REDUCING CAR TRIPS BY PROMOTING ALTERNATIVE MODES OF TRANSPORTATION

– review –

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ABSTRACT

Transport has become an essential part of our life. We use transport to travel to work and to school, to shops or in leisure time. But transport has a number of negative effects that are reflected both in the environment and also in human health. These effects are particularly evident, due to the high density of transport in urban areas. Many city councils have begun to deal with the question how these negative effects of transport could be reduced. Simultaneously with the restrictions of car industry allowing only certain maximum of harmful emissions in exhaust gases, authorities are also promoting a gradual reduction of car trips. This review provides a comprehensive overview of the possibilities of reduction of car trips. The whole review is compiled from technical papers and studies dealing with similar topic. The negative effects of transport in cities are mentioned here and also the possibilities of its replacement by promoting other modes of transportation such as walking, cycling or public transport, since half of all car trips are shorter than 5 km. The last part is dedicated to the structure of the transport in the city of Vienna completed with estimations of possible CO_2 emissions reduction if a certain number of car trips could be replaced by other modes of transportation.

Key words: bicycling, walking, public transport, physical activity

Mobilität ist ein wichtiger Teil unseres Lebens. Täglich legen wir Wege zur Arbeit, zu Ausbildungsstätten, zum Einkauf oder zu Freizeiteinrichtungen zurück und produzieren dabei Straßenverkehr. Probleme, die durch den Straßenverkehr entstehen, liegen meist dem Autoverkehr zugrunde, der sich negativ auf unsere Gesundheit und auf unsere Umwelt auswirkt. Gerade im städtischen Raum werden die Folgen durch immer dichter werdenden Autoverkehr besonders evident. Um die negativen Konsequenzen zu verringern, werden der Automobilindustrie Richtlinien vorgegeben, wie viele schädliche Abgase ein Auto maximal produzieren darf, Stadtverwaltungen versuchen Bewusstseinsarbeit zu leisten, um Leute zum Umstieg auf umweltfreundliche Verkehrsmittel zu bewegen. Dieser Artikel gibt einen umfassenden Überblick über Möglichkeiten, den Autoverkehr zu reduzieren, wobei auf technische und sozialwissenschaftliche Studien zurückgegriffen wird. Es werden die negativen Folgen des Autoverkehrs beschrieben sowie Möglichkeiten aufgezeigt, wie

alternative Fortbewegungsarten (Gehen, Radfahren, ÖV-Nutzung) gefördert werden können. Der letzte Teil des Artikels beschäftigt sich mit der Verkehrssituation in Wien und mit Schätzungen wie viel CO_2 durch eine Reduzierung des Autoverkehrs eingespart werden kann.

Schlagwörter: Radfahren, Gehen, Öffentlicher Verkehr, Bewegung

SHRNUTÍ

Doprava se stala nezbytnou součástí našeho života. Využíváme ji jak při cestování do práce, tak při cestování do škol, za nákupy nebo ve volném čase. Doprava ale skrývá řadu negativních vlivů odrážející se nejenom na životním prostředí, ale i na zdraví člověka. Tyto vlivy jsou zřejmé zejména, díky vysoké hustotě dopravy, v městském prostředí. Řada měst se tak začala zabývat otázkou jak tyto negativní vlivy z dopravy snížit. Vedle vydávaných směrnic, určených pro automobilové výrobce popisující maximální přípustné množství škodlivých emisí ve výfukových plynech, se rovněž úřady snaží postupně omezovat automobilovou dopravu. Tato zpráva podává ucelený přehled o možnostech snížení automobilových jízd. Celá zpráva je sestavena z odborných článků a studií zabývající se podobnou problematikou. Jsou zde popsány negativní dopady dopravy ve městech a také rozpracovány možnosti jejího nahrazení jinými druhy dopravy – chůzí, cyklistikou, nebo veřejnou dopravou, jelikož více než polovina automobilových jízd je v některých městech kratší než 8 km. Poslední část je věnována složení dopravy ve městě Vídeň s odhady možného snížení emisí oxidu uhličitého při nahrazení určitého podílu automobilových jízd jiným druhem dopravy.

