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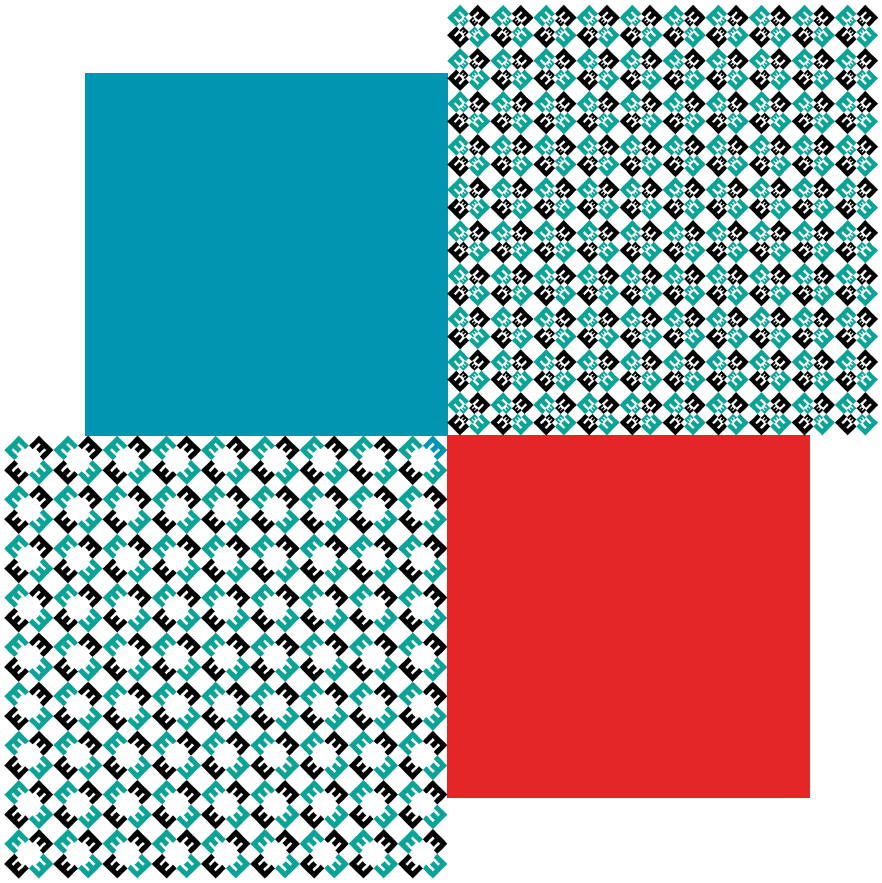
OPTIONS FOR SUSTAINABLE AND ENERGY EFFICIENT URBAN TRANSPORT IN THE V4 REGION

A joint report in the frame of the international project "Cooperation for sustainable transport in the V4 region"



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FOREWORD

In the four Visegrad countries, transport sector can be characterised with similar problems. After the regime changes in 1990 the then-outdated transport systems started to be deteriorated. The modernisation of the road infrastructure mainly focused on the motorway segment, and the increase of the usage of private (especially old, second-hand) cars, resulting in the declining share of the public transport, also contributed to the worsening environmental performance of the transport sector.

However, there are good symptoms as well. The membership of the European Union means that measures, investments, aiming the decrease of the CO_2 emissions and other burdens of the environment, should be implemented. While there is a need for a change in the attitude, financial sources are also available for these targets.

If we consider the still high share of public transport in the region; the rising energy prices; the spreading of cycling within urban areas; the more common use of up-to-date methods and technologies in transport management, the increased usage of more environmental fuels etc., it can be stated that there are not just vast potential, but good chances for the improvement of the energy efficiency of the transport sector. Although the process is being under way, as it is shown by several best practices from each country that are introduced in our study, for succeeding, all stakeholders should participate in the processes: inter alia, state and local governments, NGOs, authorities, companies and the public.

This study was prepared in an international project, named as "Cooperation for sustainable transport in the V4 region", that was launched in autumn 2011 in order to provide guidelines for strategy formation in the transport sector. For this aim, the participating organisations undertook several tasks in the frame of the project, supported by the International Visegrad Fund. One of these tasks was to analyse the opportunities of increasing energy efficiency in urban transport in the four participating countries.

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I. INTRODUCTION

Changes of the environment – including climate – and human actions influencing these are related to society and economy. Transport must fulfil society's mobility needs in the space defined by the natural, economic and social environment in an economically efficient, environmentally friendly way [1]. The fast-paced – scientific and technological – development that took place in the previous century gave humanity tools and technological solutions that increased the impact of interfering with environment exponentially. "Fulfilling increasing consumer demands is inevitably harmful to the environment, while reducing environmental pollution is one of the fundamental requirements of survival." [2] Achieving this is based on technical development, the application of waste minimizing technologies, and the utilization of renewable energy sources, environmentally friendly traffic and transport. "Due to the size of our Earth – the inertia of the system –, harmful substances emitted in the past would impact our future environment even if the emissions stopped right now."[3]

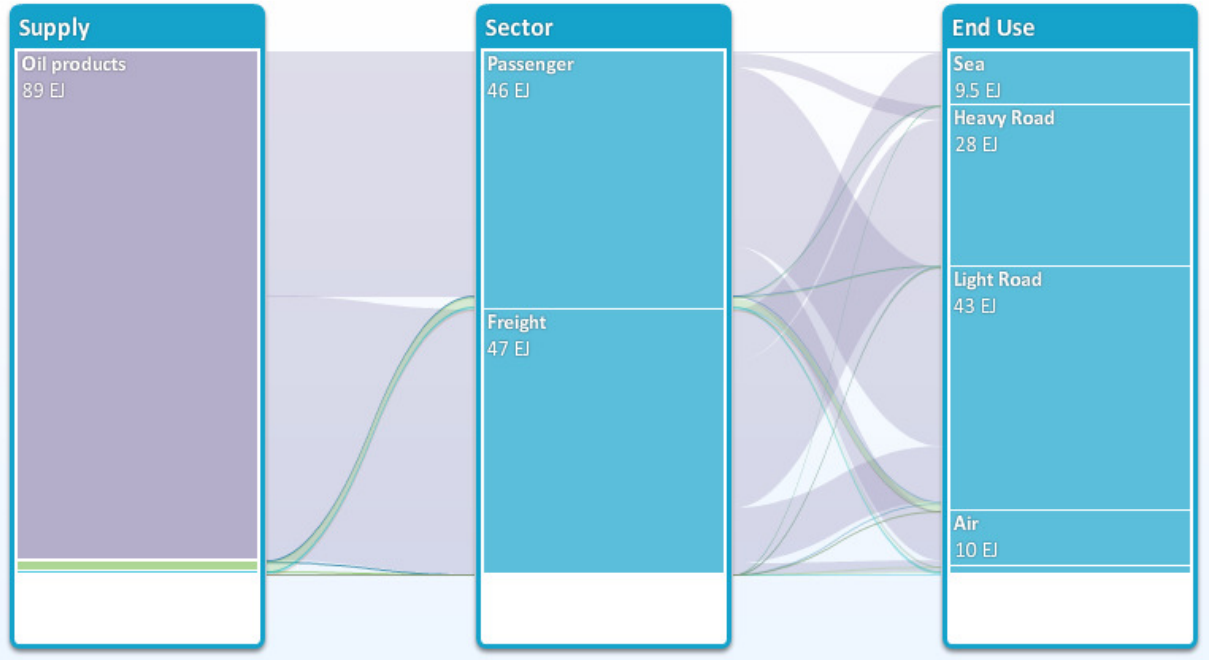

Figure 1: The sources of the transport sector's energy demand, 2009
Source: http://www.iea.org/etp/explore/

The high amount and increasingly dynamic growth of harmful substances and carbon-dioxide emitted by the different sectors (agriculture, industry, transport, service and household sectors) mean problems not just for Hungary, but for Europe and even the whole world. At the same time, the issue of supplying energy to the different sectors is more and more widely discussed. Providing the necessary amount of fossil fuels and replacing them with other energy sources receives increasing attention as well.

