# Potentials of electric mobility in Germany and the US on the basis of car movement patterns and car immobilisation time patterns.

Dr. Torsten Luley
Explanandum – Gesellschaft für empirische Sozialforschung mbH
Schlüsselwiesen 23a
70186 Stuttgart
tel.: (0711) 5052 872
mail: torsten.luley@explanandum.de

Jürgen Müller
Manager
Strategic Marketing Bosch Automotive
Robert Bosch GmbH
Postfach 10 60 50
70049 Stuttgart
tel.: (0711) 811 7304
mail: juergen.mueller17@de.bosch.com

Michael Dalaker
Explanandum – Gesellschaft für empirische Sozialforschung mbH
Schlüsselwiesen 23a
70186 Stuttgart
tel.: (0711) 5052 079
mail: michael.dalaker@explanandum.de

Siegfried Ritter
Vice President
Strategic Marketing Bosch Automotive
Postfach 10 60 50
70049 Stuttgart
tel.: (0711) 811 6041
mail: siegfried.ritter@de.bosch.com

Susanne Hauber
cand. Bachelor of Arts in Economics
Strategic Marketing Bosch Automotive
Robert Bosch GmbH
Postfach 10 60 50
70049 Stuttgart
tel.: (0711) 811 6936
mail: fixed-term.Susanne.Hauber@de.bosch.com

**Abstract :** At the moment electric mobility is one of the big issues in the area of motorized individual transportation. The problem is at present that it is very difficult to estimate the prospective consumer acceptance of cars with a pure electric drive.
The prospect of the authors is that it is purposeful in a first analytical step to fade out the economic and psychological factors of the consumer acceptance of electric cars

and to explore the potentials of electric mobility on the basis of existent micro data of the everyday car mobility behaviour. The focusing on the elementary unit of ‘car’ becomes a critical denotation when analysing the potentials of electric mobility since only on this basis there can be made statements on the necessary range of electric cars. In turn, the range is the basis for the dimensioning of the used batteries. Comparative potential analysis for electric mobility show that the elementary unit of the individual personal trip - which is very popular in mobility research – leads to blurrings in the estimation of potentials for electric cars.

The aim of this contribution is to show typical, everyday car mobility behaviour patterns and analogical car immobilisation patterns for Germany and the US. On this basis there can be made statements for the potential market share of electric cars. In addition, the car movement types can be combined with specific car types or different household types. On the basis of these results in combination with official car registration- and demographic data the findings can be explored to different market sub-segments. Empirical basis of the contribution is the (raw-)data of the studies “Mobilität in Deutschland 2002”, “Mobilität in Deutschland 2008” and the „National Household Travel Survey 2001“. Furthermore, this work gives a comparison of the changes concerning individual mobility for persons and vehicles between 2002 and 2008 based on MID 2002 and MID 2008.

**Key Words:** travel behaviour, trip chains, Mobility in Germany 2002, Mobility in Germany 2008, NHTS 2001, electric mobility, potentials of electric mobility

## 1. Problem definition and research question

Mobility and traffic are attributes of a modern society and so they are subjects of a continuous change. Flexibility, spontaneity, speed and an increasing fragmentation of activities have an influence on the everyday-life. What is the effect of these developments on individual mobility and traffic? At the same time there are technical innovations such as electric cars which will also have an influence on the transportation system. This paper focuses on the question if individual everyday-mobility today is compatible with the concept of electric car.

The topic car and electric mobility is actually much discussed. Through the austerity of resources, in particular oil, many experts are forecasting a paradigm shift in drive engineering from gas and hybrid engines to pure electric drives.

However, the actual development status implicates many unsolved problems: costs of batteries and technique as well as the problem of the range of electric cars. So far car users are familiar with using their car without substantial controls in regard to the range of their car.

So in this paper the following central questions will be answered: What are the everyday movement patterns of cars? And consequentally, how high is the potential of electric mobility today?

To answer these questions the scientific reference on the everyday mobility is accurate and important, but we have to consider that the holiday travel function of a car – and accordingly higher ranges of the car – at least in households with only one car are probably the critical factor for the purchase decision of an electric car. Additional concepts like car sharing could be the answer to the problem in the medium term.

Most contributions to the topic ‚electric mobility' state that electric mobilty will basically be an urban phenomenom. This assumption is at least from a German perspective rather arguable; because the average car travel distance of a day is only 24% higher in small towns with lower than 5.000 inhabitants than in towns with 500.000 inhabitants or more.