Klíčová slova: chůze, cyklistika, veřejná doprava, fyzická aktivita

ROAD TRANSPORT AND ITS NEGATIVE IMPACTS

The emphasis on mobility emanates from most of human activities. Requirement of the European Union of free mobility of people, goods and capital through the European Union accommodated this need. Moving of people is one of the basic human activities that is carried out in order to meet needs, such as commuting to school, work, shops or going on trips (Pichler, 2010). With the growing population and with rising standards of living of the population in developed countries, the numbers of drivers and cars are increasing, too, especially in cities. Hence, the passenger cars in big cities do not represent the fast mode of transportation today. Due to high density of traffic and frequent congestions, the average speed of cars in Paris is approximately only 20 km/h (Rabl & Nazelle, 2012). One reason why people accept such slow mode of transport is that a vehicle (car) has the function of a status symbol. Although in developed countries cars have ceased to be a matter of luxury, and congestion on roads in cities and on highways rapidly increased, many people still use cars. For example, in the United Kingdom, the car is the dominant mode of transport; data from the National Travel Survey shows that 63 % of all trips are made by car (Carse et al., 2013). The car has certain advantages compared to other modes of transport in terms of flexibility, safety and personal space.

The high number of cars (especially in cities) is among other things caused by the fact that many of them go only with drivers with no other passengers. *In 2009 in Vienna car trips accounted for 32 % of all trips. From this amount, car trips with only a driver accounted for 75 % and car trips as a passenger accounted only for 25 % (Institut für Verkehrs- und Infrastrukturforschung GmbH, 2010*). Hence the high occupancy cars are favoured and are even provided with a special lane called high-occupancy vehicle lane in many cities in the world.

Traffic congestions do not reflect all problems caused by cars. The high density of traffic in cities has a negative impact on the health of the population and on the environment. The increasing number of cars in cities particularly causes:

- increase in air pollution of GHG (Green Houses Gases) emissions (*85 % of them account for carbon dioxide (CO_2) in Austria in 2011, according to the Environment Agency Austria, (Umweltbundesamt, 2013*) and of harmful emissions - carbon monoxide (CO), nitrogen oxides (NO_x), unburned hydrocarbons (C_xH_y) and particulate matters (PM),
- fatal accidents caused by cars,
- increase of noise level,
- decrease of physical activity,
- and some others, for example: loss of public space; loss of walking quality for pedestrians; high maintenance costs; repairs and building of roads for traffic etc.

GHG emissions from means of transport are rising faster than from other energy-using sectors and are predicted to increase by 80 % between 2007 and 2030 (Woodcock et al., 2009). In general, based on information from the study of Ajanovic & Haas, road transport contributes with approximately 23 % to the European Union's total GHG emissions. 70 % of road transport GHG emissions are accounted by passenger cars only. *In 2010 in Austria, transport accounted for a share of 26.5 % in national total GHG emissions, 14.4% of national GHG emissions were released by passenger cars (Environment Agency Austria, Umweltbundesamt, 2012)*.
In urban areas, the situation is worse because the motor vehicles are the major source of environmental and noise pollution. Based on the EEA 2010 report, about 70 % of environmental pollution and 40 % of greenhouse gases in European cities come from motorized transport (Rojas-Rueda et al., 2012). The reduction of GHG emissions, or rather CO_2 emissions in passenger car transport is a major objective of many governments world-wide; the EU's goal is to reduce CO_2 emissions at least by 20 % (compared to the 1990 level). To meet these goals various types of policy strategies are considered, for example using lower-carbon-emission motor vehicles, technically efficient improvements of conventional cars as well as the introduction of electric vehicles, promotion of bio-fuels, introduction of congestion charges (Ajanovic and Haas, 2011) and last but not least, reducing car trips by replacing them by other modes of transportation, particularly in urban areas. Hence, many cities gradually create such facilitating conditions that car trips can be replaced by other modes of transport, for example by walking. Walking is the initial and final phase of every executed trip. For this reason, it is necessary to refine pedestrian pathways network and improve the protection of pedestrians against motor-vehicle traffic. (Of course, pedestrian traffic has also its restrictions, like distance and time limitations, but those can be overcome if walking and public transport are combined).

