

# Future of car-sharing in Germany: Customer potential estimation, diffusion and ecological effect

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## Keywords

car-sharing, mobility, travel behaviour, eco-balancing of traffic, social milieus

## Abstract

The article summarises selected key results of the project "Future of Car-Sharing in Germany", funded by the Federal Ministry of Education and Research. The target of the research was to improve the informational basis for the traffic and environmental assessment of car-sharing in Germany by means of an empirically based estimation of the medium-term perspective (time horizon 2020). Intermediate results were presented at the ECEEE congress 2005.

Basis of the demand analyses, which were aligned to the milieu concept, was provided by two surveys (a non-representative survey of circa 500 customers and former customers and a representative survey of around 1,500 non-customers). In the interviews two service scenarios of a "new" Car-Sharing in the shape of short-term car rental without ecological requirements were used. The analysis of the surveys was differentiated on two levels: On general level covering the whole sample and on the level of sub-samples covering the different milieus.

Findings are provided with regard to prospective customers (social milieu affiliation, social profiles, notional using patterns) and backgrounds of their interest in short-term car rental as well as results of a customer potential estimation and a traffic and eco-balance. The results show that a diffusion of short-term car rentals appears feasible with an eco-balance remaining positive. For various reasons, the market development to be achieved by the year 2020, however, should be relatively limited. Similar is true for the potential contribution of car-sharing to a sustainable mobility altogether.

## Introduction

As a business model car-sharing is a sort of short-term rental for cars. However, it was not invented by car renters in search of new business fields<sup>1</sup>, it is in fact a product of the car-critical ecological movement.

In Germany, car-sharing started in the late 1980s as a social innovation: car mobility was initially provided in the form of self-help projects of local communities and used by its members. Prototypical users were persons who already lived without a private car or persons who were willing to sell their already rarely used car. A comparatively large number of users who sold their own car or waived to buy one and further reduced their car use after joining a car-sharing organisation resulted in a positive eco-balance.

In the second half of the 1990s the mobility research observed a system transformation of the German car-sharing (Byzio/Heine/Mautz 2002, Wilke/Bongardt 2005). Civic self-help project evolved towards an entrepreneurial self-image. Car-Sharing organisations that understood themselves as mobility service providers became dominant in the car-sharing market. Through professionalisation, standardisation and harmonisation of the fragmented provider landscape a broad market diffusion of the service - going beyond pioneers and supporting groups - was targeted. However, even though major growth rates exist, in 2006 the clientele of car-sharing comprises only approx. 80,000 users.<sup>2</sup>

1. Only in the late 1990s, car-sharing in form of 'Kilometre Leasing' has been examined as a potential new business field for car retailers (Frick/Diez/Reindl 1998).

2. This number is significantly lower than the proposed market potential of earlier studies (Baum/Pesch 1994, Frick/Diez/Reindl 1998, Loose/Mohr/Nobis 2001, Maertins 2006). While these analyses are related to the current form of car-sharing.

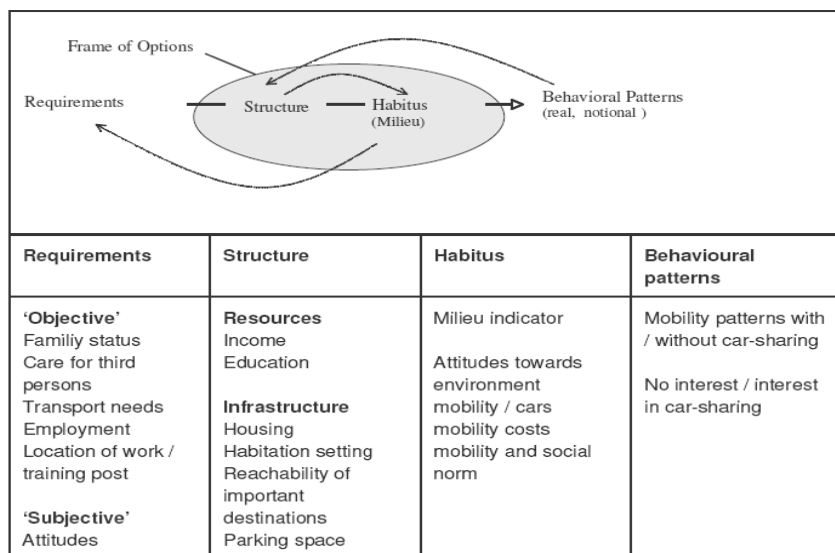


Figure 1: Explanatory model of the use of and the interest in car-sharing

Despite the system transformation, the continuing eco-efficiency of car-sharing was regarded as certain. If new users and their possible new using patterns would change the eco-balance of car-sharing, is a question that was either not posed or positively responded (Holm 2003).