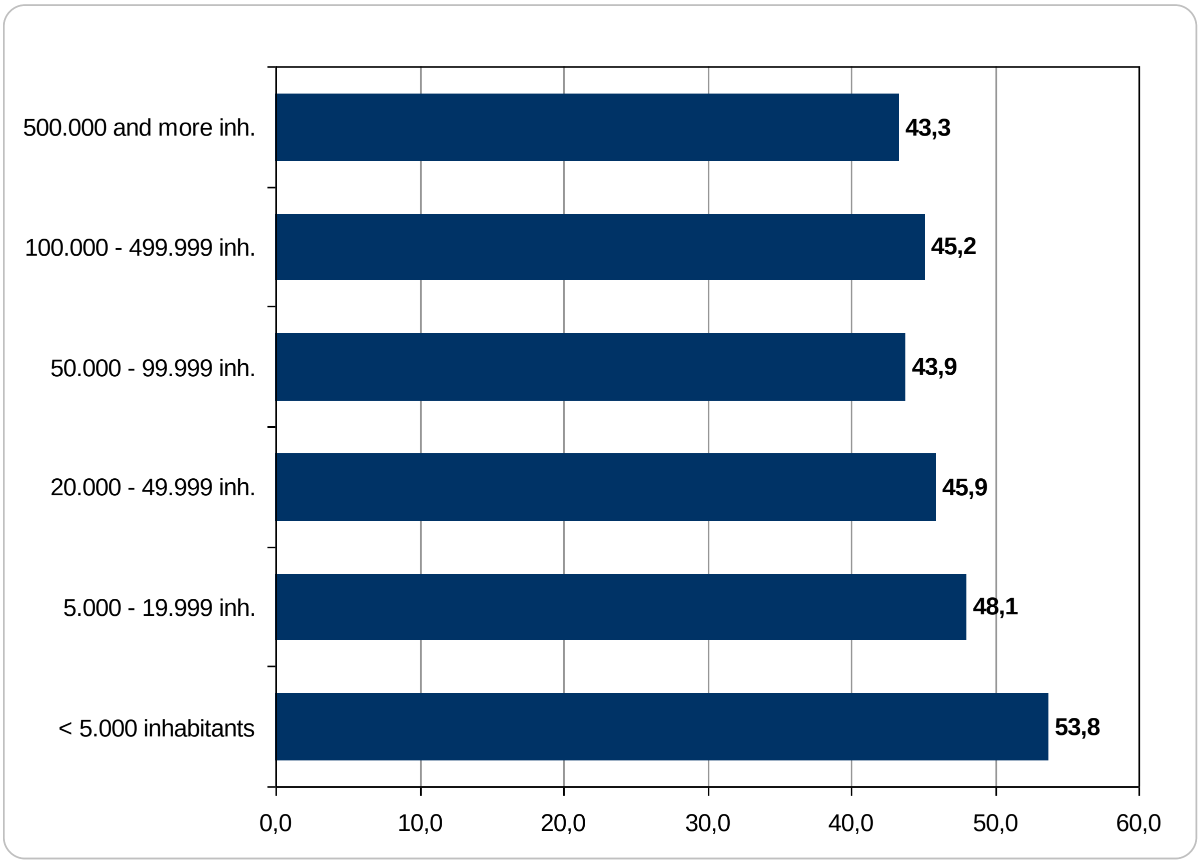


Figure 1: Average car travel distance per day in Germany in km in 2008

This example shows that it is necessary to have an accurately descriptive look on the existent empirical micro data to provide clarity in the academic discussion.

## 2. Reference day data as analytical basis

To evaluate the potentials of electric mobility the present contribution uses reference day data – in this case data from the studies "Mobility in Germany 2002" (MIG 2002) [1] with 62,729 person, 167,851 trip and 33,768 car data sets, "Mobility in Germany 2008" (MIG 2008) [2] with 60,713 person, 193,290 trip and 34,601 car data sets and for the USA the "National and Travel Household Survey 2001" (NHTS 2001) [3] with 60,282 person, 248,501 trip and 53,275 car data sets.

All of the three used studies are spit in four different data sets: household, person, trip and car. To create the empirical basis on car movement patterns, it was necessary to combine data of the car and the trip data sets on the basis of a distinct car identification number. For the analysis only cars which were in movement on the reference day were included.

Thus the everyday car movements of 15.925 cars of the MiG 2002, of 20.601 cars of the MiG 2008 and of 28.740 cars of the NHTS 2001could be analysed altogether Due to the fact that the data for the USA that is used for this contribution is rather old and so maybe not comparable with the empirical situation today, it is helpful to have a look at the changing of the car movement patterns between the years 2002 and 2008 in Germany. Generally speaking, there is no fundamental change in car movement patterns. This can be seen for example in the case of the everyday car travel distances, which increased from 46,5 km to 47,8 km between 2002 and 2008 – this means an increase of 2,8%. It is to assume that the changes of car movement patterns in the USA are likewise marginal like in Germany - certainly on a much higher level.