The efficient use of available resources, improving the energy supply of each sector, sustainable development, including modal split, and promoting environmentally friendly solutions in transport have become global problems and tasks.
With emphasis on the transport sector – as it is highly harmful to the environment as well as having significant economy boosting potential –, the energy supply and energy efficiency of this priority sector should gain more focus, taking mobility needs into account. According to the 2012 report of the International Energy Agency (IEA), world transport may be responsible for 10,810 million tons of CO_2 equivalent in 2050, which could lead to a 6°C increase of the Earth's average temperature. If we want this increase to be 2°C at most we should decrease this figure by approx. 30%. The energy supply of the transport sector shall also be closely examined because almost all the energy use of world transport is provided by oil products.

In terms of emissions of harmful substances, road transport is responsible for much higher levels of emissions than any other sector. Within the field of road transport, urban traffic is inherently much more harmful to the environment due to the technological characteristics of the vehicles than long-range, interurban transport.

More than 70% of the EU's population lives in cities, which may be very attractive for a more efficient use of resources and a more comfortable life, but it also leads to special problems. These problems include overcrowding; the lack of green, natural environment, concentrated pollution, smog, traffic jams etc. Many move out to the agglomerations because of these reasons, but the commuter's lifestyle has created problems characteristic of urban life on municipalities in the country in a short span of time, while it has not improved the situation in cities. These processes brought the idea to innovator city administrators that the city's usual functioning should be somehow changed, and negative impacts associated with urban living should be diminished. There are several exemplary developments considering environmental consciousness and improving the standard of living in big cities all over the world. In our study we attempted to collect the problems of a liveable city, as well as the solutions in terms of technology, transport management and economy.

There are several means for increasing energy efficiency with regard to the specifics of the urban transport sector; there are local solutions as well as ones that can be implemented on a global scale, at system level. An example for the first is the development and modernisation of vehicles participating in traffic, with special regard to fuel consumption and emissions; while an example for the latter is the provision and expansion of energy-efficient alternative travel modes for end users, as well as improving existing alternative modes, adequate transport management and shaping the perspective of persons participating in transport.

It is unavoidable that the transport section should keep up with the requirements of the dynamically developing world. However, promoting the appearance of specific innovations, technological novelties are not enough, efforts should be made to implement and develop these. This is impossible by introducing restrictions without alternatives. As in every other area, changes should be gradual.

II. COMPARING TRANSPORT MODES

1. COSTS

Transport modes and their impacts differ in many aspects. In order to see the true costs of particular transport modes it is necessary to include externalities. The results of economic studies show that road transport in urban areas in particular does not cover its costs.

There are several private and social benefits and costs to transport:

– Private benefits – benefits of transfer of persons or items to the destination for the user or owners of said items

– Private costs – operation of vehicles, purchase of tickets.

– Private costs and benefits are key factors in the decisions made by particular individuals on the transport market.

– Social benefits – positive effects of transport for society (for economic growth)

– Social costs – all costs borne by the whole society (i.e. also by individuals that are not involved in transport), also included are the side effects of transport – the cost of congestion, damage to health, environmental damage, landscape fragmentation, etc. (4)

Category	Private costs	External costs
Transport costs	Costs of the transport vehicle and the fuel, tickets	Costs covered by others (i.e. when parking is provided for free)
Infrastructure costs	Tolls, road taxes, vignettes, partly excise tax on fuels	Infrastructure costs not covered by the user (usually covered from the state budget)
Costs of accidents	Costs covered by insurance and costs covered by the individual	Accident costs not covered by the user (i.e. pain and suffering for family members)
Environmental costs	Health effects etc.	Environmental costs not covered by the user (i.e. noise pollution)
Congestion costs	Costs of one's own time	Costs of delays caused by others

Table 1: Classification of costs in transport
Source (4)

2. ENERGY CONSUMPTION

2.1. Transport energy demand

Energy demand of transport increased vastly in Poland in the last decade, while just a slight increase was shown in the other three IVF countries. The increase is arisen mainly from road transport (both individual personal cars and freight) whereas the public modes (mainly railway) suffer from outflow of customers. The problem is moreover augmented by decreasing utilization of vehicles capacity and by massive imports of old second-hand cars. [5]

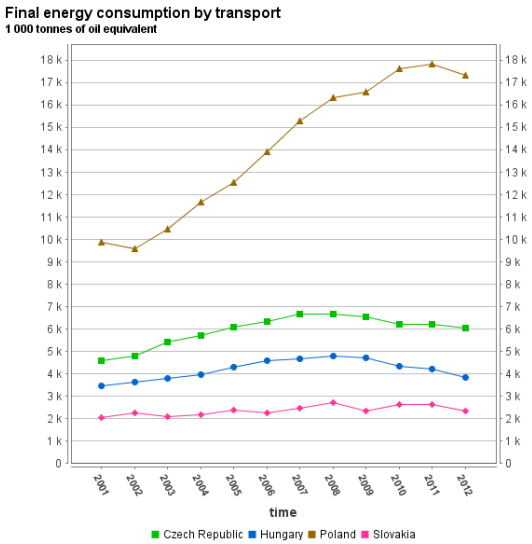

Figure 2
Source: Eurostat

Out of all energy consumed in a city about 25-30% is used in urban and intercity transport. The influence of urban life style on transport energy demand is huge. For example USA consumes in transport four times more energy than Sweden, which population is less dense.

The most energy efficient vehicles are those that use electricity as the driving force, i.e. electrified railway, trams, metros and trolleybuses.

2.2. Transport energy demand (passenger transport)

Energy efficiency improvements for passenger transport can come from more efficient vehicles (e.g. cars), as well as from a shift of art of the traffic by car to public transport (rail, metro, buses) that are less energy intensive.

