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Environmental Benefits of Innovative and Integrated Urban Mobility Concepts

Summary

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Environmental Benefits of Innovative and Integrated Urban Mobility Concepts Summary

by

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1 Research Interest and Object of Investigation

Sharing offers, often integrated into public transport, are available in more and more cities nowadays. On the part of administrations and politics, regularly the question is being raised if sharing offers contribute to a reduction of traffic induced environmental pollution, and what effects these transport services have on land consumption. However, a systematic and comparative analysis of these integrated transport offers, which takes into account their actual impact on improving environmental balance and carbon footprint, is yet totally missing. The present research project will concentrate on all these issues.

In the course of this research project, the types of transport services being integrated into public transport will be analysed:

- **Public transport and public bikes,**
- **Public transport and public pedelecs,**
- **Public transport and station-bound car sharing** (including electric cars) and
- **Public transport and free-floating car sharing** (including electric cars as well),
- **Combination of public transport, public bikes and pedelecs, and one type of car sharing** ("triple combination").

In the process, integrated transport services in German cities with more than 50,000 inhabitants has been taken into account.

2 System, User and Usage Analysis

The conducted system analysis has shown that sharing offers are available in more and more cities. Furthermore, in many places they are combined with public transport at least at one of the following levels:

- Infrastructural integration or linkage of traffic offers,
- Integration of fares,
- Sales and distribution,
- Linkage with information and communication.

Figure 1: Number of Inhabitants per Group of Same Size Cities that could provide an Integrated Offer

Status quo Trend Scenario 2030 Integration Scenario 2030	public bicycles + public transport	public pedelecs + public transport	station-bound carsharing + public transport	free-floating carsharing + public transport	Public bikes/pedelecs + station-bound/free-floating carsharing + public transport
Cities with 50.000 - 100.000 inhabitants	3 % 8 % 12 %	0 % 0 % 0 %	25 % 30 % 35 %	3 % 3 % 3 %	0 % 5 % 7 %
Cities with 100.000 - 500.000 inhabitants	32 % 50 % 75 %	2 % 5 % 10 %	73 % 90 % 100 %	5 % 7 % 10 %	14 % 30 % 50 %
Cities > 500.000 inhabitants	92 % 100 % 100 %	5 % 10 % 15 %	100 % 100 % 100 %	76 % 80 % 100 %	30 % 65 % 100 %

Source: Mucha / Sommer (2014b)

Therefore, it is expected that the sharing offers will increase in the future and will be integrated in medium term into the public transport in most cities, in which they are already existing. This development will be assumed accordingly within the scenarios defined for estimating the potentials for the years 2020 and 2030 (see Figure 1) The trend scenario assumes a moderate increase whereas in the integration scenario, additional actions are taken to promote public transport services and to integrate them further into the public transport. However, in doing so, the availability of offers in big cities with a diverse and differentiated offer will furthermore be distinct from that in small and medium size cities. In the smallest considered city size group, it can be expected that even in medium term an integrated offer is not available everywhere - at least with regard to public bikes and free-floating car sharing.

In order to interpret the estimated potential of environmental relief for a group of people, a user and usage analysis has been carried out. The **user analysis** implies that today's users of all integrated transport services finally show similar sociodemographic characteristics. Mainly young adults and students have been reached. Unemployed persons, housewives and – husbands as well as senior citizens are clearly underrepresented among all costumers. The largest amount of costumers is aged under 45 years, whereby the number of men overweighs explicitly concerning the free-floating car sharing, and slightly concerning the other offers. The research project is predominantly dealing with people of higher and formal education, higher income and people living central to or close by the supply location (car sharing parking spaces, stations for public bikes etc.). Customers of sharing offers are using the public transport more often than average German citizens.

The **usage analysis** shows that despite the relatively wide distribution of integrated transport services, the average user frequency per customer remains low concerning all sharing offers. However, a low frequency of usage is not tantamount to a low meaning of the offers for the individual traffic behaviour. The integrated transport services are used by most customers for specific situations, for instance, the station-bound car sharing is used for a trip to the countryside, the public bikes for the journey to return from leisure activities at night. Consequently, they supplement the public transport

since they are available at times and space, in which the public transport, for economic reasons, cannot provide an offer. The backbone of mobility consists of public transport and partially also of the private bikes (see chapter 3 of the main study). In spite of interactions between public transport and sharing offers, a (notable) cannibalisation for public bikes and station-bound car sharing cannot be found. The same applies when considering free-floating car sharing (see chapter 4 of the main study).