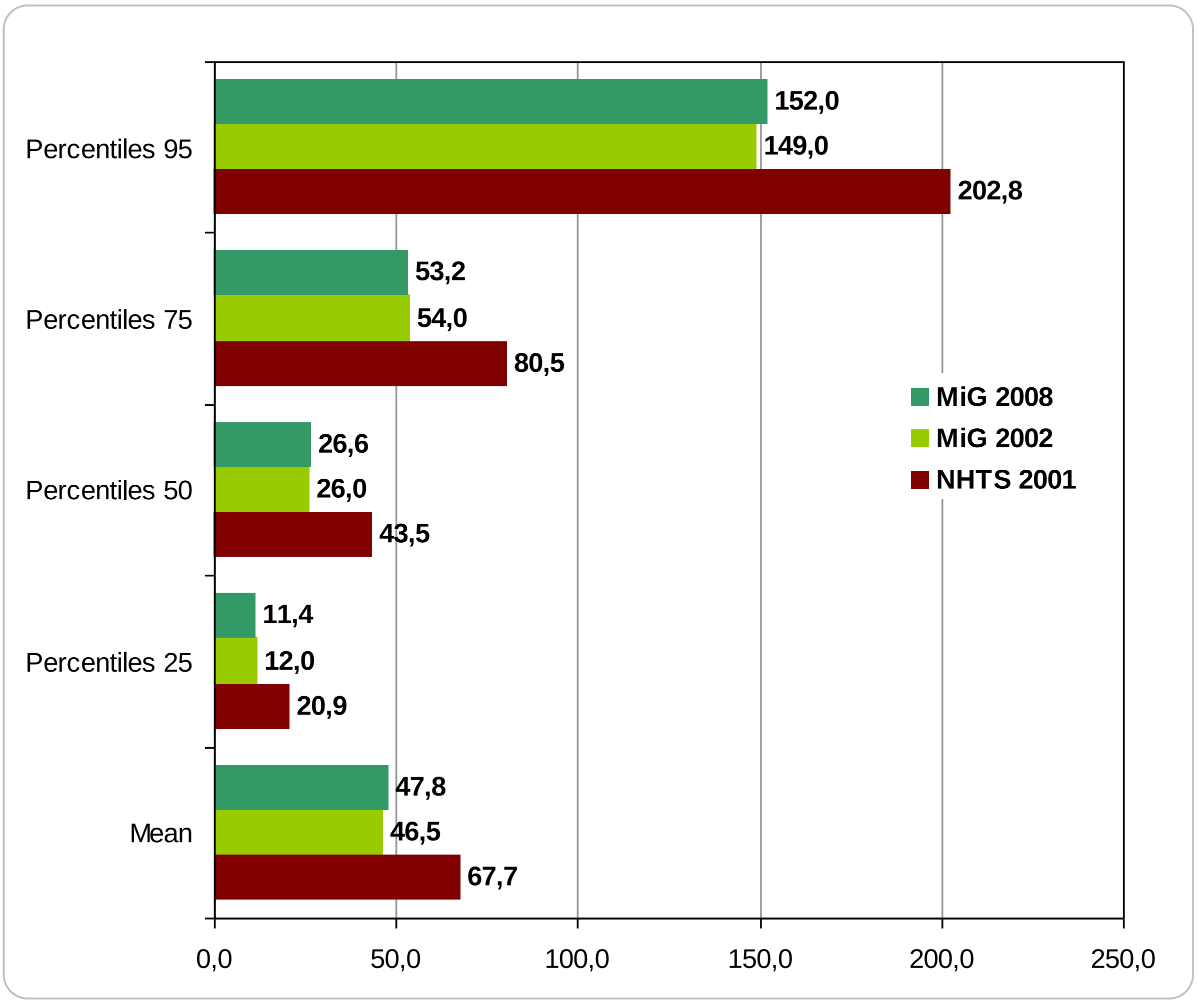


Figure 2: Average day travel distance of cars in Germany and the USA

Another basic problem of reference day data should also be addressed: That is the fact that intra-individual variations of behaviour cannot be reproduced. Individuals normally have multiple typical behavioural daily and weekly patterns with a high intrapersonal variance and a relatively small share of completely repeated daily patterns. This statistical fact is defused through bigger samples which are spread over all days of the year. Fact is that the data which is used in this contribution is of high quality and thus the results which were generated with these data sets are resilient.

The following figure shows the analytical schema which is the basis for all analyses that were made in the context of this contribution. The example describes the movement pattern of one car for the reference day.

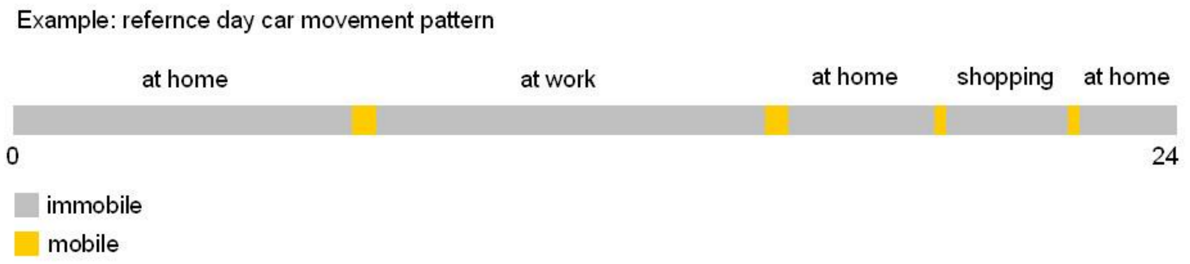


Figure 3: Example reference day car movement pattern

## 3. Empirical findings

As shown in figure 2 there are big differences between Germany and the US in regard to the everyday car travel distance: German cars in the year 2008 were driven an average of 48 kilometres a day, US cars were driven an average of nearly 68 kilometres – this means a higher day travel distance of 25%. But it is also to state that in the USA only 25% of the cars were driven an average of more than 80 kilometres per day.

### 3.1 Different car types

If we look at the average car day travel distances for Germany in 2008 differentiated in car type classes of the German 'Kraftfahrtbundesamt' there can be seen interesting results: the hit list is lead by 'Utilities' with 57 kilometres per day, followed By the 'large capacity vans' and the upper class cars. Then there is a broad middle field from the upper middle class cars to the compact class cars. Small cars and sports cars have the lowest average car day travel distances. But also in this case we can see that only 25% of the mobile cars are moved longer than 60 kilometres a day.