The presented findings of this article are results of the research project 'Future of Car-sharing in Germany', funded by the German Federal Ministry of Education and Research. Its aim was to improve the informational bases for the traffic and environmental assessment of car-sharing in Germany by means of an empirically based estimation of the medium-term perspectives (time horizon 2020). Basic hypotheses of the project were 1. the transformation of the car-sharing system is both condition and result of the targeted market diffusion, and 2. the system transformation is likely to alter the eco-balance of car-sharing.<sup>3</sup>

This contribution summarises selected pivotal results of the project for the field of private customer<sup>4</sup> car-sharing and intends to answer some crucial questions of the car-sharing research. After outlining the exploration approach and the empirical bases (section 2), a comparative characterisation of today's customers and prospective customers is being provided by means of socio-demographic features and usage patterns (section 3). Results for the condition configurations of the expressed interest will be described (section 4). On the basis of the representative survey of mainly non-customers, an estimation of prospective customers (section 5) and the ecological impacts resulting from car-sharing use will be undertaken (section 6). The article will conclude with a brief evaluation

ing, this study is based on a scenario of a modernized service offer. Therefore and due to methodological differences the referred studies and the numbers of this article are not directly comparable.

3. For lack of space, this article is limited to the description of the ecological impacts of short-term car rentals and does not provide a comparison with the present car-sharing system. The question if the eco-balance would stay positive was decisive. – The eco-balance used the indicator CO<sub>2</sub>-equivalents. A sub-project also investigated land use impacts.

4. In the context of the project, comprehensive analyses were conducted regarding the newly developing (and yet rarely investigated) car-sharing for business customers.

of the prospective contribution of car-sharing to a sustainable mobility in Germany (section 7).

## Exploration approach and empirical bases

### EXPLORATION APPROACH

Specific to the exploration approach are the underlying explanatory model and the two possible service scenarios that were used for the interviews. The explanatory model (see Figure 1) was developed on the basis of a theoretical reference frame. It is aligned to the social-scientific milieu concept and, inter alia, bases upon theoretical and empirical analyses of Vester et al. (2001). Vester et al. have theoretically reconstructed the milieus that are differentiated by Sinus Sociovision Heidelberg for Germany, mainly by recourse to the French sociologist Pierre Bourdieu (1993) and enhanced them through own empirical research.

According to the explanatory model, the day-to-day behaviour of individuals and consequently the mobility behaviour are determined by structural conditions and the corresponding milieu-specific habitus.<sup>5</sup> Relating to the structural conditions, the habitus acts like a filter. "The term habitus refers to the living conditions that influence the day-to-day life of individuals. It names a complex of ways of thinking and views, perception patterns, principles of judging and valuing that structure the actions and thus the lingual and practical expressions of social actors' (Hillebrandt, translation by the authors). Structure and habitus together evolve the *frame of options* for decisions and actions of individuals. The elements of the model were operationalised and displayed as variable complexes for the survey. A 'milieu indicator' developed at the Hannover University for this project reflects the habitus variables in this model and allows for the attribution of the social milieu affiliation of the interviewees (Vester/Gardemin/Teiwes-Kügler 2006).

5. Different from what this simplified model shows, impacts do not emerge linear in reality. Dashed arrows in Figure 1 indicate dependencies and interactions between the model elements.