DISTANCE AND NUMBER OF CAR TRIPS IN THE CITIES

According to the publication City for Pedestrians (2006), half of all trips in urban areas are shorter than 5 km and one third is shorter than 3 km. In this context, the bicycle proved as a suitable mode of transportation. A cycle trip is faster than a car trip for distances from 5 km up to 8 km, or the time of the cycle trip is comparable with the car trip (Pichler, 2010). Based on data from the London area travel survey, 55 % of distances travelled in cars accounted for trips shorter than 8 km, including 11 % by trips shorter than 2 km (Woodcock et al., 2009). Thus, more than half of all car trips in London are

shorter than 8 km, which again suggests that a reduction of car trips has a high potential and is possible.

BENEFITS FROM REPLACEMENT OF CAR TRIPS

Replacement of car trips by walking or bicycling can bring about significant benefits for our health and environment. These health benefits are attributed mainly to higher levels of physical activity by walking and cycling. In the study by Woodcock et al. it was pointed out that increased physical activities reduce the risk of cardiovascular disease, depression, dementia, diabetes, breast cancer, and colon cancer and reduce therefore the premature mortality. Replacing the use of cars by public transport can bring also the economic advantage related to the reduction of road traffic fatalities (Rojas-Rueda et al., 2012).

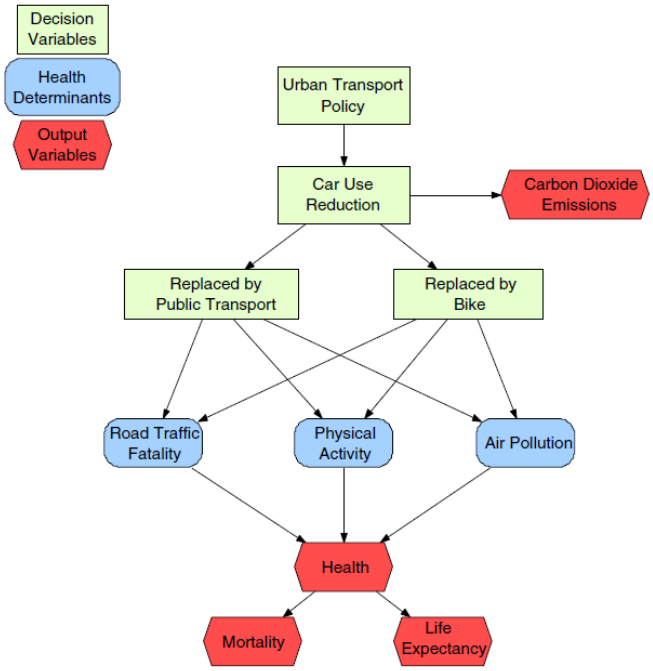

Fig. 1 Contextual framework for assessment of impacts of car trip reduction from Joffe & Mindell (2002) as stated in the study from Rojas-Rueda et al., 2012

Fig. 1 indicates the positive impacts when car trips are replaced by public transport and cycling (walking is included in public transport). These impacts affect three main determinants – road traffic fatality, physical activity and air pollution. These determinants subsequently contribute to changes in health of a population – in mortality and life expectancy. We cannot omit the impact on the environment, which is achieved by carbon dioxide emissions reduction.

Energy saving belongs to the other advantages relating to the reduction of car trips due to the decrease of fuel consumption (Lovelace et al., 2011).

CHOICE OF TRANSPORT MODE

The choice of transport mode is affected by many factors, like attitudes, socio-economic and demographic factors and by trip-specific factors, such as distance, point of time, and weather (Bergström & Magnusson, 2003). As Carse et al. (2013) refer, for short trips there are really only three alternatives to the car in most areas – public transport, walking and cycling. While public transport and walking provide alternatives in some areas, in others – for instance inadequate timetables, poor public transport and pathway network, time-consuming walking - bring about limits how effectively public transport and walking can compete with the car. For these reasons and for compliance with timetables people may likely decide to use the bicycle (if preconditions in the cities are given: e.g. safe bicycle paths, bicycle points etc.) instead of public transport or walking. In some parts of Europe, cycling accounts for a much higher modal share than in others, e.g. up to 26 % of all trips in the Netherlands and 16 % in Denmark (Cycling Embassy of Denmark, 2010, Ministry of Transport Public works and Water Management, 2009).