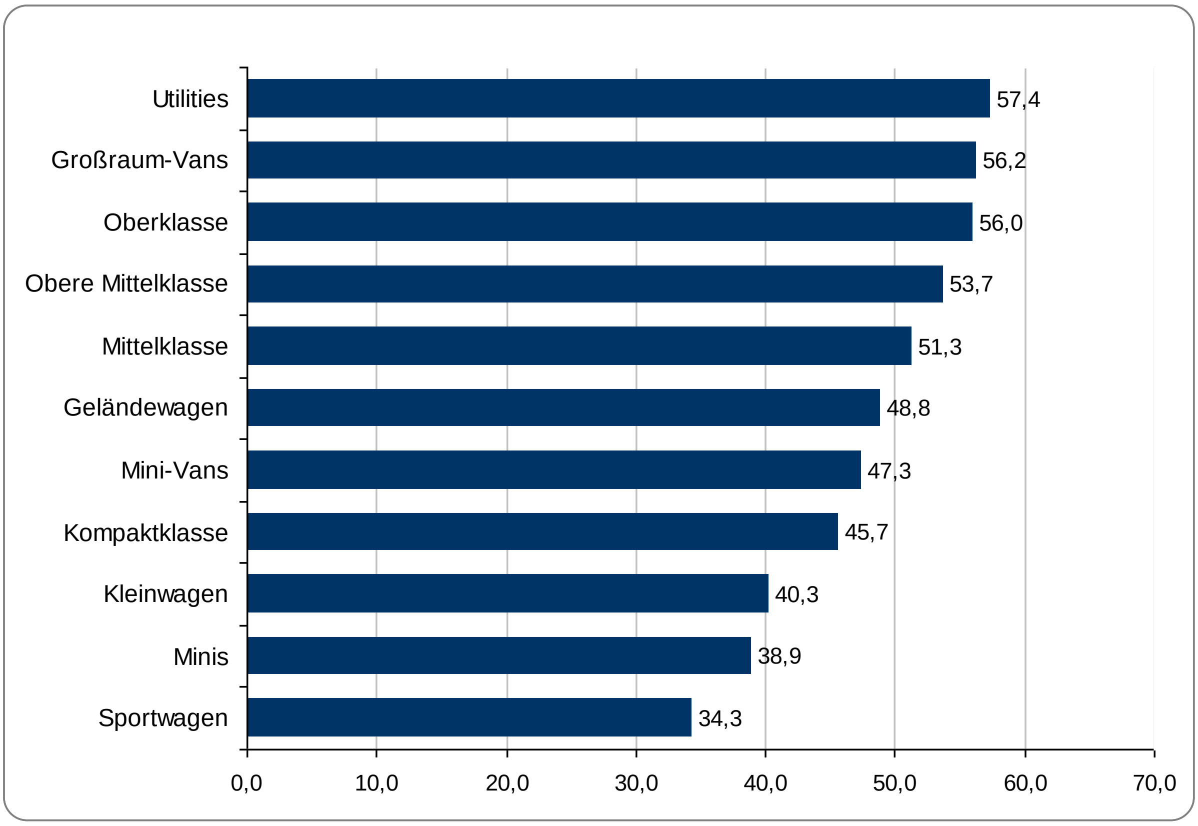


Figure. 4: Average day travel distance of cars in Germany 2008 by car types of the Kraftfahrtbundesamt (KBA)

In case of the USA the differentiation in car types shows a basically analogical situation: in fact the utilities, here the 'other trucks', lead the hit list of everyday car travel distance in an impressive way, but apart from that category the data are in the midfield relatively homogenous. The lowest average day travel distance falls upon the category 'car/station wagon'.

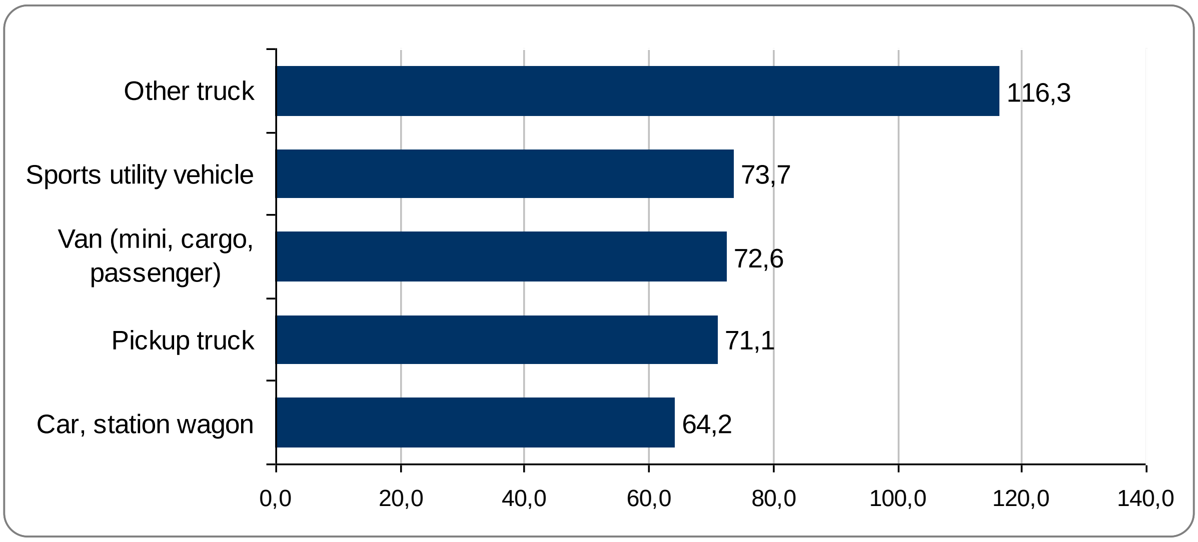


Figure 5: Average day travel distance of cars in the USA 2001 by car types

### 3.2 Trip-chains of cars, mobile and immobile times

To analyse the potentials of electric cars in the everyday mobility of people, it is - in addition to the day travel distance of cars on the refernce day - also necessary to analyse the immobile times of the car, for example to identify potential battery-charging-stations. As shown in figure 3, it is necessary and possible to show where the car is parked or driven for how long.

In the following figure there are shown for example the five most frequently car trip chains for Germany in the year 2008. These five trips chains represent at least 32% of all trip chains. The most frequent trip chain is - not very surprisingly – 'home-work-home' with a share of 16% of all trip chains.