**Table 1: Service scenarios short-term car rental**

Basic scenario	Extended scenario (= Basic scenario plus additional options)
station-based (max. 5 minutes walk to next station)	compact car in traffic area (without stations)
offhanded use without prior booking and booking without fixed return of golf-class vehicles and compact cars	one-way use
chip card for use and charging	
perfect adaptation of costs to time used and kilometres travelled	

**Table 2: Car-sharing customers and non-customers interested in short-term car rentals**

Interest in short-term car rentals	Customers of car-Sharing		Non-customers of car-Sharing	
	absolute	share	absolute	%
Interest (total)	418	87 %	644	44 %
... only in basic scenario	138	33 %	146	23 %
... in both scenarios	254	61 %	317	49 %
... only in extended scenario	26	6 %	181	28 %
No interest	64	13 %	816	56 %
Total	482	100 %	1460	100 %

Two scenarios illustrated car-sharing in the year 2020 in the enquiries – a ‘basic scenario’ which pooled the current innovative elements of car-sharing and an ‘extended scenario’ which was supplemented by additional options like one-way driving (see *Table 1*). The intention was to confront the interviewees with a range of choices that are hypothetically realised by 2020. Both scenarios assume an area-wide service in German cities. Car-sharing customers and non-customers were interviewed regarding their interest in the two service scenarios.

The use of scenarios should provide a consistent reference and avoid associations with present various car-sharing options. In order to obviate influence on interviewees (as far as possible) through positive or negative connotations associated with today’s car-sharing, the term car-sharing was replaced by the more neutral term car rental.

**EMPIRICAL BASES**

The following results base upon telephone interviews (CATI) in the field of car-sharing for private customers that were carried out in the period of September until October 2005:

- a non-representative survey of circa 500 customers and former customers of selected car-sharing organisations, and
- a representative survey of about 1,500 non-customers (German-speaking holders of driving licences between 18 and 75 years) in German cities with more than 100,000 residents.

**Characteristics of respondents interested in short-term car rentals**

**INTEREST IN SHORT-TERM CAR RENTALS**

Not surprisingly, 87 % of the responding car-sharing customers and 44 % of the non-customers, i.e. almost every second person, are interested in the introduced short-term car rentals (see *Table 2*). Persons that are interested in both the basic scenario and extended scenario constitute the largest group among the interested customers and non-customers. It is striking that the extended scenario only hold minor additional benefits (6 %) for the group of interested customers whereas 28 % of the interested non-customers particularly became interested in short-term car rental through the introduction of the extended scenario.

**AFFILIATION TO SOCIAL MILIEUS**

The basis for the classification of customers and non-customers into social milieus was a milieu model designed for this project by Vester, Gardemin and Teiwes-Kügler (2006).<sup>6</sup> The results confirm a long lasting assumption that present car-sharing customers concentrate in particular milieus (see *Table 3*). ‘Educated liberals’ are predominantly represented in the sample with 49.9 %. In contrast, interested non-customers are found in all social milieus, which reveals a tendency of milieu indifference of interest in short-term car rental. Within the social milieus (*Figure 2*), the share of interested persons is particularly large among the ‘adventure-oriented underprivileged’ (64.0 %) and the ‘young adventure-oriented employees’ (55.3 %).

6. Factor, cluster and discriminant analysis was applied here.

**Table 3: Distribution of car-sharing customers and persons interested in short-term car rentals to social milieus**

Milieus	Customers of car-sharing (N=487) In % of sample	Non-customers of car-sharing interested in short-term car rentals (N=648)	
		In % of sample	In % of milieu groups
Educated liberals	40.9	11.0	45.5
Distinctive conservatives	13.1	10.1	38.2
Young adventure-oriented employees	11.7	13.7	55.3
Self-determined modern employees	13.1	14.8	48.5
Lower-middle class educated	15.0	12.1	43.6
Modernised lower-middle class employees	4.7	14.4	40.6
Restrictive lower-middle class employees	0.8	6.4	31.5
Adventure-oriented underprivileged	0.0	8.9	64.0
Realistic underprivileged	0.6	8.7	35.9
<i>Total</i>	<i>100</i>	<i>100</i>	<i>44.0</i>