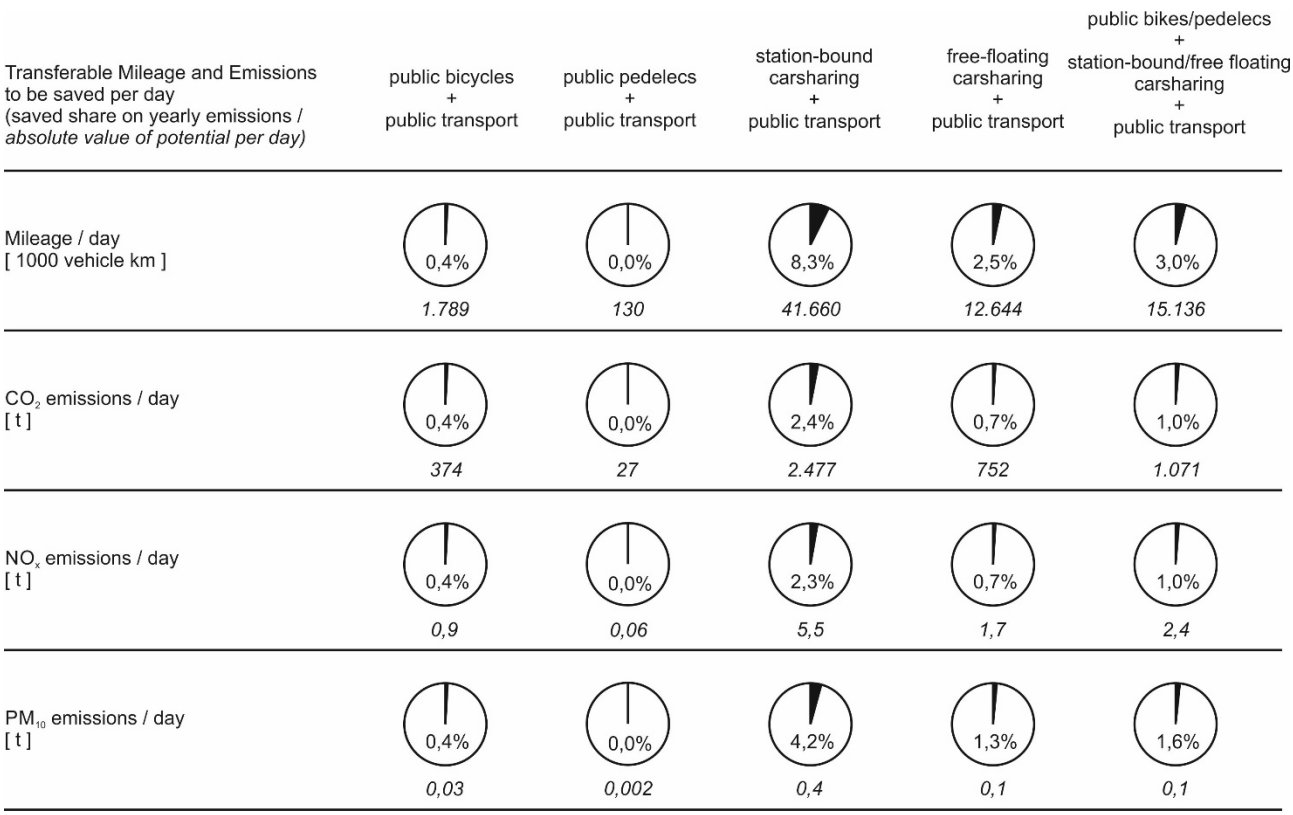
3 Environmental Impacts and the Potential of Environmental Re-lief

An analysis of previous research according to **environmental effects of sharing offers** has shown that particularly station-bound car sharing is able to influence car ownership and consequently the choice of transport services. When considering free-floating car sharing, this question cannot be finally answered yet. Ongoing research projects may possibly deliver knowledge about that. In case of Munich it has been proved that about 10 percent of user of free-floating car sharing disposed of own car “becauce of using car sharing.”

Nevertheless, both types of car sharing, station-bound and free-floating car sharing, have cars lower in emissions in comparison with the private car fleet. Car journeys can definitely be shifted to public bikes and pedelecs. But, based on current knowledge, these offers have no significant influence on the motorisation rate.

In order to estimate the theoretical potential of environmental relief that the integrated transport services in cities with more than 50.000 inhabitants might have, an **analysis of potentials** has been carried out as well. It has been estimated the quantity structure of car routes that are suitable for a shift to the integrated transport services as well as their model and scenario based transport performance (demand and potential model). With regard to the just identified transferable mileage, the emissions to be saved has been identified and the potential of environmental relief, concerning the traffic related emissions, has been estimated. For the status quo the results are summarised in the following Figure 2.

Figure 2: Transferable Mileage and Emissions to be saved per day – Analysis of Potentials Status quo



Source: Mucha (2015)

In the status quo[1], in cities with more than 50,000 inhabitants, the largest amount of all considered integrated transport services with over 8 percent of the daily mileage can be shifted to station-bound car sharing. Due to the small distribution of offers, free-floating car sharing and the triple combination show with 3 percent each a clearly weaker shifting potential. Though public bikes are available in numerous cities, the mileage that could be shifted to them, is extremely low due to the short travel distance covered by public bikes. Despite longer travel distance, the same applies to public pedelecs since they are currently available only in two cities.