CONCRETE FIGURES

Some studies focused on health benefits and impacts on the environment when replacing car trips by other modes of transportation in cities. One of them is a study by the authors Rojas-Rueda et al. Their study was focused on the assessment of health benefits in Spain when replacing car trips by the use of public transport and by bicycling. They assessed additional benefits from physical activities and additional risks due to increasing air pollution inhalation and increased exposure to the risk of road traffic fatality for people who changed mode of transportation (when compared to previous exposures as car users). The study focused on car trips within Barcelona City and on car trips which started or ended in Barcelona City and started/ended in Barcelona metropolitan area (Barcelona metropolitan area is a region consisting of a densely populated urban core and its less populated surrounding territories, sharing industry, infrastructure, and housing). They assumed that short trips (trips shorter than 5 km) could be replaced predominantly by bike trips and for long trips they assumed that the replacement would be predominantly by public transport. The authors elaborated several scenarios, which included a replacement of 40 % and 20 % car trips. They replaced car trips by bike trips or bike trips + public transport (50:50) within Barcelona City and car trips by public transport or bike trips + public transport (20 % and 80 %, respectively) within Barcelona metropolitan area. Their study did not single out walking as a mode of transport but each trip by public transport was assumed to include 10 min walking. Hence the public transport can also bring health benefits. To estimate the impact of physical activity they used a linear dose–response function used by the World Health Organization in Health Economic Assessment Tools for walking and for cycling and other models from previous studies for the estimation of impacts on the environment.

Based on the results, they found out that using bicycle and public transport instead of car could improve both the health of travellers (i.e. those who shift mode of transport) and also the health of the population in Barcelona. The major benefits of the reduction of car trips by replacing them by bike or public transport comes from the increase in the levels of physical activity of travellers, followed by the benefits associated with the reduction of air pollution in the population and to a much lesser extent also from the reduction of the risk of traffic accidents specifically in the case of public transport. The health benefits for those who would change their travel modes would be much larger than the benefits to the population, even though the total number of people affected in the population would be much larger. *The annual health impact of a shift of 40 % of the car trips in Barcelona City to cycling would be for the travellers who shift modes 1.15 additional deaths from air*

pollution, 0.17 additional deaths from road traffic fatality and 67.46 deaths avoided as a result of physical activity. These are resulting in a total of 66.12 deaths avoided. Fewer deaths would be avoided annually if half of the replaced trips were shifted to public transport - "only" 43.76 deaths. The annual health impact in the Barcelona City general population of the 40 % reduction in car trips would be 10.03 deaths avoided due to the reduction of PM2.5 concentration about 0.14 μg.m^{-3}. This reduction would result in 5 % reduction of emissions of PM2.5 and subsequently 0.64 % reduction in PM2.5 ambient concentration. The total number of deaths (including travellers and general population) avoided in Barcelona City therefore would be 76.15 annually. So based on these results, we can conclude that the health benefits of a shift towards to public transport and cycling or rather to active travel are likely to strongly outweigh the harms.
The CO_2 emission reduction by replacing car trips by other modes of transport (bike and public transport) in Barcelona City and in Barcelona metropolitan area was estimated to be about 203,251 t CO_2 emissions per year. As the authors refer: *Based on OCCC (Oficina Catalana del Cambio Climático), this amount represents a reduction of about 1.25 % of CO_2 emissions by the transport sector in Catalonia.*

In closing, the authors Rojas-Rueda et al. compare their results with other studies. They mention a Dutch study which reported the benefits of cycling, which outweighing the risks in terms of months of life compared to travel by car. A study in New Zealand reported that the health benefits from physical activity if 5 % of the vehicle kilometers are shifted to cycling in all urban areas of the country could lead to 116 deaths avoided annually in the cycling population. The authors also mention studies from the United States that estimated the health impacts of reduced environmental pollution related to the replacement of 50 % short car trips in 11 United States metropolitan areas by the bicycle. The authors there found that eliminating short car trips decreased PM2.5 levels by 0.1 μg.m^3, resulting in a health economic benefit of 3.5 billion dollars annually and that an extra 3.8 billion dollars could be saved due to the increase of physical activity. A study reported by Rabl & Nazelle evaluated benefits of active transport comparing them with mortality impacts from changes in air pollution, road traffic fatalities and with CO_2 emissions. They found out that the greatest economic benefits of replacing a regular 5 km commuter trip by car with a bicycle trip would come from increased physical activity, yielding a 1310 € per year benefit per traveller who shifts the mode.