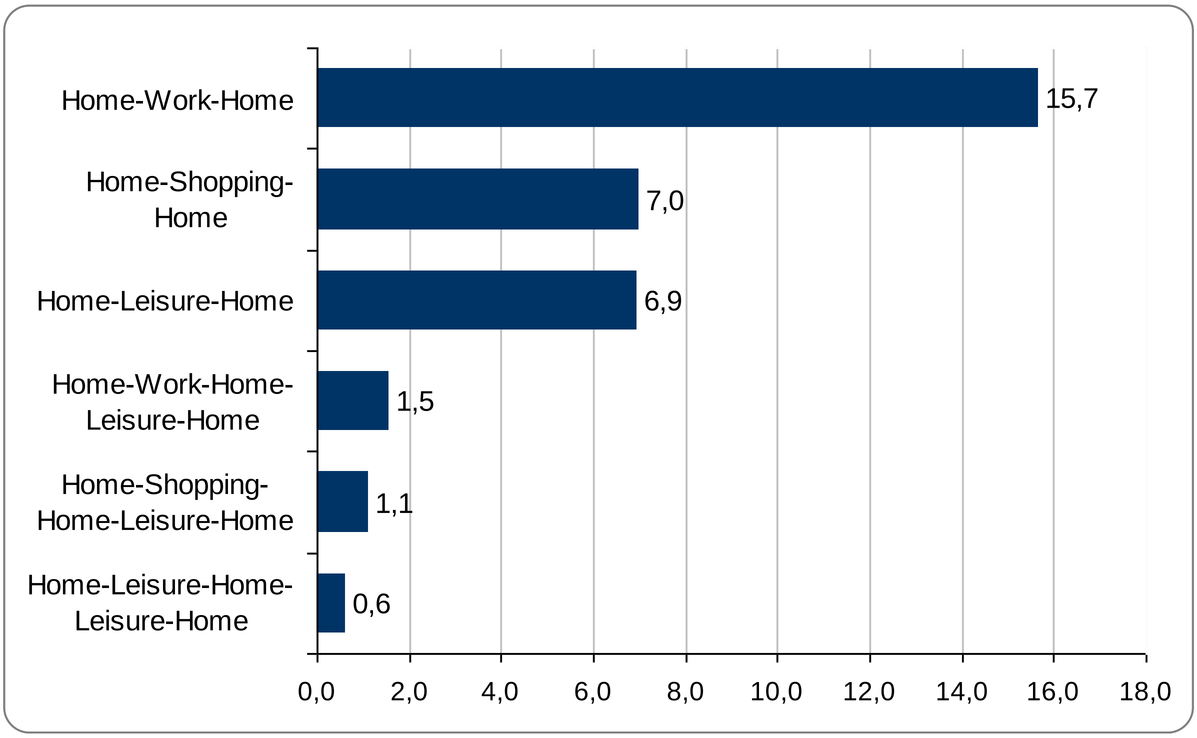


Figure 6: Most frequent car trip chains in Germany 2008

At the same time it is to consider that a growing trip number per day goes hand in hand with decreasing trip distances. This means that a higher complexity of trip chains leads to a lower time budget per single trip in the chain.

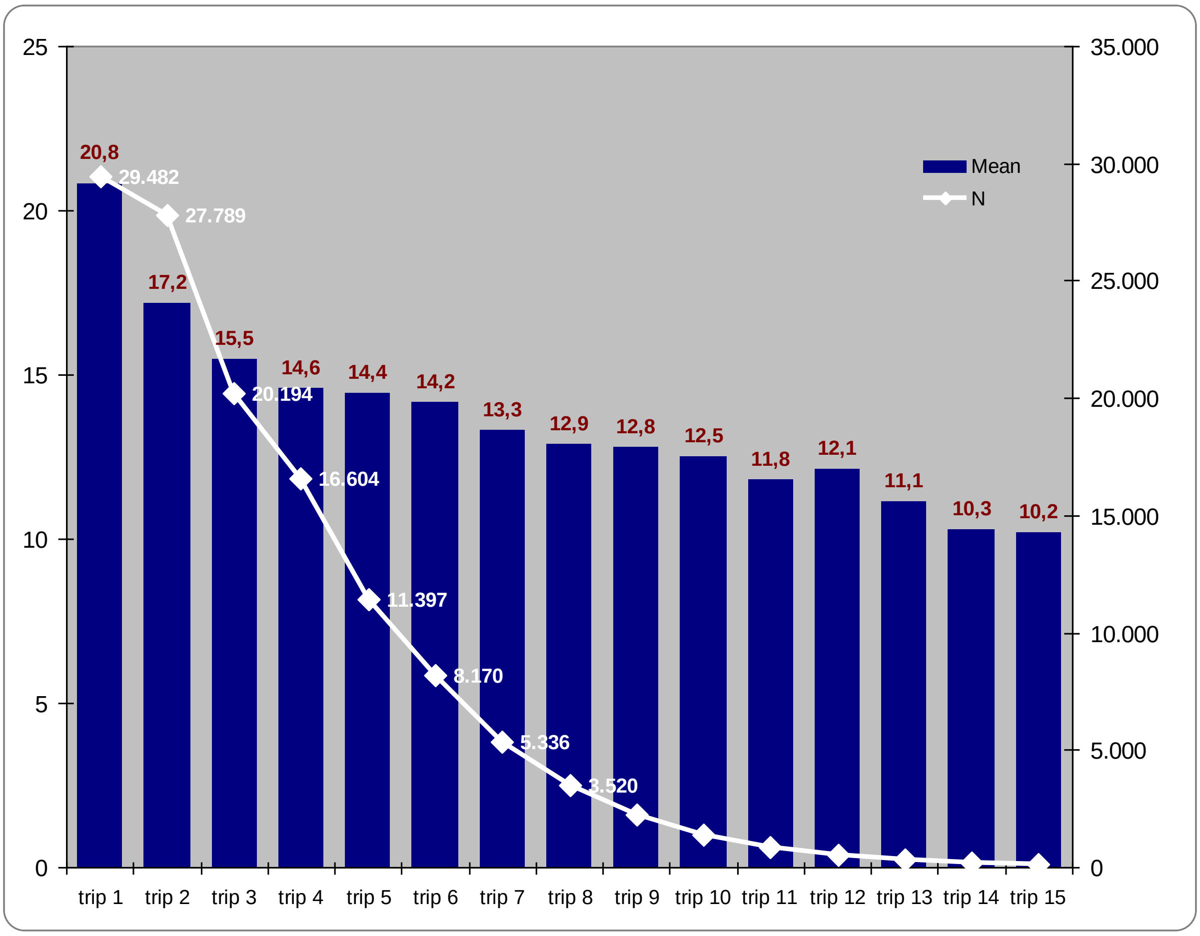


Figure 7: Frequency of car trips and average car trip distance in the USA 2001

For the subject of electric car mobility there is the fact that the times of immobility or rather battery loading times – irrespective of the character of the activity – between the trips are shorter the more trips the car has to make. This tendency is naturally on a different level for different activities – the stay at work will normally be longer than the stay in the bakery. The same is true for immobile times of a car.