Indeed, the analysis of potentials shows that a relatively high amount of the mileage can be shifted to station-bound car sharing – and if available – to free-floating car sharing as well as to the triple combination. Nevertheless, the resulting emission savings are quite low. This is related to the fact that car drives are merely shifted to low-emission car sharing vehicles. But, when considering an unchanging road behaviour, there is no reduction of the mileage. Regarding public bikes and pedelecs, the emission savings per transferred distance is relatively high, because these vehicles are almost emission-free. However, since the mileage, which can be shifted to all these offers, is outstandingly low, the emissions to be saved concerning these offers are finally extremely low, too.

[1] Mobiliy and spatial data from the year 2009, information about spread of integrated transport services from the year 2014

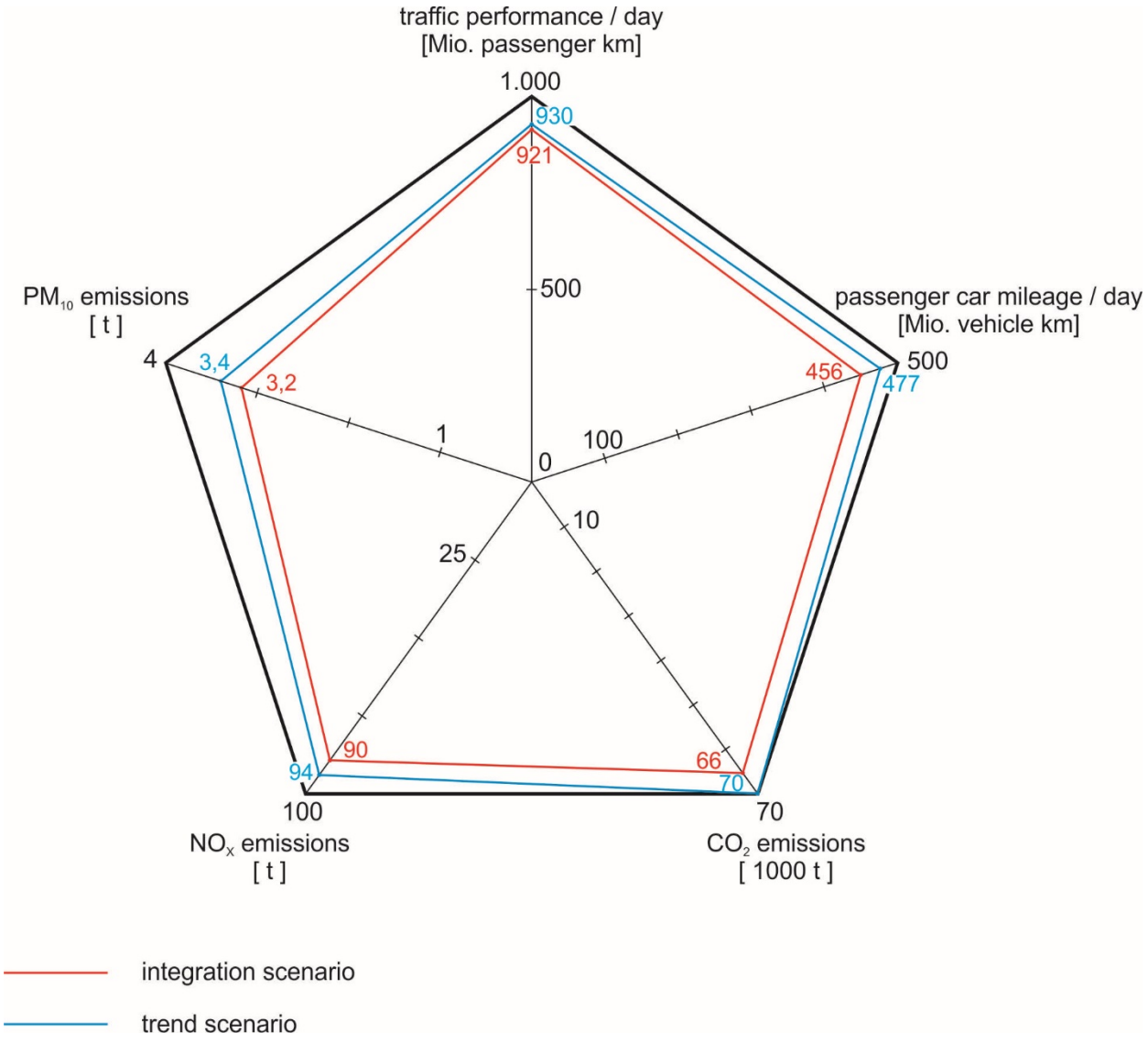
In the status quo, the savings of particulate matter emissions (PM_{10}) are the most evident. This can be explained by a different composition of the car sharing fleet in comparison with the private car fleet: For car sharing vehicles, it is understood that in average the vehicle fleet is 5 years younger and the emissions output is 25 percent lower. Technical innovations of these vehicles allow comparatively high savings in the status quo. In the year 2030, this difference will be barely recognisable, because then the corresponding automotive technology will be put into private vehicles as well.