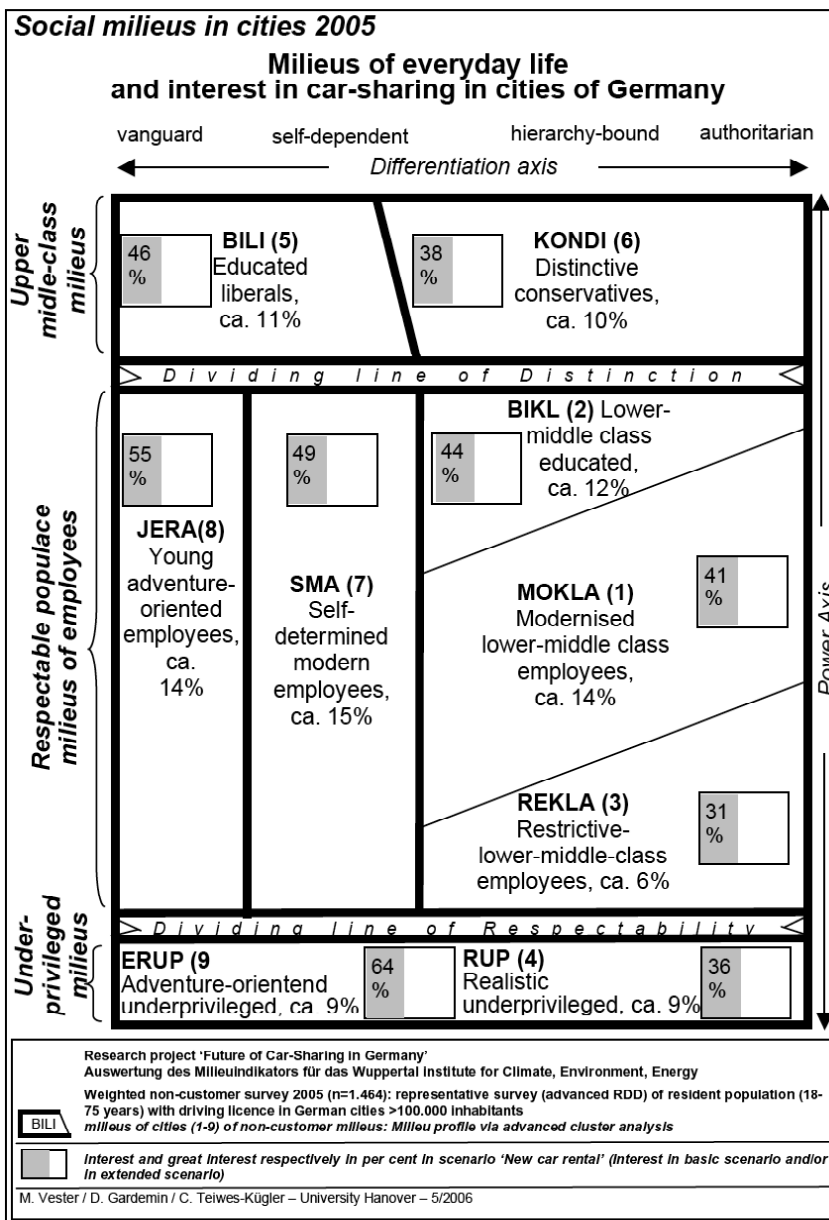


Figure 2: Shares of non-customers interested in short-term car rental in the social milieus

**Table 4: Social profiles of car-sharing customers and non-customers (in %)**

	Car-Sharing customers	Non-customers	
		interested	non-interested
<b>Sex</b>	(n=487)	(n=645)	(n=821)
Male	57.7	54.6	53.1
Female	42.3	45.4	46.9
<b>Age</b>	(n=487)	(n=645)	(n=821)
18-24	1.6	13.8	7.6
25-44	62.0	59.5	41.8
45-59	32.0	24.7	25.3
60-74	4.3	12.0	25.3
<b>Education</b>	(n=487)	(n=645)	(n=821)
Elementary school, dropout, not specified	3.5	32.6	38.9
Secondary school, junior high school or similar	8.6	21.7	22.2
higher education entrance qualification	87.9	45.7	38.9
<b>Income equivalent</b>	(n=413)	(n=561)	(n=687)
up to 1,000 Euro	16.0	29.6	26.9
1,000 up to 1,700 Euro	35.8	40.3	40.3
1,700 Euro and more	48.2	30.1	32.8

**Table 5: Mileage of car-sharing customers and non-customers (in km)**

Number of passenger cars of household	Car-Sharing customers (N=468)			Non-customers			
	incl. car-sharing	incl. other cars	Total	Interested (N=490)*			Non-interested (N=736)
				incl. short-term car rental	incl. other cars	Total	Total
No car	1,020	644	1,664	5,496	285	5,781	524
<b>Cars</b>							
One car	280	8,552	8,832	4,345	7,477	11,822	10,901
Two or more cars	331	16,147	16,478	4,194	10,660	14,854	15,527
<b>Total</b>	<b>779</b>	<b>3,668</b>	<b>4,448</b>	<b>4,827</b>	<b>4,783</b>	<b>9,609</b>	<b>11,166</b>