The study by Rojas-Rueda et al also showed that an increase in number of cyclists can lead to an increase in additional deaths from road traffic fatality. Authors Schepers & Heinen deal with similar issues, or rather with the question of how the replacement of car trips by cycle trips can affect road safety. Their results show that replacing short car trips by cycling has a neutral effect on the number of fatalities and results in an increased number of serious road injuries. The increased number of serious road injuries is caused by a high number of cyclist victims in crashes with no motor vehicle involved (predominantly single-bicycle crashes).

FACTORS AFFECTING THE USE OF THE CAR FOR SHORT TRIPS

The impacts on health of travellers and population and on environment were described earlier. The main problem, which affects the replacement of car trips by other modes of transport, is the question how to discourage the car drivers from using their cars for short trips. The factors that hamper the spreading of cycling in cities are: a poor infrastructure of the bicycle path network and too much traffic on the roads. However, many cities in the EU approve policies to create better conditions for walking, cycling and public transport. Despite these improvements, many people still

use the car for short trips. A study by Carse et al is aimed to identify which characteristics are significantly associated with the choice of the car versus the bicycle for work, shopping and leisure trips in Cambridge. The authors found out that commuting distance and flexible working hours were strongly linked with the choice between bicycle and car for work trips. Car availability and lower levels of education were also associated with the use of the car for leisure, shopping and short-distance commuting trips. A study by Woodcock et al. arrives at a similar conclusion: differences between high-income and low-income groups in distances covered by walking were small, but high-income groups are more likely to cycle and to participate in recreational physical activity than people from low-income groups. High level of education groups, or rather high-income groups are aware of the benefits from physical activities and of the negative impacts of car traffic on the environment. Measures which could increase cycling and reduce the use of car for short trips, are (according to Carse et al.): a limitation of free car parking areas/places; improved conditions for cyclists (e.g. cycling facilities and rights of way for cyclists); the increase in safety for cyclists viz. a reduction of injures (e.g. by speed limit reduction of motor vehicles, at least within certain zones); increasing the cost of car travel; education (to demonstrate and understand the negative impacts of traffic on health and environment). In the United States based on the Willson & Shoup study, it has been suggested that removing free parking could reduce car travel to work by up to 81 % (Carse et al., 2013). Another study by Mackett shows, that an improvement of public transport (frequency, improved bus shelters, network etc.) could lead to a reduction of car trips, too.

Promoting the replacement of car trips by cycling should not be only a seasonal thing, but a year-round campaign. In a Swedish study, the authors Bergström & Magnusson assume that by improving winter maintenance service levels on cycle ways (especially snow clearance) might make possible an increase in the numbers of bicycle trips during winter by 18 %, representing a corresponding decrease in the number of car trips by 6%.

LOWER-CARBON-EMISSION VEHICLES VERSUS NON-MOTORISED MODES OF TRANSPORT

As mentioned at the beginning of this review, using lower-carbon-emission vehicles is another countermeasure for the reduction of CO_2 emissions in the EU. Studies by Woodcock et al. compare the impacts of using lower-carbon-emission motor vehicles and impacts following the replacement of car trips by active travel on public health and on the reduction of greenhouse-gas emissions in urban transport. They assume that the lower-carbon-emission vehicles produce an average of 95 g/km CO_2. These cars are compared with cars which produce 177 g/km CO_2. In the case that car trips have been replaced by active travel, they assume that the distance walked will be more than doubled and the distance cycled will increase eight-fold compared to the situation in London in 2009. They developed separate models that linked transport scenarios with physical activity, air pollution, and the risk of road traffic injury.