If one looks at the immobile times differentiated by activities in Germany 2008, irrespective of the complexity of the car trip chains one can see that the established results are very different. The average immobile time of a car 'at work' which is nearly 8 hours, is from the perspective of a potential battery charging station very joyful, above all because 39,2% of all car trip chains in Germany contain the activity 'work'. The potentials for battery recharging are accordingly considerable. At first view it seems more difficult to provide infrastructure for battery charging for the activity 'shopping' with an average immobile time of 1.5 hours.. In this case it will be useful to take a deeper scientific look into the future of car immobilty times related to the shopping of short-, medium- and long term goods. It is probably possible and reasonable to install battery recharing infrastructure at the parking space of a furniture store like IKEA in Germany or a shopping mall in the USA.

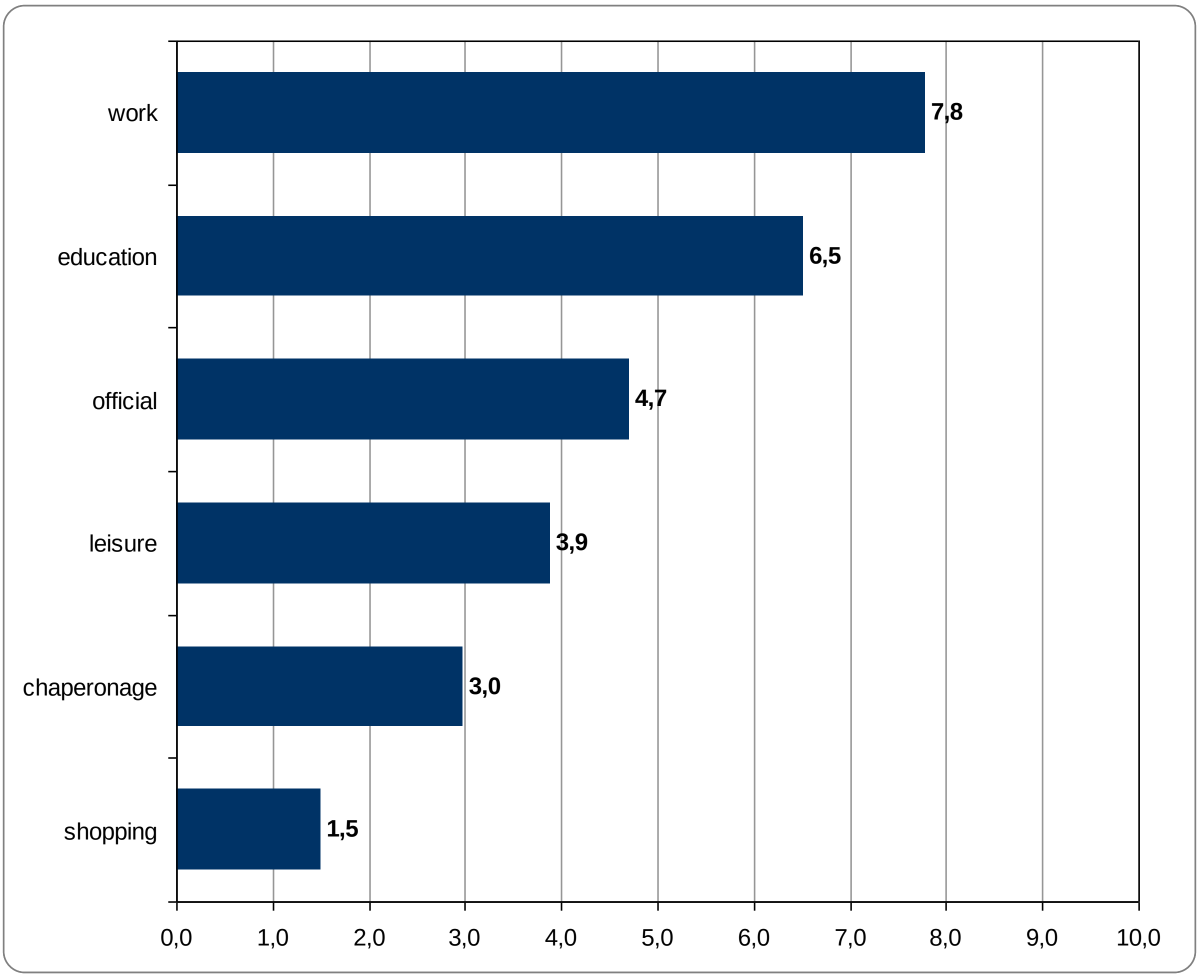


Figure 8: Average immobile time of cars by different activities in Germany 2008

A further important indicator for the potential of battery recharging is the immobile time over night. In Germany 2008 for example the average immobile time over night per car is 16.5 hours, only 25% of the cars are immobile less than 13 hours[1].

[1] Die Standzeiten für die USA sind entsprechend der intensiveren Nutzung der Kfz etwas niedriger, werden aus Platzgründen hier aber nicht mehr separat dargestellt.