**SOCIAL PROFILES**

The interviewed car-sharing customers show a social profile (see Table 4) that is well-known from car-sharing research but is more contoured. Men and the age group of 25 to 45 years dominate the picture. The customers predominantly hold a higher education entrance qualification and have from middle to substantial incomes at their disposal. The interested non-customers are evidently different from the present customers of car-sharing services: only 46 %, compared to almost 88 % of the customers, hold a higher education entrance qualification. Persons with low incomes are represented more frequent, persons with high incomes are clearly represented more infrequent. The social profiles of the non-customers interested in short-term car rentals and the not interested non-customers are a lot more similar. The age-group of 25 to 45 is stronger

represented and the educational attainment levels are higher. For this reason, it can be concluded that potential customers of short-term car rentals may widely correspond with the average population in German cities in relation to their socio-demographic characteristics.

**MOBILITY PATTERNS**

The finding that car-sharing customers are optimisers<sup>7</sup> (Wilke 2005, Maertins 2006) applies to prospective customers of short-term car rentals too (see Table 5). The corresponding frequency

7. This result cannot be discussed in detail but has far-reaching consequences for the understanding of car-sharing and its diffusion potentials. For a long time it was assumed that joining car-sharing expressed an individual drastic change of mobility patterns.

**Table 6: Car-sharing customers and non-customers interested in short-term car rental according to household equipment with passenger cars**

Car equipment of households	Car-sharing customers (N=487)	Non-customers	
		Interested (N=633)	Non-interested (N=819)
No car	64.5 %	18.6 %	8.3 %
Cars	35.5%	81.4%	91.7 %
One car	29.4 %	53.8 %	63.0 %
Two or more cars	6.2 %	27.6 %	28.7 %

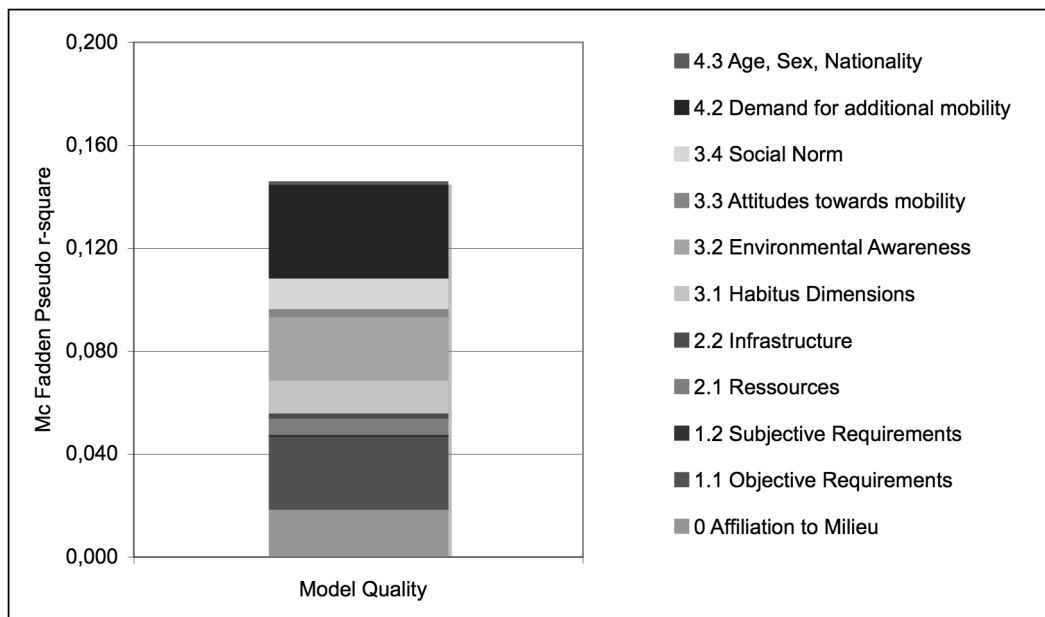


Figure 3: Determinants of interest (basic scenario and/or extended scenario) in short-term car rentals on the total model level\*  
 \* In this analysis the variable complexes of the theoretical model (see figure 1) have been slightly modified.

of the car-sharing use shows that the general day-to-day mobility is not being travelled via car-sharing. The (notional) extent of usage of the prospective customers of short-term car rentals is clearly higher than that of the present car-sharing customers. A further important difference between customers and prospective customers is the share of customers and prospective customers that use car-sharing as alternative option to their private car (see Table 6). The numerical proportion of car-less and car-owning users amongst customers is approx. 65 % : 35 %, whereas it is about 20 % : 80 % amongst prospective customers. That implies, different from today's customers, the prospective customers would predominantly use car-sharing as additional option besides an own car.