On average, cars require four times more energy to transport one passenger-km than public transport (rail transport and buses), and five times more energy than rail transport alone (trains, metros and tramways). The specific energy consumption per passenger-km has decreased by 0,9% a year for cars since 1990. For public modes, it has slightly increased. (6)

When comparing the energy consumed by particular transport means for the same distance and number of passengers, the largest energy consumer is air transport, followed by intercity bus transport and then individual car transport. Urban public transport uses 47% less energy than individual car transport. Passenger rail transport uses only 29% compared to car transport. Cycling has the lowest, or rather zero, consumption of energy from non-renewable sources. (7)

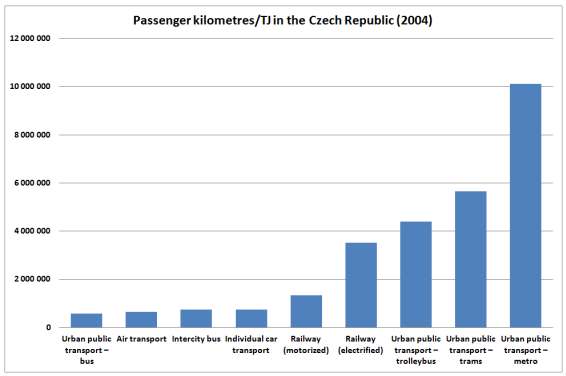

Figure 3: Specific energy use of different transport modes in the Czech Republic (2004)
Source (7)

When trying to save fuel and energy in transport it is necessary to change the structure – move from energy intensive means of transport (individual car transport) to energy efficient ones (rail and electrified transport). (7)

2.3. Usage of public transport in total passenger traffic

The Czech Republic and Austria have the highest use of public transport modes (around 3000 km/year), compared to an EU average of around 2000 km. Belgium and Croatia recorded the highest increase over the period 2000-2009 (about 30%). The decline in the share of public transport offsets one third of achieved energy savings. (6)

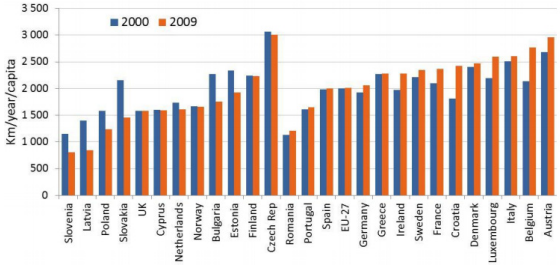

Figure 4
Source: (6)

3. COMPARISON OF DIFFERENT TRANSPORT MODES FROM AN ENVIRONMENTAL PERSPECTIVE

3.1. Emissions

Road transport is the branch that is most capable to provide flexible solutions to requirements based on user needs. It is quite mobile so it can provide door-to-door transportation, it is independent of any other transport mode, it does not have to adapt to any other transport branch, and it is not limited by a timetable. So, this branch is most suited to user needs. Owing to the competition it has sufficiently low transport costs. In addition to flexibility and low costs, it offers very fast transport.

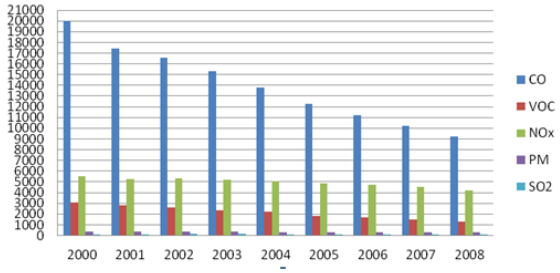

Figure 5: Emissions of road transport in the states of the EU
Source: Authors on the basis of European Environment Agency data

However, road transport has the largest share of the environmental pollution. Carbon monoxide has the largest share of the produced harmful emissions and also a nitrogen oxide is produced in considerable amounts. As it is shown in Figure 5, a gradual introduction of alternative fuels decreases the production of emissions gradually in road transport. Mainly production of the largest

share of harmful carbon monoxide (CO) as well as nitrogen oxide (NO_x) is decreasing.

Road transport has the worst characteristics among transport branches: not just in absolute terms, but specifically it is also the most polluting transport method. In terms of environmental impact, water transport is the least negative branch; its specific energy need is rather low.

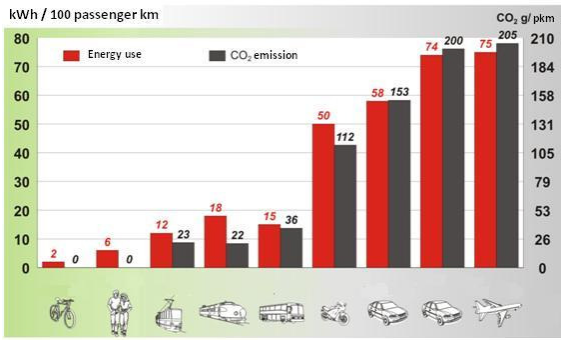

Figure 6: Medium energy use and CO_2 emission of transport modes
Source: KTI graphic trend database, www.kti.hu

3.2. Space

Space requirements also differ among transport modes (when distance travelled and number of passengers remains the same). Below is a table displaying space requirements for particular transport modes. Space requirements correspond with the amount of funding needed for construction, maintenance and modernization of the infrastructure. (7)

Car	100%
Bus	10%
Train	6%
Bicycle	8%

Table 2: Space requirements of transport modes
Source: http://hluk.eps.cz/hluk/doprava-a-zivotni-prostredi/

Passengers in urban areas can use various transport vehicles or even their own muscle power, i.e. walking. From the perspective of efficient use of road space, cars are the least desirable compared with other means of transport. If a car is not fully occupied, its use in comparing number of passengers/ space is very inefficient. The chart below (Figure 7) displays how many people pass a 3.5-meter stretch of urban space in 1 hour. When using rail transport, 22 thousand persons cross the section, compared to 19 thousand pedestrians, 14 thousand cyclists, nine thousand city bus passengers and only two thousand people who used cars. (7)

Figure 7
Source (8)

3.3. Noise

Transport noise has a major impact on human health. It is a major cause of hearing loss, heart disease, learning problems of children, and also causes sleep disturbance. The main source of noise is road transport, which is responsible for 95% of the noise pollution in the Czech Republic (9). Rail transport contributes to noise pollution only minimally. In total, 278 800 inhabitants (2.5% of the population of the Czech Republic) is bothered by noise that exceeds 60 dB during the night, and 226 700 people are bothered by daytime traffic noise that exceeds the limit value of 70 dB. In Prague, 12.9% of the population lives above the noise limit values, along with10.8% in Ostrava and 10.3% of the population in Brno. (10)

3.4. Age of fleet, state of road and railway infrastructure and other factors

In the case of Poland, between 1990 and 2009, the greenhouse gas emissions in transport increased by approx. 88% [11]. This is at least partly due to the increasing age of the fleet if vehicles. Personal motorized vehicles are in the worst quality, the average age of cars registered in Poland is 14-15 years. Most of the passenger cars in 2009 were cars with diesel engines, most of which lacked dust filtration systems for exhaust fumes and thus had a high level of dust emission.

The age of the bus fleet is similar to that of passenger cars. In this vehicle group, buses with the capacity of up to 15 seats are in the worst situation. More than 65% of buses of this type are over 20 years of age [12]. Larger

buses are in a better condition, although 70% of vehicles in this group are at least 10 years of age [12].

Lorries are, in comparison, the newest fleet, especially in the group of truck tractors, almost 50% of which are less than 10 years old [12]. The modernisation of this group has long been stimulated by a catalogue of transport fares on national roads, varied with respect to the European emission standards. The fares are lower for vehicles that meet stricter emission standards.

The regulations on and control of speed limits are also of some importance for the energy efficiency of road transport in Poland. Since 2011, Polish regulations have allowed road speed limits that are the highest in Europe. One can drive on the motorway as fast as 150 km/h [13], whereas specifications of most car engines state that the most optimal fuel consumption conditions occur at the speed of 80–110 km/h.

Additionally, means of traffic calming are virtually non-existing in Poland. The means very often used instead of traffic calming are traffic lights or local speed limits combined with speed cameras. These are often accompanied by badly maintained road surfaces and the lack of ring roads of built-up areas. Such a situation, instead of enforcing fluent, more ecological ways of driving at lower speeds, encourages a high level of speed changes, which is energetically inefficient. On the top of that, many roads are over-dimensioned (too wide), which results in driving at speeds over the speed limit.