More important than the shift of single car drives is therefore the impact of the situation of the modal choice[2], because, on average, people who do not own a car are eco-friendlier than people who own a car (see chapter 4 of the main study). The impact of the situation of the modal choice on the potential of the environmental relief has been proved for two different scenarios, the trend and integration scenario, through the estimation of the potential based on the model. Until the forecast horizon 2030, the same demographic framework conditions have been assumed for both scenarios. For the trend scenario, assumptions were made that are very likely on the basis of previous developments and the political regulatory framework of transport. As a result, a moderate increase of the offers for the integrated transportation services is perceived. In the integration scenario, on the other hand, a traffic policy orientated towards a stronger sustainability is assumed which may lead to a clear increase of offers (public transport and sharing offers) and a stronger integration of sharing offers into public transport. Because of this, integrated transport services will be available to more people. Above all, they offer an alternative to car ownership. Therefore, in the integration scenario a different situation of the modal choice is assumed in comparison to the trend scenario – the number of people without a car but with the availability of a season ticket is about 15 percent higher than in the trend scenario[3] (cf. chapter 9 of the main study).

[2] The situation of the modal choice describes the framework conditions of the choice of transport mode that is further influenced by the possession or availability of different transport modes of the individual transport (car, bike), the accessibility to modes of public transport (stops, car sharing stations, locations of public bikes and similar locations) and the possession of respective tariff offers of public transportation services (especially public transport season tickets).

[3] Trend scenario: 23 percent without car and 29 percent with public transport season ticket, integration scenario: 27 percent without car and 33 percent with season ticket (average share values of all adults); in the model specific values of groups of persons have been taken into account.

Figure 3: Comparison of essential results of the trend and integration scenario



Source: Mucha (2015)

Due to the different situation of the modal choice, the daily mileage in the integration scenario is 21 million vehicle kilometres lower (477 million vehicle kilometres in trend scenario compared to 456 million vehicle kilometres in integration scenario) compared to the trend scenario (see Figure 3). Hence, it can be inferred that in the integration scenario 3,100 tons less CO_2 are emitted. This corresponds approximately to the shift potential of the station-bound car sharing in the integration scenario and is considerably more than what could be reached by the shift to public bikes or pedelecs (see Figure 4). Thus, the situation of the modal choice has a significant impact on the potential of environmental relief so that an influence towards the direction of decreasing car ownership and increasing season ticket availability for the usage of public transportation services should be pursued with high priority.

Due to the further distribution of integrated transport services, noticeably more vehicle kilometres can be shifted in the integration scenario than in the trend scenario. Analogous to the status quo, the

station-bound car sharing has the highest shift potential again in the future with about 17 percent of the daily mileage. Furthermore, free-floating car sharing with about 7 percent and the triple combination with about 15 percent of the daily mileage show a relatively high potential, too (Figure 4). In large cities with more than 500.000 inhabitants it is even possible to shift every fifth vehicle kilometre through station-bound car sharing or every third vehicle kilometre through the triple combination.

Analogous to the status quo, the mere shifting of private car transport to vehicles with lower emission only leads to relatively small emissions savings. However, by changing the car sharing fleets into electric vehicles a much greater potential of environmental relief can be realised if the operating power is gained from regenerative energy sources. In the ideal case of only using regenerative energy sources, a reduction on the scale of the share of the saved car mileage would be possible (e. g. about 17 percent with station bound car sharing in the integration scenario 2030).

Figure 4: Transferable Mileage and Emissions to be saved per day – Analysis of Potentials Integration Scenario 2030

Transferable Mileage and Emissions to be saved per day (saved share on yearly emissions / *absolute value of potential per day)*	public bicycles + public transport	public pedelecs + public transport	station-bound carsharing + public transport	free-floating carsharing + public transport	public bikes/pedelecs + station-bound/free floating carsharing + public transport
Mileage / day [1000 vehicle km]	0,8% *3.567*	0,13% *584*	17,1% *77.777*	6,9% *31.283*	15,0% *68.246*
CO_2 emissions / day [t]	0,8% *520*	0,1% *84*	5,3% *3.526*	2,1% *1.418*	5,3% *3.506*
NO_x emissions / day [t]	0,8% *0,7*	0,1% *0,1*	5,7% *5,1*	2,3% *2,1*	5,6% *5,1*
PM_{10} emissions / day [t]	0,8% *0,03*	0,1% *0,004*	5,2% *0,2*	2,1% *0,07*	5,2% *0,2*