The result from their study show that the reduction in CO_2 emissions through an increase in active travel and less use of motor vehicles would have much larger health benefits per million population than from the increased use of lower-emission motor vehicles. With the lower-carbon-emission motor vehicles scenario, the total number of premature deaths and DALYs (Disability-Adjusted Life-Years) would be reduced through reductions in the rate of mortality caused by air pollution. For the increased active travel, substantial reductions would be noted in premature deaths and DALYs as a result of increased physical activity and reductions in the rates of mortality caused by air pollution. **These gains many times predominate above premature deaths and DALYs deaths resulting from road traffic injuries***. Their injury model was based on assumptions of a linear*

association between distance travelled and risk of injury from road traffic. In 1 year, the lower-carbon-emission motor vehicles scenario would save 160 DALYs and 17 premature deaths per million populations, increased active travel would save 7332 DALYs and 530 premature deaths per million population. The largest gains would be from decrease in ischemic heart disease (10–19 % of total ischemic heart disease burden), cerebro-vascular disease (10–18 % of cerebro-vascular disease burden), dementia (7–8 % of dementia disease burden), depression (4–6 % of total depression disease burden), and breast cancer (12–13 % of total breast cancer disease burden). Although walking and cycling would become safer per km travelled, the large increase in the total distance walked and cycled would lead to a road traffic injury disease burden rise of 39 % (disease burden is the impact of a health problem in an area measured by financial costs, mortality, morbidity, and other indicators). But despite this the health gains would be still much larger from increases in active travel and reductions of motor vehicles than from the use of lower-carbon-emission motor vehicles.

The authors Woodcock et al. also found out that replacing car trips by active travel would bring about a larger reduction of CO_2 emissions than the use of lower-carbon-emission motor vehicles. The use of lower-carbon-emission motor vehicles would lead to a 35 % reduction in CO_2 transport emissions and replacing car trips by active travel would lead to 38 % reduction in CO_2 transport emissions compared to 1990 levels. This conclusion points out the important health benefits and reductions in CO_2 emissions gained by replacement of car trips by active travel. Technological measures reducing vehicle pollutants might reduce emissions, but the health effect would be smaller. Authors also point out possible deficiencies of their results, because the created models for estimation of impacts did not include effects of traffic on noise or health, effects of bio-fuels, or impacts of increased vehicle speed due to decreased traffic congestion and the reduction in the number of vehicles.

THE SITUATION IN VIENNA

Due to the continuous increase of GHG emissions Vienna, like many other cities, adopted the program for climate protection, which counteracts CO_2 emissions rising. The main focus - apart from long distance heating and electricity generation, habitation, companies, city administration - is also on mobility. The requirement for mobility of the city population is rising and therefore the ecological damage is rising too. Within the field of mobility, Vienna has set itself the goal of reducing the traffic volume and an increase in the efficiency of vehicles till 2020 (Rüsch, 2009) by

- increasing the use of public transport to 40%,
- increasing the rate of cyclists and pedestrians to 35 %
- reducing the car traffic to 25%

The tendency of this development is shown in figure 2.

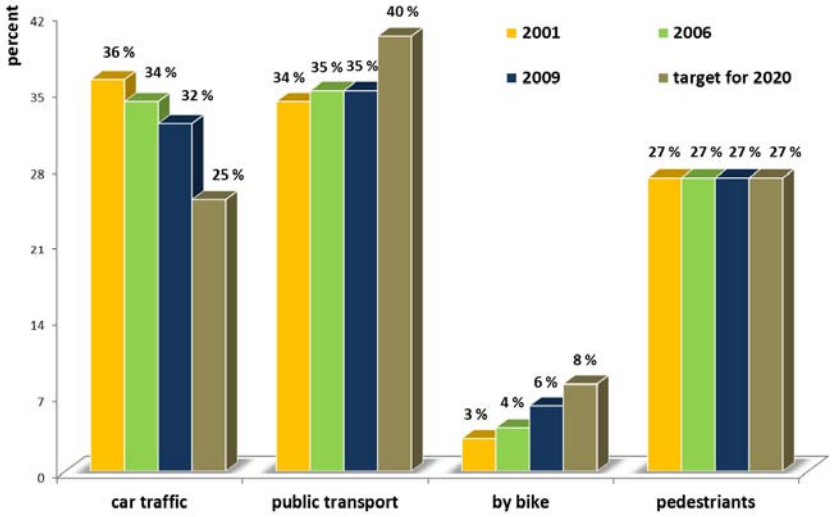

Fig 2 Share of individual mode of transport in Vienna (Rüsch 2009, Madreiter et al. n.y.)