Narrow gauge railway is probably the least modern and energetically effective in Poland, because its rolling stock and the infrastructure are governed by local authorities, which often do not have the necessary means needed for full modernisation. Much of the narrow gauge rail transport is carried out on steam traction solely for touristic purposes [14].

There is another significant factor in the Polish railway network decreasing the energy efficiency of railway transport. There's virtually no rail line in the country that does not have local speed limits, forcing trains to reduce their maximum speed of e.g. 120 km/h to even 20 km/h [15]. For heavy and old trains running in Poland, such limits are a waste of considerable time and energy; they also contribute to diminishing the competitiveness of the railway when compared to the road transport.

3. ALTERNATIVE FUELS

Nowadays, protection of the environment is one of the main topics in the developed countries. Therefore their attention is concentrated on the development of vehicles with low or zero emissions. Reduction of the emission of greenhouse gases by transport – similarly to other sectors – may be approached from several sides. Possibilities include technological development as well as modifying our lifestyle and, through it, our travel culture. The best solution is always provided by a complex approach, therefore if we want results we should not focus on either of these paths exclusively.

3.1. Alternative Fuels of Internal Combustion Engines

The most widely used fuel in the world is petrol and diesel fuel. The technological development, aiming the reduction of the emission of combustions engines, resulted in a growing number of eco-friendly vehicles which use other fuels for combustion like petrol and diesel. Those vehicles have been on the road for several years and can be divided into vehicles, which uses biofuels (methanol, ethanol, biodiesel), LPG (propane-butane), CNG (natural gas) and hydrogen.

We can see that, if we regard first-generation biofuels as the exclusive solution, instead of minimizing environmental impact we increase it. Second-generation biofuels seem promising, but we have no information what environmental risks their wide-spread application may bring. The production of biofuels, even if we leave all other factors out of consideration, cannot keep up with the ever increasing energy demand of travel; therefore it is inevitable to rationalize transport itself. [16]

The utilization of LPG (liquefied petroleum gas) began to be widespread (legally) from the 90's on. Motorized vehicle owners (especially delivery truck drivers, cab drivers) can enjoy the savings from using LPG all over the world. The benefits are not restricted to the owners' finances; LPG vehicles help reduce greenhouse

emissions: the amount of NO_x in LPG is approx. 20% of the amount in gas-fuelled engines, and its CO_2 emissions are 15% lower, which means that the amount of unburned fuels is lower than in gas engines, there is no lead emission, and the amount of carbon dioxide emissions is close to zero. Exhaust can be neutralized at lower vehicle combustion accelerator temperature, which spares the combustion accelerator of gas-fuelled engines.

CNG (compressed natural gas) used as engine fuel is of the same quality as natural gas used in households. The gas compressed to a pressure of 250 bars is produced at fuelling stations using high-pressure compressors, and this gas is filled into vehicles. Natural gas is transported to fuelling stations through the national grid. The pressure of natural gas in the compressed-gas cylinder depends largely on temperature changes, but that does not affect the operation of the engine. CNG cylinders are filled either at low pressure ("slow filling") or high pressure ("fast filling"). [17]

Its use leads to a slight excess in consumption and a loss of performance, but its better combustion makes torque steadier. The amount of excess consumption depends on driving style and average distance driven, but if we focus on consumption in litres we will find that about 5 to 20% more liquid fuel is needed for the same performance than of gasoline. Nowadays, using so-called third generation equipment – with the latest software-supported linear gas injectors close to gasoline injection in character – with optimal settings the excess consumption can be kept under 10%. As LPG is cheaper than gasoline, the price of excess consumption may break even after approx. 30,000 km.

Hydrogen is not expected to appear at fuelling stations in the near future. Due to the costs of its production and the complexity of its storage, even the creation of a few test runs seems unlikely in Hungary. A possible application of hydrogen is blending it with natural gas, but even that may only be realized at an experimental level by 2013. For production – on the basis of renewable energy sources – water dissolution may be technologically implementable even on an industrial scale. However, storage difficulties significantly limit the vehicles' spatial and timely range. Hydrogen is not expected to reach a 1% share on the fuel market by 2020.

3.2. Beyond conventional combustion engines

3.2.1. Electric Motors in Vehicles

Electric vehicles differ from the classic cars (petrol, diesel, natural gas, propane, biofuels etc.) by that the electric vehicles replace the internal combustion engine by electric motor and they have rechargeable batteries instead of fuel tank. Each battery is similar to storage batteries (by size and shape) which are used for starting of classic cars. But the electric vehicles have more batteries (typically 15 to 30 pcs).

3.2.2. Hybrid Vehicles

Hybrid vehicles combine several advantages of two methods of propulsion. In the most of cases, they combine the advantages of the combustion engine of different fuels and electric motor. Furthermore, the hybrid vehicles are usually equipped with an electric generator that recharges the batteries while driving, thereby extending the driving range of vehicles per one battery charge. The batteries are recharged continuously or only when they are discharged at a certain level. These hybrid vehicles eliminate the main disadvantages of electric vehicles which are the short driving ranges of vehicles and long charging times of batteries.

3.3. Impacts of the alternative fuels and drives on the environment

Transport is generally one of the biggest polluters of the environment. One of the main ecological problems is production of emissions which has an impact on all types of living organisms. In addition to the direct impact on humans and vegetation it also causes global climate changes that affect us for a long time. In general, it is estimated that in the world there can be produced up to 10 billion cubic meters per year of emissions despite efforts to achieve the cleanest burning. Generally, the pollutants represent great amounts of different types of substances generated by transport. The main pollutants, generated by transport, are carbon monoxide (CO), carbon

dioxide (CO_2), sulfur dioxide (SO_2), nitrogen oxides (NO_x), unburned hydrocarbons (HC), volatile organic compounds (VOCs) and particulate matter (TPM).

3.3.1. „LPG" Emissions

LPG is a mixture of gaseous hydrocarbons, mainly propane and butane, originating from the extraction of natural gas and oil. According to temperature of ambient surroundings, propane is a gas, while butane can be either a gas or liquid.

	CO	HC	NO_x	TPM	Together	
	g/kWh				g/kWh	kg/year
Diesel	1,5	0,46	3,5	0,02	5,48	2 718
CNG	0,3	0,25	2,0	0,02	2,57	1 275
Difference	1,2	0,21	1,5	0	2,91	1 443

Table 3: Comparison of CNG and diesel emissions http://www.spp.sk/download/cng/Zemny-plyn-v-doprave-CNG.pdf

LPG has two physical properties that specifically affect air quality:

– Although composition of LPG is natural variable to the certain extent, however, it has a comparably high calorific value, which means that it contains more energy per kilogram than most competing fuels.

– Simple molecular structure of LPG facilitates its combustion and ensures lower pollutant emissions profile than most other fossil fuels.

LPG has a lower proportion of air pollution compared to other conventional fuels. It has been demonstrated that LPG is involved in deterioration of atmosphere much lower than diesel and approximately at the same level compared to petrol (Figure 8). LPG has clearly lower content of NO_x emissions than petrol and diesel. Basically, it has the same content of particulate emissions (TPM) as petrol and much lower than diesel. The content of volatile organic compounds (VOC) is only slightly lower than in petrol but higher than the VOC content in diesel.