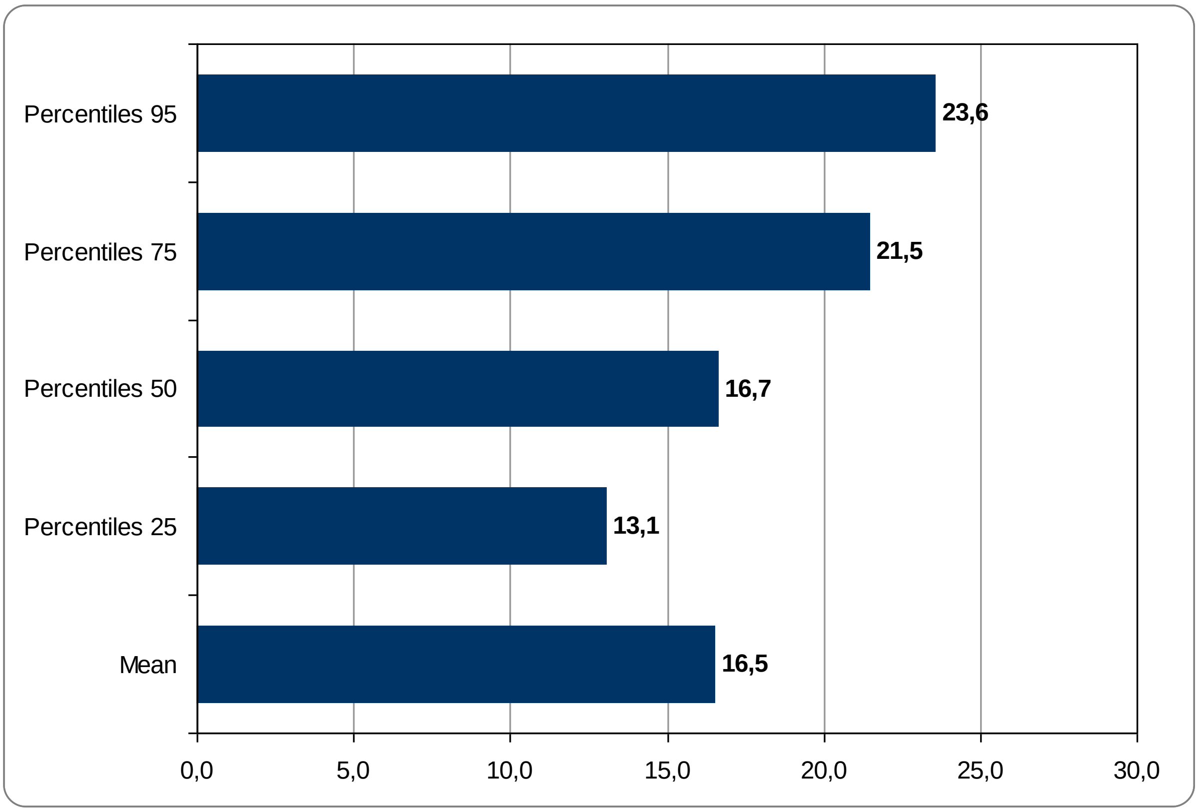


Figure 9: Average immobile time of cars over night in Germany 2008

But not only how long the car is immobile between the activities or over night is an important question, but also where the parking space of the car is over night. In the study MiG 2008, data of the 'usual parking space' at home was collected. And the results are very positive in the view of the possibility to recharge batteries over night, because 73% of the cars are parked at home on own properties. Naturally the situation in big cities is different from rural areas. In German cities with 500.000 or more inhabitants only 41% of the cars can be parked on own properties, in small towns with less than 5.000 inhabitants the number is nearly 85%. Related to the possibilities of recharching batteries on the own property the rural areas in Germany have key benefits.

