bicycle parking spaces at transport stations.

### **6.3 Motorcycle/moped users**

Due to the low degree of penetration in the study area, motorcycle/moped drivers are a small group. Among the households with access to this type of transport there are mainly households with two motorcycles/mopeds which suggests use in the leisure time. Driving experience and speed are therefore essential usage criteria and environmental friendly alternatives can hardly compete.

### **6.4 Pedestrians**

Both the current mobility behavior and the attitudes towards footpaths show that the majority of the inhabitants regard walking as essential part of their mobility. The situation for pedestrians could be improved by providing additional options like bike sharing for longer distances. This allows for time saving as well as

a more convenient transport of goods. E-bike sharing can contribute to their quality of life as long as the offer is adequate in terms of availability, accessibility and related costs.

## 6.5 Cyclists

Those already using the bicycles want to maintain or expand this mobility pattern. The equipment of the households with conventional bikes does not encourage e-bike usage. E-bike sharing could be interesting for those people as long as unconventional and practical designs are available for rental.

## 7 CONCLUSION AND OUTLOOK

Achieving CO<sub>2</sub> savings in a well-connected area in terms of public and private transport is challenging. As inhabitants usually do not have to deal with major shortages or inconveniences on their day-to-day journeys and leisure trips, they are hardly required to alter their mobility behavior. The only way to encourage behavior change is the provision of attractive options that bring an absolute added value. The survey results show that a successful introduction of additional low emission mobility options strongly depends on the characteristics of the offer itself and how well the implementation addresses requirements for performance, minor shortages in the current infrastructure as well as the spatial conditions.

The results of the exploration of mobility habits and attitudes show that the limited openness towards transport alternatives is partly also related to the scarce information and experiences the inhabitants have regarding several transport options, especially e-vehicles and sharing services. For boosting the potential for behaviour changes, it is therefore reasonable to install infrastructures providing both information and low-level access to try out and test unfamiliar mobility alternatives for the local population. These insights were used for the conceptualisation of mobility points in the study area.

Based on the collected information from the survey, the technical features and site of the envisaged mobility point have been fixed. The approval is still pending and therefore the information on the services provided has not yet been officially disclosed to the public. The mobility point is about to be constructed on the centroid next to the Geiselbergstraße, a rapid rail transit station in the center of the area. The success of the introduction of additional low emission mobility options is to be evaluated in a second and third survey in the study area after two and three years, respectively.

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