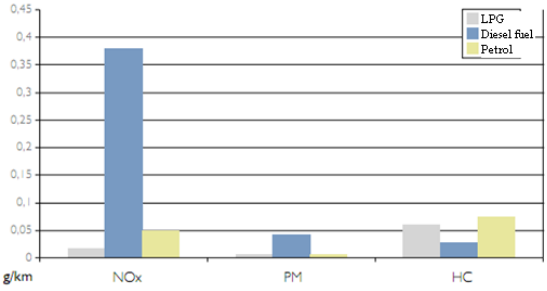

Figure 8: Comparison of emission LPG, petrol and diesel
Source: http://www.probugas.sk/stranka/4_na-stiahnutie

3.3.2. Emissions of Natural Gas (CNG)

CNG is natural gas compressed by the compressor to a pressure of 20 MPa and in this form it is filled into a pressure tank in the vehicle. It represents an alternative ecological motor fuel because its combustion produces a significantly smaller amount of harmful emissions compared to conventional fuels (petrol, diesel) and contributes to slow global warming. CNG combustion generates practically no particulate matter and produces fewer harmful greenhouse gases. In particular, it produces less of sulfur by 99%, NO_x by 75%, carbon oxides by 50%, solids by 86% and hydrocarbons by 45%. It is used mainly for the greening of urban and suburban bus transport. As it can be seen in Table 3, the bus with CNG propulsion produces 1.275 tons of air pollutants per one year. However, it produces about 1.443 tons less harmful substances per one year compared to bus with diesel engine.

3.3.3. Biofuels Emissions

Current biofuels of the first generation are made from surplus of agricultural commodities such as wheat, corn, sugar beets, sugar cane, and fatty acids, mainly rapeseed and soybean oil.

3.3.4. Bioethanol

It offers net reduction in greenhouse gas emissions. For 100% ethanol produced from sugar beet and wheat it is possible to achieve a reduction of CO_2 by 50% - 60% and the use of 5 % of bioethanol reduces CO_2 emission by 2.5% - 3%. Climate changes depend on the feedstock used to produce ethanol. If a cellulosic raw material is used, a saving of greenhouse gases can be at the level of 75% -

80%. Its use can contribute to mitigating climate changes.

3.3.5. Biodiesel

The use of biodiesel can reduce the production of greenhouse gases. For 100% biodiesel, it can reduce the total CO_2 by 50% - 60%, and use of 5% biodiesel can reduce CO_2 production by 2% - 2.5%. In practice, however, there is limited reduction of CO_2 emissions from biodiesel, which is made from oil crops, because the cultivation and processing of crops requires supply of fossil fuel. The use of biodiesel can contribute to meeting the EU targets for climate change mitigation. Biodiesel can reduce some other exhaust emissions from road vehicles. Emissions of nitrogen oxides (NO_x) emissions are relatively higher because the temperature in the combustion chamber of the engine is higher and biofuels also contain more oxygen.

3.3.6. Electric Motors

Vehicle using the electric motor as the power source do not directly produce harmful emissions, but increasing the number of these vehicles will increase electricity production from coal-fired and nuclear power plants. Production of energy from these sources has an impact on the environment and pollutes our air, soil and water. Table 4 shows the production of emissions when 1 kWh of electricity is produced in factory. Increasing in number of electric cars would raise production of emissions (CO_2). On the other hand, it is possible to reduce the production of harmful substances and obtain electrical energy from renewable sources such as biomass, wind energy, hydropower, and solar energy.

Technology	gram CO_2/kWh electricity
Solar, water and wind energy	from 10 to 40
Nuclear energy	from 90 to 140
Combustion gas	from 330 to 360
Combustion of coal	from 1000 to 1100

Table 4: CO_2 production of plant at electricity generation

4. CONCLUSION

When comparing transport modes in various aspects we get the worst result for individual road transport regardless of whether we look after energy demand, emissions, space requirements or noise. The most energy efficient vehicles are those that use electricity as the driving force, i.e. electrified railway, trams, metros and trolleybuses.

The easiest way towards energy savings in transport therefore seems to be the shift from individual road transport to public transport or even non-motorized modes of transport.

Among railways as many rails as possible should be electrified, in CEE there are still many motorized rails. Further it is necessary to provide electricity from renewables.

The use of alternative fuels can be best described on the circular intersection traffic sign, which is shown in Figure 9. We can imagine the world of motor fuels as an imaginary crossroad where we must decide which is the best fuel to power vehicles for long term use. We can refer petrol and diesel to the narrow road traffic sign because of limited availability of oil. LPG and alcohols (methanol and ethanol) produce lower emissions, but they are also made from oil products. In the short and medium term there is the most appropriate alternative fuel natural gas and biofuels (indicated by sign of express roads in Figure 9).

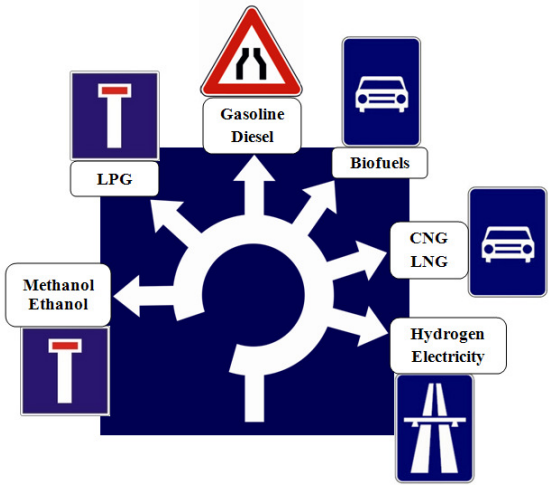

Figure 9: Advantages of alternative fuels
Source: Authors

In the combustion of biofuels there are the least harmful contaminants. Limiting factor is

the nature of the gas at normal temperature and pressure, which is circumvented to some extent by using natural gas at higher pressure (CNG) or at a lower temperature (LNG). Biofuels reduce car emissions which depend on the raw materials. Biofuels provide a suitable solution for waste treatment. From long term the most appropriate alternative of power source for cars are hydrogen and electricity because they have the least impact on the environment with zero emissions. Hydrogen as the future fuel may increase competition among suppliers of fuel and especially the developed countries may reduce or remove their dependence on oil. It can be produced from renewable sources such as biomass, hydropower, wind power, and solar energy.

III. TRAFFIC MANAGEMENT AND INTEGRATED TRANSPORT SERVING ENERGY EFFICIENCY

1. INTRODUCTION

Technological solutions are insufficient in handling negative effects arising from transport, such as air pollution and traffic congestions. Demand management is another paramount pillar of revising transport policy measures in the EU. The aim is to create measures that assist the development of public transport, including making it affordable and sustainable, and help satisfy the needs of the local population so that it can become competitive with personal motorized transport. The marginal abatement cost (MAC) curve is one of the tools with which the carbon-dioxide reducing projects and technologies can be compared with financial aspects taken into account. [18]

The following means could enhance the transport system's energy efficiency:

– the use of road traffic management systems, whose aim is mainly to increase the speed and fluency of the road traffic;

– introducing integrated fare systems in urban agglomerations, with the primary aim of including the railway in the system of public transport fares and thus increase the attractiveness of public transport to passengers (cheaper and faster transits with a single ticket);

– limiting motorized traffic in cities by managing the demand for parking spaces and limiting the access of cars to selected streets or zones in the city;

– giving priority to public transport in the road traffic, partly with using the above mentioned systems and means.

1.1. Road traffic management systems

Many are convinced, including influential transport engineers and decision-makers, that one of the means to increase the transport system's energy efficiency is developing the road system, since it contributes to the fluency of road traffic. However, as the experience of many cities worldwide shows, these measures enhance traffic fluency only temporarily and new roads are sooner or later filled with additional cars that, again, get stuck in traffic jams [19].