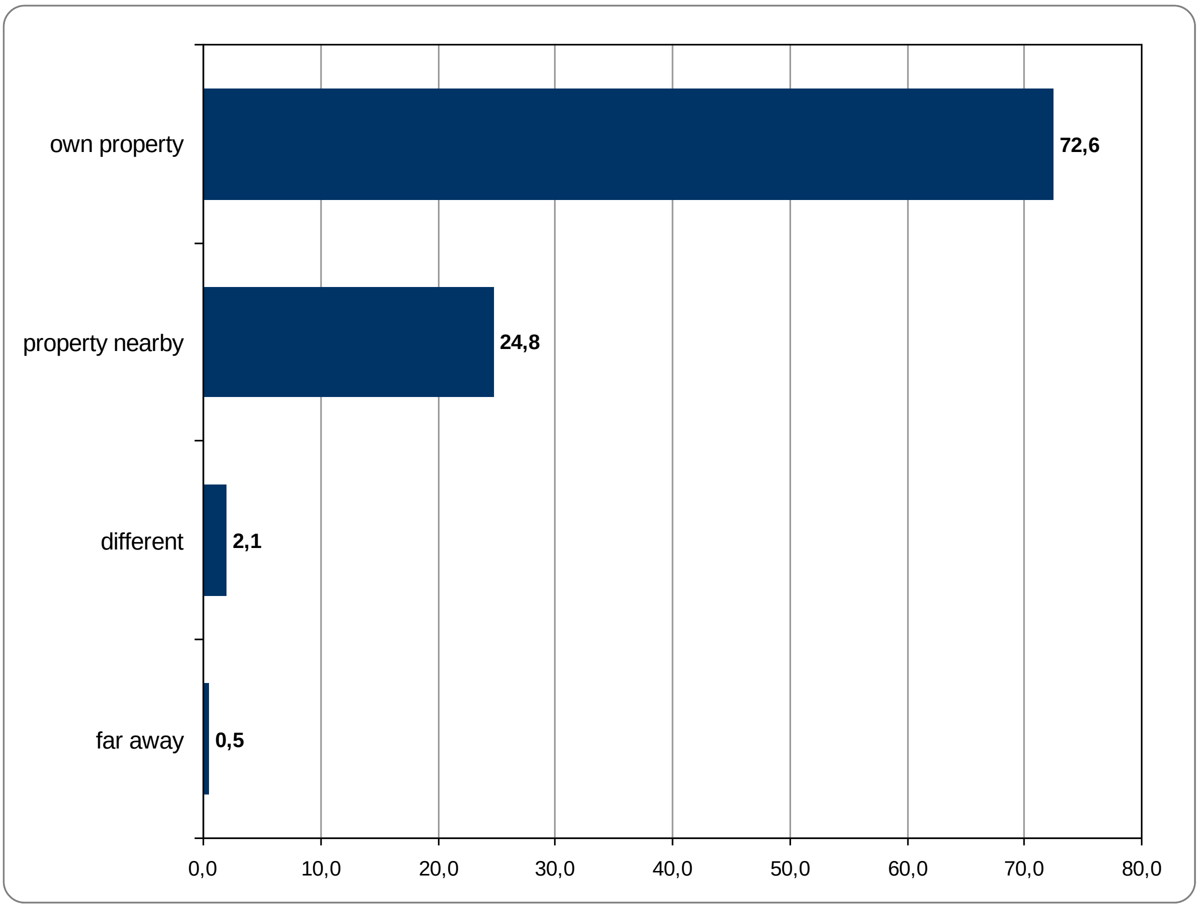


Figure 10: Usual parking space of cars at home in Germany 2008

### 3.3 Socio-demographic aspects

With the data sets which were used for this contribution it is possible to combine the car movement patterns with socio-demographic data. If we combine for example the variables ‘age of the key user’ of the car with the average car travel distance per day we can see that older people cover smaller distances than younger or middle-aged people.

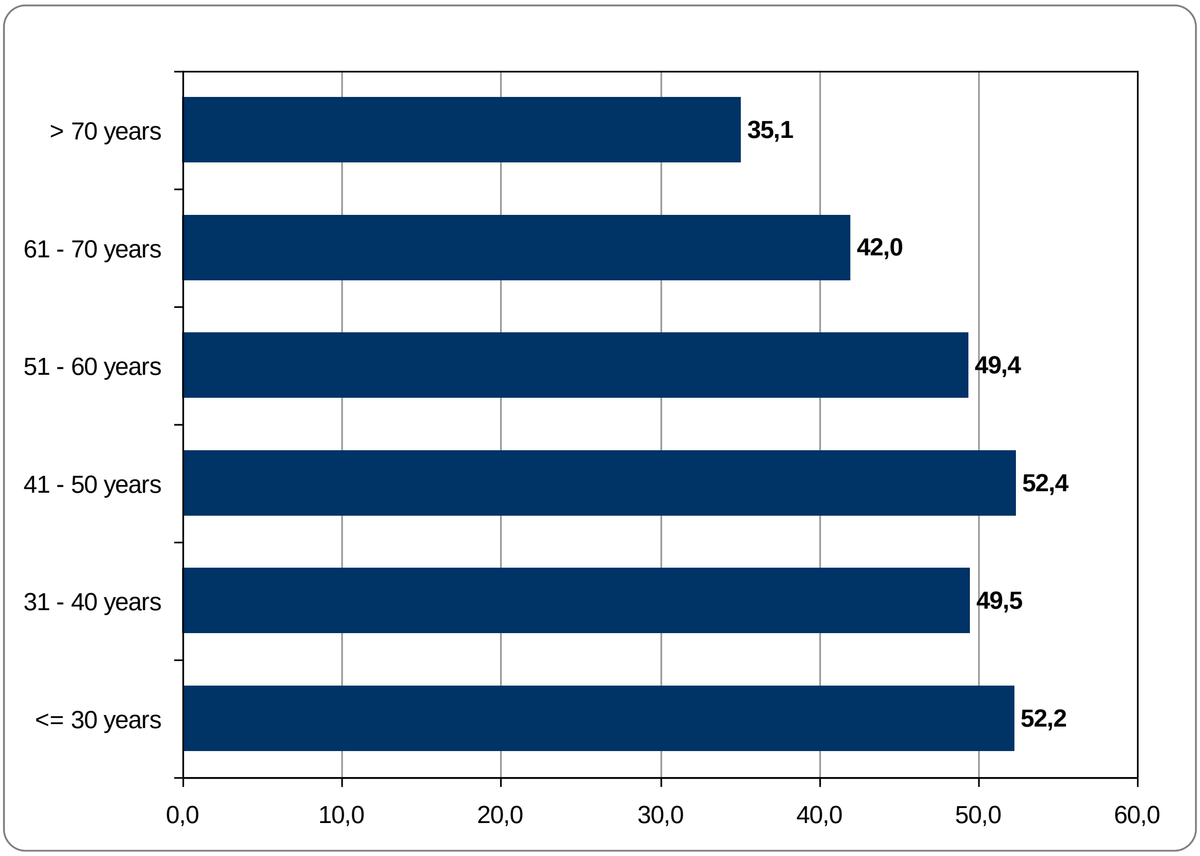


Figure 11: Usual parking space of cars at home in Germany 2008

## 4. Conclusions

This contribution shows the possibilities of potential analyses for the electric mobility on the basis of the concept of everyday car movement patterns with the raw data of the studies MiG 2002, MiG 2008 and NHTS 2001.

If we assume an average range of the electric car of 100 kilometres we can see that a substantial share of the car mobility in the everyday life – in urban and rural areas – in Germany and the USA could be accomplished without problems already today. Since this is especially true for households with two or more cars, these hoseholds will probably have fewer problems with the decision to use an electric car – apart from all the other problems of market launches of electric cars like pricing or infrastructure. The results show that cars of the small or compact class with their low average day travel distance driven by older people are qualified for electric mobility.

If we additionally include the analysed car immobility data or rather the battery recharging possibilities, we can assume that 85% to 90% of the German eyeryday car-mobility could be accomplished electrically already today.

## References

[1] Further information MiG 2002: http://www.mobilitaet-in-deutschland.de/03_kontiv2002/index.htm
[2] Further information MiG 2008: http://www.mobilitaet-in-deutschland.de/02_MiD2008/index.htm
[3] Further information NHTS 2001 and 2009: http://nhts.ornl.gov/