Source: Mucha (2015)

A great potential of environmental relief results from removal of private cars or from the decision against a new acquisition of a private car. People who do not own a private car are much more environmentally friendly concerning transportation, even if they are clients of a station-bound car sharing provider, than people who have a private car at their disposal. This means that these people use a car considerably less frequent, but instead use public transport and bikes more often. Moreover,

every car sharing vehicle can replace several private cars because these cars are not subject to the "exclusive" usage of one household. This also leads to a potential of environmental relief in form of a smaller space requirement for parking spaces.

Based on proven and generalizable findings, only the combination of public transport and station-bound car sharing substitutes private cars and thus saves space for stationary traffic. To identify the potential of saved **parking spaces**, the amount of theoretically not required cars and the amount of car sharing vehicles, which theoretically would have been required, too, has been estimated in the so-called car sharing model in order to cover the distances which are transferable to station-bound car sharing (see chapter 4 of the main study). The result out of this has been used for the space calculation hereafter.

Providing that private vehicles can only be abolished, if

- All journeys with private cars could be transferred to car sharing,
- The accessibility of public transport was rated with „good",
- The annual mileage of private cars would not go beyond 10,000 km,

every tenth private car can be substituted (approximately 1.5 million vehicles). In consideration of the additional required vehicles (approx. 80 thousand) for car sharing, the amount of theoretically saved cars as well as the potential of saving space due to station-bound car sharing can be determined. In total, 2.4 million parking spaces with an area of approx. 58 square kilometres could be saved; this equals an area of approx. 8.100 football pitches. However, whether these parking spaces will be used differently or not, depends substantially on the local government's willingness to rededicate the released area. Otherwise, due to the high parking pressure, a space saving for parked vehicles could not be achieved.

In order to estimate the effect of a changed availability of private cars by station-bound car sharing, the results of the car sharing model has been used for a further calculation of the potential (feedback of car sharing model and model of demand). Due to this feedback, in the model of demand, the number of people not having an own car, compared to the first model calculation, has been increased-hence, the situation of the change of transport choices has been changed. This was done under the assumption that people, who recently do not own a car, behave just like people, who stated in the MiD-survey that they have no car (see chapter 8 of the main study).

Of all considered groups of city sizes in the status quo, five to nine percent depending on the kind of emission can be saved, in the integration scenario about nice percent, by the shift as well as through the substitution of private cars. Finally, this is clearly more than can be achieved just through the transfer of journeys to integrated transport services.

In addition to the above-named potential of environmental relief, it can be assumed that sharing offers are responsible for indirectly positive environmental effects. Like this, they are "advertising" for the principle "using instead of owning" and hence, are showing alternatives to private car owning. Public bikes are increasing the visibility of bikes and make a contribution to cycling promotion on a municipal level, especially in cities with low bike traffic.

The largest potential of environmental relief can be expected if the situation of transport choices, especially the availability of private cars, will be changing. This change – **from car owner to car user** – is a process for the longer term that is basically dependent on both the quality of alternatives and the quality of integrated transport services. In this regard, both components of integrated transport

services – public transport and sharing offers – as well as the correlation of both components has to be taken into account:

- The classic public transport, as back bone of mobility to take daily and regularly trips, should be able to adapt crucial parts of the individual traffic behaviour. This is only possible when certain quality standards with regard to spatial development, temporally operation, sales and tariff access etc. are fulfilled. If these standards are not fulfilled, the dependency of private cars will be high, with the result that many sharing offers cannot survive for economic reasons. The system analysis has shown the better the public transport the more numerous and more diverse the sharing offers. The users of sharing offers are usually costumers of public transport, and often customers of season tickets.
- For rarely taken journeys, in which the public transport represents no alternative due to a long journey time, transportation needs etc., sharing offers could be very suitable due to their flexibility. Station-bound car sharing meets the requirements of this "supplement-mobility" to a high degree due to its system features and its tariff structure: If a car sharing station is available near people's place of residence, there is normally no spatial constraint. Moreover, a sufficient number of cars guarantees that a car is available at almost any time. The tariff structure and the ligation to a pick-up station lead to the fact that short journeys and journeys parallel to axes of public transport are rather unattractive.

4 Legal Requirements of Car Sharing and Public Bicycle Rental Systems

A sufficient number of parking spaces is a basic prerequisite for the growth of car sharing. Therefore, one essential measure for the promotion of car sharing is to provide parking spaces for car sharing in the public space. However, while implementing this idea practically, a few legal difficulties come up, which will be discussed in the following.