Fig. 2 demonstrates that only 6 % (in 2009) of the trips in Vienna are bicycle trips. This low level of bicycle trips (in comparison with the Netherlands 26 %, and Denmark 16 %) could be increased, because of the favourable conditions for bicycling in Vienna. Vienna is relatively flat with an average annual temperature of 10.2°C, and 50 % of all car trips are shorter than five kilometres, which is the next preconditions for the successful promotion of bicycle trips. The authorities continually improve conditions for bicycling in Vienna. For example in 2009, the total length of bicycle pathways was 1071 km. Bicycles could be hired at 58 bike stations across Vienna (Rüsch, 2009). Just as in other cities (based on described studies), cycling could contribute significantly to climate protection and it also would support reducing the emissions of greenhouse gases in Vienna.

In the following argument, we refer to reducing car trips by half, even if we know that reducing those 50% of car trips that are shorter than 5 km does not nearly correspond to a reduction of, e.g., car kilometres by half. But the calculations can be taken as an example: If we find out how many kilometres are covered in total by the car trips that are shorter than 5 km then we can produce and accurate estimation of the potential that a sensible transfer from car to walking and cycling would have.

Estimation of reduced CO_2 emissions

The estimation of reduced CO_2 emissions induced by the replacement of car trips by other modes of transportation uses two models. The first model is based on the total number of car trips (in kilometres or person kilometres) in the city per year. When estimating the total emission savings, it is necessary to know the average amount of emissions produced by passenger cars per kilometre or per person kilometres (see in Statistik Austria or Umweltbudesamt). The second model comes from the volume of CO_2 emissions per capita of the population.

The first model for Austria (data for calculation were used from journal VCÖ – Mobilität mit Zukunft) shows:

- *72,400,000,000 person kilometres were performed by passenger cars in Austria, in 2009,*

- *Passenger cars produced 12,308,000 tons of CO_2 in Austria, in 2009 (170 grams of CO_2 per kilometre).*

When we reduce the person kilometres about 50 %, we can achieve a reduction of up to 6,154,000 tons of CO_2 per year (2009) in Austria. If we assume that passenger cars contribute with 14.4 % to the total volume of national CO_2 emission (according to the Environment Agency Austria, Umweltbundesamt, 2012), then 6,154,000 tons of CO_2 represent a reduction of CO_2 emissions of about 27 % of the CO_2 emissions produced by transport and about 7 % of the total volume of CO_2 emissions in Austria[1].

<u>The second model for the city of Vienna</u>:

- *in 2009, according to data.worldbank.org, the average amount of CO_2 emission was 7.4 metric tons per capita,*
- *the population in Vienna, in 2009 was 1,692,067 (Statistik Austria)*
- *the share of individual passenger cars in the total volume of the national GHG emissions is 14.4 % (Environment Agency Austria, Umweltbundesamt, 2012)*

The total volume of CO_2 emissions produced by passenger cars in 2009 is subsequently calculated by:

$$CO_2 = \frac{1{,}692{,}067 * 7.4 * 14.4}{100} = 1{,}803{,}066.6 \frac{t}{rok}$$

Based on this result, we can estimate that by the replacement of 50 % of the car trips by other modes of transportation (non-motorized), it is possible to achieve a reduction of up to 901,533 tons of CO_2 per year (2009). This volume represents also a reduction of CO_2 emissions of about 27 % of the CO_2 emissions produced by transport and about 7 % of the total volume of CO_2 emissions in Vienna.

CONCLUSION

The number of car trips shorter than 5 km represents half of all car trips or more. This suggests that the reduction of car trips through substitution by other mode of transportation has a high potential and is possible. The review also shows that replacement of car trips can lead both to reduction of air pollution and also to health benefits, due to increased level of physical activity. These factors have a positive impact on the reduction of various diseases and on life expectancy. The focus should be on the support and promotion of non-motorised modes of transport or on public transport – bus, tram, train etc. and not s much, or not mainly, on the improvement of technical devices.

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[1] Based on results, calculated total volume of CO_2 emission (85,472,223 tons per year of 2009 is not consistent with total volume of CO_2 emission mentioned on **Statistik Austria website** – 67,230,000 tons per year of 2009).

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