### Determinants of the interest in short-term car rentals

In order to investigate the determinants that shape the interest (and non-interest respectively) of non-customers of short-term car rentals, logit regression analyses<sup>8</sup> were conducted on the level of the total model (total sample as basis) and on the level of models for the different milieus (partial sample as basis).

When all variable complexes are included, investigation on the level of the total model (see Figure 3) shows a satisfying performance. A key result is that social milieu affiliation has only low explanatory power. However, facing the higher variance of prospective customers of short-term car rentals between different milieus (compared to today's car-sharing customers), this is not surprising. The interest in short-term car rentals is strongly influenced by the objective day-to-day requirements that cor-

8. The analyses were carried out by the logit regression method focusing on a stepwise improvement of the quality of the logit model (Mc-Fadden pseudo r-square). Based on the theoretical model the variables have been added to the model in blocks. Therefore, the McFadden numbers indicate the additional quality improvement by extending the model step by step. Hence, the numbers must be interpreted in strong relation to the earlier introduced blocks (variable complexes) and cannot be compared easily.

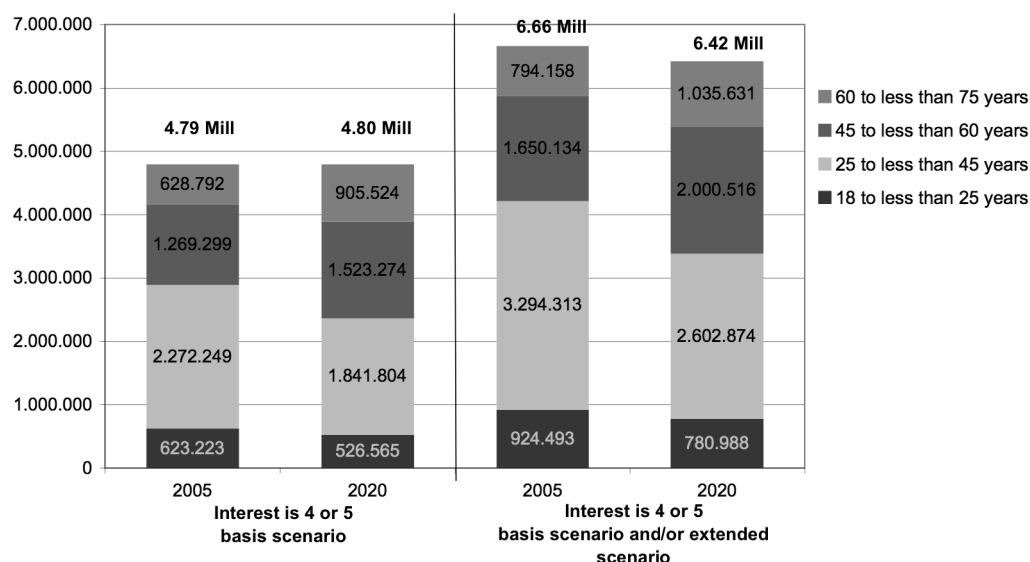


Figure 4: Estimation of theoretic potentials for short-term car rentals

respond to the particular living conditions and the demand for additional mobility. Furthermore, the attitudes towards mobility and the mobility behaviour improve the quality of the model significantly. In contrast, the environmental awareness is negligible as a determinant.

The overall model performance is improved when the analyses are applied to the partial samples of milieu affiliation (without figure). This is partly due to the reduced variance through the analysis of sub groups. However, the key result is that the condition configurations for interest and non-interest in short-term car rentals vary significantly among the social milieus. For instance, the interest in the milieu ‘educated liberals’ is strongly determined by the attitudes, among ‘young adventure-oriented employees’ by the objective requirements and among ‘modernised lower middle class employees’ by the resources. These findings are of decisive importance for the development of successful marketing strategies.