Car sharing as a component of integrated transport services faces numerous legal issues concerning the development of the respective distribution network. Especially the station-bound car sharing related establishment of assignable parking for the particular providers causes difficulties in practice. A federal regulation on the establishment and designation of car sharing stations is not available. The federal states have made various attempts to satisfy the need for assignable car sharing spaces. The applied instruments are not always uncritical for a provider-specific designation of car sharing parking.

There have been different attempts on the level of the state law and the federal law to solve the parking space problem through **road traffic law** and the **road law and right of way** of the federal states. The road traffic law must be distinguished from the road law and the ROW of the federal states. In both areas there are autonomous law matters with different regulation purposes.[4] The purpose of the road traffic law is to ensure the participation in traffic and its safety and efficiency. It regulates the

[4] Janker in: Burmann/Heß/Jahnke/Janker (Hrsg.), StVR, Kommentar, 2012, Einführung Rn. 90.

use of the public transport area for traffic purposes.[5] The road traffic law seeks to ensure the participation in traffic and its safety and efficiency and regulates the use of the public transport area for traffic purposes.[6] The legislative power for this is in accordance with Article 74 para. 1 no. 22 of the Basic Law in the realm of the Federal Government and is therefore associated with the competing legislation. The road law and right of way governs the legal relations of public roads, thus their origin, commissioning, dedication, classification, migration and termination by confiscation.[7] Due to failure to register the matter of the street right in art. 73 and 74 of the Basic Law, the federal states have the legislative competence for the state's roads, community roads and other local roads, rural roads and other confined public ways in accordance with Article 30 Basic Law, 70 para. 1 Basic Law. The previously missing uniform federal solution lead to numerous municipalities issuing substitute provision themselves.[8] The country's legal options were implemented by applying the instruments of public use, the special right of use as well as the (partial) confiscation. At federal level, the establishment of car sharing parking spaces without a change in the provisions of § 6 para. 1 StVG depending only on road law reasons is not possible.[9]

Prerequisite for the use of the car sharing parking areas is primarily a corresponding **marking of the vehicles**, in order to clearly distinguish them from other road users as car sharing vehicles. If necessary, an extension of Appendix 3 to § 43 para. 2 StVO must be performed to introduce a uniform designation of car sharing parking spaces. Differences in the **signage** of parking spaces may arise from the fact that it must be possible to either assign a vehicle to a specific parking space or any vehicle of a car sharing provider's pool to any parking space of the car sharing station. The signs listed in the appendix of the Road Traffic Act are final, therefore the communities have no entitled right to "signs inventions". For a legal signage of car sharing parking zones, appendix 3 needs to be altered according to § 42 para. 2 StVO.[10] As protection against foreign parking especially constructional coverings come into consideration. Again, this needs to be initiated by the federal legislature, because § 43 para. 1 sentence 1 StVO and annex 4 for § 43 Abs. 3 StVO, for instance, do not take into account any folded or retractable transport facilities[11].

Furthermore, in terms of regulating the parking space problem, **construction planning and building laws** come in question. Planning measures may support the implementation of car sharing concepts but are, however, optionally associated with a high expenditure of time. A designation of concrete car sharing parking spaces in the zoning plan is conceivable by a representation of land for non-local traffic according to § 5 para. 2 no. 3 BauGB. However, a claim to implement the parking spaces

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5 Janker in: Burmann/Heß/Jahnke/Janker (Hrsg.), StVR, Kommentar, 2012, Einführung Rn. 90.

6 BVerfG, Urteil vom 10.12.1975 – 1 BvR 118/71, NJW 196, 559 (560); BVerfG, Beschluss vom 9.10.1984 – 2 BvL 10/82, NJW 1985, 371 (371); Janker in: Burmann/Heß/Jahnke/Janker (Hrsg.), StVR, Kommentar, 2012, Einführung Rn. 86, 88.

7 BVerwG, Urteil vom 28.11.1969 – VII C 67.68, BeckRS 1969 30425332; Richter, Car-Sharing, Nachhaltig mobil – eine rechtliche Einordnung, 2007, S. 70f.

8 Glotz-Richter in: Beckmann/Klein-Hitpaß (Hrsg.), Neue Mobilitätskonzepte, 2013, S. 223.

9 Richter, Car-Sharing, Nachhaltig mobil – eine rechtliche Einordnung, 2007, S. 74, der sich zugleich ablehnend gegenüber einer solchen Erweiterung ausspricht, da die Möglichkeit der Einziehung als ausreichend angesehen wird. S. derselbe, Car-Sharing, Nachhaltig mobil – eine rechtliche Einordnung, 2007, S. 86ff.