Road traffic management in cities is made more efficient mainly through systems integrating traffic lights over several crossings or whole zones of the city. Such systems are present, to a greater or lesser degree, in virtually every bigger agglomeration. Less advanced systems simply create the so-called green wave for cars on longer segments of streets running through the city, most often on exit or ring roads. More advanced systems, such as the one implemented in Warsaw, gather information on and predict the road traffic and manage traffic lights on the basis of the results of these predictions and analyses of the existing traffic [20]. At the same time, steering the traffic in such systems is practically solely limited to car traffic and their aim is to improve road traffic, which in practice is reduced in many places to giving priority to car traffic over public transport, bicycles and pedestrians. The priority for cars is reflected in implementing, as a result of introducing the traffic management systems, the following:

– buttons triggering green light, which are onerous for pedestrians and cyclists, often set in such a way that not pushing the button completely eliminates the green phase from the light sequence instead of shortening it [21];

– prolonged phases of red light sequences for public transport vehicles, especially trams on tracks separated from the road [22];

– separated phases of light sequences and turn lanes on crossroads, which make it difficult to implement, for example, separate bus lanes.

1.2. Integrated fare systems

Systems of integrated ticket prices are developing rapidly in urban agglomerations. In Poland, Gdansk, Wrocław and Warsaw have been intensively integrating fare systems with different organisation schemes. In Gdansk, one large unit – was established, integrating all town and commune governments in one organisation in order to create a joint transport system, including the agglomeration railway. In Wrocław, the railway was included in the public transport system thanks to bilateral

arrangements between the public transport authorities and the main railway operator. Warsaw's public transport management, after arranging the cooperation conditions with the railway operator, decided to sign annual agreements with every neighbouring commune the public transport reaches. The results of transport integration in Warsaw in 2008 were very positive: from the moment of introducing a joint railway and public transport ticket, the number of passengers on suburban trains has grown by leaps overnight. Owing to organising feeder lines to railway stations, park and ride car parks, and a gradual growth of the number of trains, which were made possible thanks to the transport integration, the number of passengers of the suburban trains has grown steadily for 5 years [23, 24].

In Budapest, Hungary, the operators of the Budapest public transport, the railway and the intercity bus lines introduced a common monthly ticket in 2009. With that ticket all lines of the three companies may be used, within the area of Budapest.

1.3. Limiting motorized traffic

Local governments mainly want to increase the efficiency of their urban transport systems by implementing the measures improving road traffic mentioned above and encouraging drivers to use public transport. Measures limiting the car traffic in towns and cities are introduced unwillingly. Metered parking zones on public streets, are an exception in this sense. Practically every bigger city, and sometimes even medium and small sized cities and towns, have a metered parking zone in downtown, economically and often physically limiting access to parking spaces and thus should limit the number of cars entering the city. However, there are three types of problems connected with such zones:

1. inhabitants of the zone have preferential access to it (e.g. lower fees, reserved spaces), causing the number of preferential users being almost equal to the number of spaces in the zone;
2. the scale of control, payment enforcement, and the lawfulness of parking in the zones could be insufficient, e.g. in Warsaw in 2008 and 2009 almost 50% of the cars were parked illegally, the number of parked cars constantly exceeded the number of parking spaces available by 20%, and only 0.3% were fined or towed;
3. local governments may not increase the parking fee above the amount set in higher level regulation, and if the fee remains unchanged, in cities, where the citizens' incomes are high, it does not discourage drivers from parking in the city centre [25, 26].

According to the Polish experience in traffic management and transport integration:

– Public transport and railway ticket integration usually causes an increase in the number of passengers, but only if the new ticket prices were affordable for them;

– It is important to use road traffic management systems not only to regulate road traffic, but also (or primarily) to include priorities for public transport, cyclists and pedestrians;

– Zone parking must be implemented with proper control of parking rules.

2. TRANSPORT MANAGEMENT, THE ROLE OF ITS IN MAKING URBAN TRAFFIC FLUENT – THE EXAMPLE OF BUDAPEST

The biggest problem of urban traffic is the excess dominance of individual needs, the lack of willingness to adapt, the low occupancy of personal automobiles (1.2 persons per car on average). The situation may be improved by the introduction of integrated transport systems (ITS) and measures that promote public transport or car-share schemes.

Every measure that acts in spite of public transport (decreasing the frequency of vehicles, significantly raising fares) initiates hardly reversible, long-term decision-making processes on the users' side, shifting modal split away from public transport. Most European cities are fervently searching for options to calm exorbitant urban traffic, to dissolve traffic congestions and traffic jams. The most successful cities are those where comprehensive transport development theories incorporating the agglomeration were developed in close relationship with and as integral parts of the strategic development ideas of the wider metropolitan region.

One of the options of traffic regulation and decreasing traffic congestion is the development and use of Intelligent Transport Systems (ITS). The development of Intelligent Transport Systems brings about a much deeper infiltration of IT into transport systems. "Intelligence" is introduced to transport through IT systems, through the use of IT tools and systems making an increasing amount of individual decisions and assisting human decisions with increasing efficiency on different transport levels (driving vehicles, maintaining road networks and supervising traffic). On the end users' level we differentiate between pre-travel, in-travel and post-travel (walk-away) information systems.

Data offered to users may be static (e.g. publications, timetables of the given year), semi-dynamic or dynamic. The latter are provided through several information sources, e.g. telephone, internet and other information services. Another method of informing passengers is using passenger information office services and on-board equipment.

2.1. Problems of Budapest

Budapest's transport has gotten close to a crisis by now. The morning and afternoon peaks of traffic congestions are starting to spread over the interim periods as well, an unexpected traffic event can lead to crippling the traffic of whole zones of the city. All this inevitably affects public transport, which consists mainly of transport modes that are not separated from road traffic. Traffic congestions significantly diminish the quality of life of people living in inner city sections and around main incoming traffic arteries; in addition they jeopardize economic development because narrowing mobility options are harmful for the economy.

Budapest's traffic is influenced by contradicting processes: the increase of mobility needs and the dominance of individual motorized vehicles are both limited by the strict boundaries of spatial structural characteristics. While still relatively high, the share of public transport is continuously decreasing, the issues of financing are increasingly urgent. Because of the latter, holding the existing traffic performance back is on the table, despite the fact that more and better services should be offered in urban and suburban traffic in order to make them attractive alternatives to personal car use.

2.2. Two options for solving the problems

2.2.1. Information systems

A wide range of in-travel information solutions can also be observed in Hungary. From the visual and acoustic elements at transport stops through visual and acoustic information sources on board through roadside visual units, to visual and acoustic services at parking facilities helping individual travel. A ready network of systems for unexpected traffic events is available for end users, depending on the quality of traffic fluency; traffic control centres can easily influence traffic. The continuous flow of public transportation is assisted by e-ticket systems. Online ticket purchasing is offered both by MÁV (Hungarian Railways) and Volán (interurban buses) to travellers.

Today, buying tickets and reserving seats online are very popular forms of purchasing tickets as users can choose their preferred seats with a few clicks, without having to stand in line. No cash is needed for the purchase; the bill is settled via bank transfer, a popular and quick way of payment. To make urban transport and ticket payments related to it more fluent, the solution may be moving towards more automatic systems, however, this is impossible without significant investments.