### Customer potential estimation for short-term car rentals for the time horizon 2020

As described in the two service scenarios, car-sharing non-customers who were interested in a use constitute the basis for the customer potential estimation<sup>9</sup> for short-term car rentals. These persons were extrapolated for the populations in the reference years 2005 and 2020.<sup>10</sup>

The calculated potentials are theoretic. Inter alia, the potential estimated for reference year 2020 assumes that the service scenarios described above have been put into practice by then.

It also implies a similar behaviour of future persons and similar future configurations of conditions.

Provided that an implemented extended service scenario for short-term car rentals would also be used by those respondents who only showed interest in the basic scenario<sup>11</sup> (with value 4 or 5), the maximum potential in the year 2020 would comprise about 6.42 millions of customers (see Figure 4). Due to the demographic development, the different age-groups feature varying shares in 2005 and 2020.

### Estimation of ecological and traffic impacts of short-term car rental diffusion for time horizon 2020

The ecological and traffic impacts of car-sharing and short-term car rentals respectively mainly result from changing mobility patterns of users including the vehicles sold and the variable number of vehicles required for automobility<sup>12</sup> (for details see Wilke 2002). The balancing that was carried out for the identification of the ecological and traffic impacts simplified the estimation by exclusively introducing a modified car use as a variable. The kilometres travelled per car and year were compared with and without use of short-term car rentals as well as the resulting emissions. In addition, a basic effect due to a younger car fleet (2 instead of 7 years in average) and a greater share of small cars in the car-sharing fleet than in average was calculated. The basis effect leads to the conclusion, that in 2020 the average car-sharing vehicle emits about 11 g less CO<sub>2</sub> equivalents per kilometre than an average private car.

However, the potential ecological effects of changing mobility patterns are even more significant. Maximum absorption of the theoretical potential of 2020 would generate a reduction

9. For economical and methodological reasons (e.g. oversizing of the interviews and restricted comparability of service offers), the investigation of the potential for car-sharing in its present form was waived. The main interests of this analysis are the perspectives and potentials of a modified car-sharing system.

10. The statistical prediction was made on the basis of the characteristics sex, age and education. Besides this potential estimation by socio-demographic features, another potential estimation was carried out on the basis of social milieus. The size of the different social milieus is of interest for marketing considerations. An estimation of potentials on social milieu basis for 2020 requires assumptions on the changes of the milieu landscape by 2020.

11. This assumption is plausible because the extended scenario includes the basic scenario.

12. This article does not reflect effects that occur due to the reduction in the overall number of vehicles (fleet). As people ‘share’ a car, fewer cars are needed for realising the same number of kilometres travelled.