10 Guber/Scherer, Gutachten Carsharing vom 15.11.2013, S. 22.

11 Guber/Scherer, Gutachten Carsharing vom 15.11.2013, S. 22.

declared in the zoning plan does not arise. On this planning level only areas for certain uses can be assigned and saved, but a concrete establishment of car sharing parking zones cannot take place at the moment, because the community is dependent on the establishment of development plans. The land use plan is not binding, but does make sense for the designation and protection of areas as part of a community-wide car sharing concept, since it is also set up for the entire municipality. According to § 9 para. 1 BauGB car sharing parking spaces can be set up close to major public transport stops, for example.[12] The promotion of car sharing within the parking space statutes and ordinances for new buildings can make a contribution in the individual case, though it cannot deliver a substantial impact on car sharing as a whole.

Besides the described solutions according to road traffic and road law as well as construction planning and building regulations, parking spaces for car sharing providers in **non-public areas** are also possible, of course. Currently this is the normal case for car sharing stations. For this, estate properties owned by the municipality or municipal-operated businesses as well as private properties come into consideration. Public contracts, which are used in public areas, should be distinguished therefrom.

The possibility of a vendor-specific construction of car sharing parking will now be facilitated by using an independent **car sharing law**. In its "Action Program Climate Protection 2020" from December 2014 the BMUB points out to the project of a car sharing law.[13] This would also circumvent the discussed issues of hostility towards privileges. Based on a car sharing law, traffic laws may be extended by preemption facts again. Such an approach has already taken in the field of electro mobility. Using such a non-independent statutory authorization in order to create separate parking spaces for car sharing parking as well as guidelines for the defining and labelling of car sharing vehicles would result in a uniform and legal privileging of car sharing vehicles. In addition, the law should also include an exemption from parking fees and regulations for the definition and identification of vehicles.[14]

For a federal law of this kind, regarding the basis of competence, there is concurrent jurisdiction in the form of the air pollution control according Article 74 paragraph 1 no. 24 Basic Law, the business law according Article 74 paragraph 1 no. 11 Basic Law as well as traffic according Article 74 paragraph 1 no. 22 Basic Law. When the electro mobility law takes into account the concurrent jurisdiction between the air pollution control pursuant Article 74 paragraph 1 no. 24 basic law and the business law according Article 74 paragraph 1 no. 11 GG,[15] it suggests itself to make use of it for a law to promote car sharing, as it shares the same goals of promoting environmental and climate friendly mobility. The public authorities, which are competent according to federal state law, can be granted – with legal certainty via means of federal law and uniformly for federal highways, state roads, district roads and local roads – the option to build parking spaces for stationary-bound car sharing vehicles (for companies chosen in a competitive tendering procedure).

For **bike rental systems** various constellations are conceivable. If the bicycles are only parked in terms of § 12 StVO, it is permitted under the license-exempt public use. This also applies below the

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12 ILS (Hrsg.), Mobilitätsmanagement in der Stadtplanung, 2009, S. 48.

13 BMUB (Hrsg.), Aktionsprogramm Klimaschutz 2020, Dezember 2014, S. 41.

14 BMUB (Hrsg.), Aktionsprogramm Klimaschutz 2020, Dezember 2014, S. 41.

15 Vgl. aus der amtlichen Begründung BT-Drucks. 18/3418 S. 12.

building sizes regulated in the federal state law according to bicycle parking quantities, for which no building permit is required. However, a building permit may be required, if no exceptions are provided in the building codes or specific sizes of these facilities are exceeded. In addition, special use permits are regularly required whenever public areas are covered with buildings.

5 Recommendations

In order to reduce the traffic-based environmental burden in cities, the change of the situation of transportation choices in favour of the environmental alliance is decisive. To increase the number of people having a season ticket for public transport and to decrease private car ownership, sharing offers as well as their stronger integration into public transport are important elements. Yet first of all, the basis for a life without a car is an attractive and efficient public transport as a backbone of mobility which enables a large part of ways to be covered, usually independent of the weather and health restrictions. Hence, the responsible entities should define standards for an attractive and customer-orientated public transport within the scope of the planning of the local transport. On this basis, they should deduce targeted measures and provide sufficient financial means for their realisation. Transport companies and associations should use the possibilities of digitisation in the fields of information, communication, sales and tariff even more than hitherto. The federal government can strongly influence the financing and infrastructure of the public transport by means of regionalisation and unbundling laws. If objectives concerning the protection of environment and climate are taken seriously, not only the maintenance of the infrastructure of the public transport is necessary, but also their expansion in many parts of Germany. Alongside the “classic” transport infrastructure, this also applies for the IT-infrastructure of the public transport (e.g. electronic fare management systems, data hubs for the connection of data from different transportation providers).