2.2.2. The potential and promotion of Park and Ride (P+R) schemes in Budapest

Urban transportation is a very complex system. The traffic flows emerging in cities include the sub-system of vehicles waiting (parking and vehicle storage), therefore parking is an unproductive sub-process of transport. The number of parking spaces has increased in recent years. In comparison with the 2006 situation, the number of parking facilities with a large capacity surpassed that of parking facilities with fewer than 200 parking spaces. The Park and Ride systems of Budapest offer 3899 parking spaces collectively.

The correct design of parking facilities may significantly influence the reduction of certain traffic flows. Most of the Park and Ride parking facilities of Budapest are in locations that are not favourable for traffic entering the city.

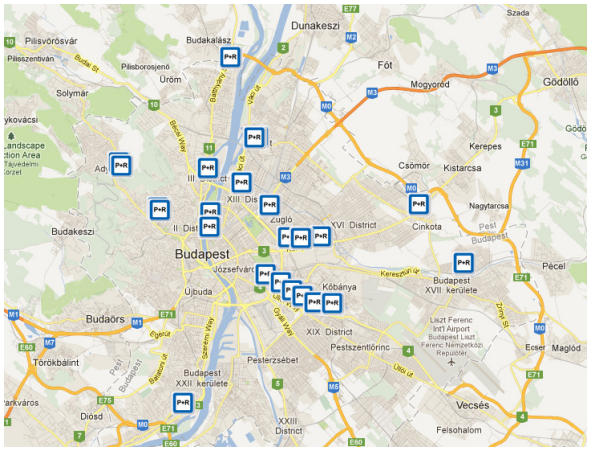

Figure 10: P+R parking facilities in Budapest
Source: http://mercator.elte.hu/~haaoaat/p&r/

As the Park and Ride facilities are located in the inner-central region of the city, they have insignificant effect in diminishing the traffic of routes entering Budapest. The system's shortcomings are not limited to professional opinion; the population also regards parking in Budapest highly unsatisfactory according to surveys. Improving the current situation would require, among other measures, increasing capacity aside from public spaces, with special regard to the construction of Park and Ride facilities in the vicinity of the city lines and outer transit zones. Due to certain investment considerations, the importance of creating a complex transport approach was not taken into account at the creation of certain parking spaces, therefore several Park and Ride parking facilities lost their ability to attract parking due to unfavourable location, capacity and design.

As a result of this, traffic heading to the city flows into the centre. Because of these factors, drivers do not benefit from Park and Ride facilities, and they can only park in parking structures and underground garages, beside public spaces. Improving current parameters can only be achieved through harmonizing parking motives (needs) and parking modes. Prerequisites of efficiency are reducing the attractiveness of entering the city centre via motorized vehicles, providing an adequate level of services available, making intermodal changes at transit points attractive, and providing adequate information (availability, occupancy) to those who wish to use the services. [27]

The necessity of adequately locating and expanding Park and Ride facilities is inarguable, it is of utmost importance in terms of prioritizing public transport. In order to increase the energy efficiency of transport, the establishment of Bike and Ride parking facilities should also be considered a priority. Their popularity and utilization, however, is impossible without informing the users.

IV. CYCLING IN URBAN TRANSPORT

1. INTRODUCTION

It is widely known that regular exercise is a necessary element of a healthy lifestyle. In today's fast-paced world, riding a bicycle is the most readily available form of exercise we can do as it does not need the allocation of extra time, it is enough if we take off for work or other errands by bicycle every day. In terms of air pollution, we know now that it affects car drivers and passengers to a much greater extent than cyclists. Scientific studies revealed that people in cars inhale a larger concentration of harmful substances as they are positioned lower than people sitting on bicycles, and they move in the middle of the road where the concentration of harmful gases and dust is higher, and the closed space of the automobile retains them longer. [28]

Cycling traffic is a chain of point of departure, route and destination. In order to enhance cycling it is necessary to focus on all three parts of the chain and build bike paths, appropriate signage and safe parking (7). We can divide the parking time into short term parking (minutes), medium term parking (up to 4 hours) and long term parking (all day during school, work, etc.). The risk of theft and vandalism increases with the duration of parking time (10).

Depending on the duration of parking, the maximum distance between a parking place and the visited site is defined as up to 5 meters in case of short term parking, up to 50 meters in case of medium term parking and up to 100 meters in case of long term parking (10).

When parking for a short time there should be a possibility of locking the bike at two spots – one wheel and the frame. If the bike owner can have a view of the bike during parking, a minimalistic version of one-spot locking is also possible. (10)

When parking for a couple of hours, ideally a stand in a U-shape should be available so one can lock both wheels and the frame. Also the stand should be positioned in a clearly visible place and near to the object the cyclist wants to visit. In case of long term parking there should be a garage facility and a stand in a U-shape. (10)

At places like central train stations where there is a high concentration of bicycles, bike depositories and systems of bike storage should be at hand. As a nice example we can mention bike boxes for 1-2 bikes and a piece of luggage. (19) Also very handy is to place bike service stations at parking garages and bike rental locations.

Parking infrastructure should always be placed at "departure and destination" places: train stations, bus and tram stops, block of flats, office buildings, shops, sporting facilities, restaurants, cultural and social facilities, and tourist spots. All parking places should be spacious enough, should be at frequented places, ideally within view of cameras and under a roof (10).

This "Bike and Ride" system is a kind of combined transport mode where cycling traffic continues by public transport or vice versa. Alternatively it is also possible to let the cyclist take the bike with them on the public transport vehicle. This measure can make the railway more attractive. Within a 10-minute radius from the train station, a bicycle can extend the catchment area up to15 times compared to walking. Compared to the bus, a bicycle is faster within a distance of 3 kilometres. (10)

2. CZECH REPUBLIC – CITY CASE STUDY

Based on findings from a Pilsen case study (29) we can see that cycling is more often associated with leisure than with commuting to work. Around 60% of respondents (in the city of Pilsen) have a bike at home, but most often it is a male under 35 years of age who uses the bike. Bicycle owners are more often people with higher incomes, who simultaneously own a car and a season ticket for public transport. Large differences can be seen in whether a bicycle is chosen when looking at the purpose of the journey. Bikes are mostly used for trips for sport and other leisure activities and are used least for business trips and when accompanied by children and other family members. (29)

The most important factors that would motivate respondents to greater use of

bicycles include expansion of cycling infrastructure, including the ability to store the bike at the destination, and increased safety. The smallest obstacles are physical demands and the terrain. (29)

In a survey conducted in Pilsen, people were asked why they are using bikes for their regular trips on weekdays. The most frequent answers were: "It keeps me in better physical shape", "I like this form of transport" and "It is the fastest". Only in a small number of cases was the reason for choosing a bike environmental protection. The stated reasons did not differ significantly for different trip purposes. (29)

At the same time, the reasons for using cars and public transport were surveyed. In the first case it was mostly the speed and comfort and, when shopping, the ability of carrying larger and heavier items; in the second it was the custom and availability. (29)

Furthermore, the motivation of potential bike use was explored. People were asked what possible changes in cycling infrastructure and other characteristics of the transport system would motivate them to use the bike more frequently instead of the mode of transport they were using so far. Motivational factors for both groups (those who bike already and those who do not) are better cycling infrastructure (more independent paths and lanes), the possibility to store the bike at the destination point and increased safety. The smallest obstacles are physical demand and the terrain. (29)