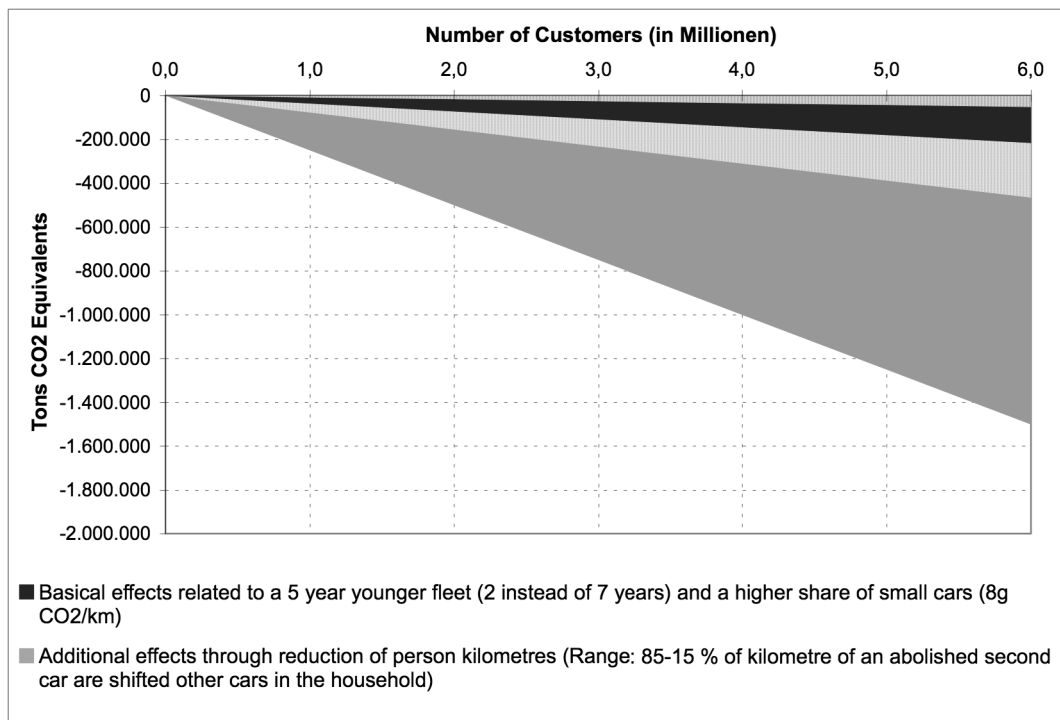


Figure 5: Change of emissions (CO<sub>2</sub>-equivalents) by the use of short-term car rentals in dependence of number of customers

for passenger cars of about 1.2 to 9.0 billion kilometres per year respectively. The range results from assumed changing behavioural patterns of those households with two or more passenger cars who intend to sell one car in the case of using short-term car rentals.<sup>13</sup> It should be noted that, due to expected technological progress, demographic change and independently from the diffusion of short-term car rentals, the traffic emissions of CO<sub>2</sub>-equivalents<sup>14</sup> from people living in German cities with more than 100.000 residents will probably decrease from 30.3 million tons in 2005 (15.2 Mill. residents with driving licence) to 22.7 million tons CO<sub>2</sub>-equivalents in 2020 (14.9 Mill. residents with driving licence). Maximum potential and maximum potential absorption of short-term car rentals would reduce the CO<sub>2</sub>-equivalents by additional 1,6 million tons.

As it is unlikely that the full potential will be tapped easily, figure 5 shows the ecological effects in relation to the number of customers. The graph shows both, the basic effect through a modern fleet with more small and less fuel consuming vehicles, as well as the effects through a change in driving behaviour in relation. The relatively large range is based on uncertainties of the fleet development of providers and uncertainties about the behaviour of people after selling a car.

13. Households would probably not travel all kilometres they usually travelled by their own car by a car-sharing vehicle instead. For research practicable reasons, data for a partial shift to other passenger cars (of the household) could not be collected. For possible shifts to other cars within the households, model calculations were carried out in the context of the traffic and eco-balancing for the variants displayed in Figure 5. Therefore, variant 15 % shift means a minor shift of about 15 % to other passenger cars of the household and variant shift of 85 % a major shift of mileage to the remaining car. As those people who sell their car contribute a lot to the ecological effects, both variants result in very different outcomes to the overall decrease of mileage per year.

14. The emission factors used are based on the German Energy Report 4 (EWI/Prognos 2006) and take the changes between 2005 and 2020 into account.

## Conclusions

The findings of the exploration prove a considerable potential demand for flexible short-term car rental with low associated transaction costs among the population in cities. In contrast to the current car-sharing customers, the interest in short-term car rental is widely indifferent among social milieus. The targeted diffusion of a modernised car-sharing beyond present user milieus of the conventional car-sharing appears possible. Theoretical potentials comprise several millions of potential users. Although the interested prospective customers would use the service clearly more intensive and more frequent in addition to their own car, the covered kilometres and the associated emissions would be reduced. Hence, the eco-balance of a modernised car-sharing model remains positive.

However, the findings require a differentiated reflection. Theoretical potentials are not tantamount to potential approachable customers. In fact, they are bound to the survey setting and the model universe of the corresponding project. Furthermore, not every prospective customer would actually use the service presented. This implies that a realistic customer potential that should be significantly below the theoretical potential. Besides, the identified potentials for 2020 apply to an area-wide service in German cities, which is – compared to the present car-sharing service – sharply expanded in quality. Limited financial resources of most providers (Wilke 2004) could question necessary investments. Even in case of a full integration of the customer potential, the contribution of car-sharing to a sustainable mobility has to be put into perspective with other strategies and measures. Its calculated share appears low for a start, at least in comparison to the emission reductions through technical progress which are assumed to be many times higher. The proximate environmental benefit of car-sharing could become less important in future as an argument for



political support of car-sharing. It should be explored to what extent car-sharing could induce collateral environmental benefits in the context of intermodal supply.

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