Based on an attractive public transport, the already existing sharing-offers should be linked with the classic public transport so that integrated transportation services are formed which allow customers an easy, comprehensible and reliable use of all offers. As the analysis of potentials (cf. chapter 3) has shown, the integration of the station-bound car sharing leads to the greatest potential of environmental relief of the analysed effects (air pollutants, climate, land consumption) in comparison to the other integrated transportation services. That is why the station-bound car sharing should be supported and promoted with a higher priority by the federal government, the federal states and the communities. This prioritisation refers to the analysed effects of this study and the current state of research; if considering different effects or a different weighting of the individual effects, the promotion of other integrated transportation services can have a higher relevance (e.g. the support of the bike traffic in general through the introduction of a bike rental system).

For further growth of the car sharing initiative it is necessary to be able to assign parking spaces in the public space to the individual car sharing-providers. By introducing a distinct car sharing law on the federal level, the legal preconditions for this purpose can be created (cf. chapter 4).

The potential of environmental relief of car sharing can be increased considerably by using electric vehicles if the operating power is gained from regenerative energy sources. In the ideal case a reduction on the scale of the share of the saved car mileage would be possible. Hence a promotion of purchase of electric vehicles for car sharing fleets would be an effective measure to reduce ecological impacts (if the operating power is gained from regenerative energy sources). This applies similarly to a promotion of purchase of electric busses.

While linking public transport and sharing-offers all four levels of integration, namely transportation offers or intermodal connection points, tariffs, sales as well as information and communication, should be taken into consideration (see chapter 5 of the main study). Thereby the following measures are especially advisable from the perspective of the authors:

- The **establishment of intermodal connection points** ("mobility points", "mobility stations") contributes to the visibility of individual transportation offers and raises the awareness of the (potential) customers that public transport also includes public cars and public bikes. This leads to changes of awareness and behaviour from monomodal car-mobility to public multi-modality.
- The successful **solidary model** (semester ticket, job ticket) should be transferred to the integrated transportation services during the tariff setting of the public transport. This leads to a bigger user group quickly, reduces the inhibition threshold of the usage and changes the traffic behaviour in favour of a more frequent usage of transportation services in the medium term.
- The access to every single transportation service should be accomplished by **means of one customer media** (i.a. chip card, smart phone), if possible. For this, the public transport has created a technical and organisational precondition in form of the VDV core application which can be used to gain access to the service as well as for the payment and account thereof. Moreover, the constantly progressing system of electronic fare management and the integration of the sale should also be used for selling further transportation and sharing offers.
- Besides the physical visibility, the visibility of all transportation offers plays an important role for **integrated information** services on the smart phone and pc. The "perceived" public transport offer will become even more attractive if information about sharing offers are integrated into the classic timetable information. The usage can be further simplified if next to the mere added value of information also the purchase of tickets as well as the reservation and booking of sharing vehicles would be possible.

Employed persons as well as retirees and pensioners cause the greatest part of car mileage and thus, they also have the greatest potential of environmental relief. In order to be able to deduce the estimated potential, **target group specific approaches** are promising for the product design and communication with the customers (market segmentation). Especially those groups of people which have not yet considered sharing offers as an option despite of a great shift potential should be the focus of the marketing. Currently, particularly people that are older than 45 years use the integrated transportation services very infrequently. In the following, examples for possible measures for one important target group will be presented.

The retirees and pensioners constitute a high and growing potential due to the demographic change as well as the increasing motorisation of this group. The comparatively big group of retirees and pensioners under 75 years is responsible for approx. 9 percent of the whole car mileage of the adult population of Germany and therefore, belong to the main causers of motorised individual transport and the resulting environmental pollution. However, this group is well suited for sharing offers objectively due to their transport behaviour (for this purpose, see chapter 8 and chapter 10 of the main study).

- The car journeys are considerably shorter than those of employed persons. Therefore, alternatively the usage of public bikes and pedelecs is possible relatively frequently.
- Owing to the fact that they are not employed, the daily journey to work as one main reason for the usage of station-bound car sharing is not given.
- The car mileage per year lies within an area in which the private car is often more expensive than car sharing and thus could be abandoned if alternatives are available.

Elderly people do not only prefer easy and comprehensible offers, but also comfortable and barrier-free ones to a much greater extent than younger people do. That is why sharing vehicles, public bikes and cars alike, should satisfy the demands of elderly people by means of their design (e.g. in form of parking aids, higher seats in car sharing vehicles or lower entries of public bikes). Moreover, it is important to consider higher safety requirements in comparison to other groups of people. This includes several aspects starting with a personalised, theft-proof and loss-protected driving licence or customer media up to well-lit access paths to the stops or mobility stations.

In addition to the measures on the supply side pointed out above, measures on the demand side are also necessary in order to reach the estimated potentials at least partly. For the reduction of setting-based and informational obstacles measures of the mobility management can be expedient, especially regarding less considered groups of people (e.g. target group specific events, direct and dialogue marketing, introductory offers).