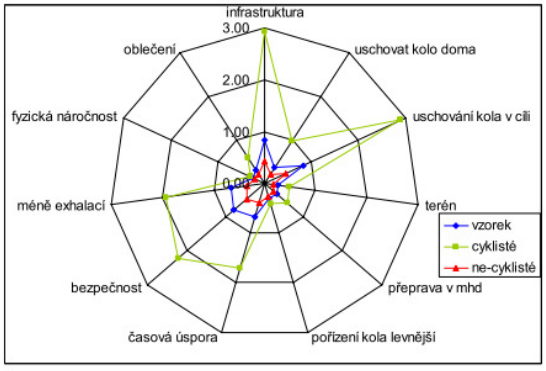

Figure 11: Motivation factors for more frequent use of bicycling
(legend from the top: infrastructure –store the bike at home – store the bike at the destination – terrain –possibility to transport bike on public transport – purchase of bike is cheaper – time savings – safety – less emissions – physical demand – clothing; at the right side: blue – sample, green – cyclists, red – non-cyclists)
Source (29)

3. DEVELOPMENTS IN A BIG CITY: BUDAPEST

In Budapest, there is a public bicycle rental system, named BUBI, under construction, with a planned start of spring 2014. Beyond BUBI, more and more measures are taken to increase the safety and fulfil the needs of people travelling by bicycle in Budapest. In 2012, almost 200 kilometres of designated bicycle paths were available in Budapest, and route number 6 of the EuroVelo international bicycle network crosses the city. [30] Bicycling gains more and more attention in Budapest, owing to the continuously increasing number of cyclists and to the health and environmental effects of this alternative travel mode. 2 and 3 dimensional maps are available to users of specific routes, making the promotion of this mode of travel much easier.

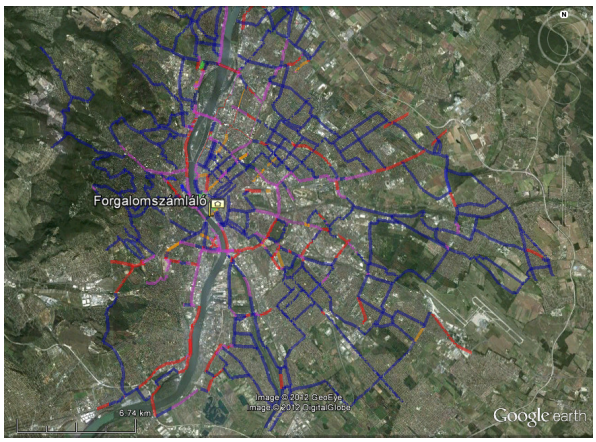

Figure 12: Bicycle network in Budapest, 2008
Source: http://www.mozgasvilag.hu/

In addition to the IT background, bicycle travel is promoted through community movements as well, the most outstanding of which is Critical Mass, which reaches the highest number of people. Owing to national movements and local, regional events as well as to a positive image, more and more employers endeavour to promote bicycle travel as a healthy travel option in the workplace. The biking event organized twice a year (on 22 April for Earth Day and on 22 September for the Car-free Day) has achieved its goal by now according to the organizers. Therefore the event was not held in the fall of 2012, the last demonstration

organized in the framework of the Critical Mass movement took place on Earth Day 2013.

The launch of BUBI and the positive bicycle infrastructure developments of recent years inspire a very optimistic outlook. Such initiatives should be supported, but spatial allocation of the development sites must include a wide-scale survey of demand, thorough consideration and accounting of possible impacts, all the while implementing a systemic approach.

4. STATUS OF CYCLING IN POLAND

The common use of the bicycle as a means of transport is limited by the several factors in Poland; however, the more measures, promoting cycling, are taken place, and bicycle infrastructure is also being developed.

Most of the Polish cities, especially the biggest ones, have a large amount of the bicycle infrastructure, mainly bicycle paths and lanes, e.g. Warsaw has about 275 km of bicycle paths and lanes [31]. However, the bicycle lanes created in cities do not create a coherent network. This leads to the lack of bicycle solutions in the city centre, where travelling by bike is the most popular.

Bicycle paths outside of cities, if existing, are marked incoherently and most often they are covered with an awful-quality surface, for example a sandy one or one that changes into mud when it rains. Special tourist bicycle paths have been created in single locations, mainly in Pomerania or near the Western border as a prolongation of German cycle routes. The Eurovelo network practically does not exist in Poland.

Public bicycle systems have been initiated and function, with a development perspective, in Krakow, Wrocław, Pozna , and Warsaw. Creating these systems is treated as motivation to develop a bicycle infrastructure rather than as a supplement of the existing one [23].

The organisation and planning of the bicycle infrastructure in Polish cities have taken much effort. The organisation model is based on a strong support to building the bicycle infrastructure proposed by environmentalist or bicycle-related non-governmental organisations associated in the Cities for Bicycles network. Most members of the organisation campaign for the creation of new bicycle infrastructure by organising the Critical Mass.

After the bicycle movement breakthrough (around the year 2004), the situation started to improve. NGOs got right to give opinions on road development, and then, special bicycle officers' posts were created in several cities, and even heading teams, being responsible for the coordination of bicycle operations in the city. Development of the bicycle infrastructure started: in larger cities it means modernisation of the existing roads, while in smaller cities separate concepts of road networks and bicycle solutions were developed. These are being implemented now or will be in the near future [23].

In 2010, standards of creating a bicycle infrastructure were developed for Krakow, and since it is being promoted on a large scale, and since 2012, the Traffic Law Act [29], contains sections that are favours and encourages bicycle travel, e.g. cyclists may ride next to each other on the road, ride along the centre of the line in intersections, and transport children in bicycle trailers.

Based on these Polish examples it should be stated that:

– Active local non-governmental organisations working in the field of cycling are usually the backbone for success stories in the development of bicycle infrastructure in the cities;

– It is prudent to grant local authorities a high degree of freedom in the implementation of bicycle infrastructure elements as they have to be fitted into the city structure and culture;

– Not only the length of bicycle infrastructure matters, so does its cohesion.

5. STATUS AND A PROPOSAL IN SLOVAKIA

5.1. The Cycling Transport in Slovakia

All development papers of Slovakia neglect the non-motorized transport in terms of transport against of other countries and also Western Europe. The support of eco-friendly transport

is in formal level. The Cycling Transport is not considered to be tantamount kind of transport in relation to other kinds of transport, even in some cases good solutions are limited by insufficient and inappropriate legislation. Just few cities of the country are engaged in cycling transport. Thanks to civil associations exist almost 6500 km of cycle roads, from which around 1500 km are situated in designed territory. For improving the situation, a Conception of Development of Bicycle Infrastructure in Western Slovakia was elaborated.

5.2. Vision of the Development of Cycling Transport

5.2.1. Goal of Concept

The goal of the concept the development of cycling infrastructure in western Slovakia is:

– to design an integrated system of cycle roads in an area with necessary infrastructure,

– to determine priorities and design of stages construction.

3.3. The Cycling Infrastructure in Western Slovakia

The cycle infrastructure on the western Slovakia is developed just partially as well as in other parts of Slovakia. The cycle network has been built mainly by non-governmental organizations.

The current cycling network is consisted mainly of existing markings on roads. In isolated situations are special asphalt roads only for cyclists. In isolated situations are special asphalt roads only for cyclists. Only in some places, the roads are supplemented of the information boards or lay-bys (for example a cycling roads of Dunajska and Moravska).

5.2.2. Proposal of cycling routes

The cycling network cannot be only created from the existed main roads of vehicles because on these roads lose a potentially cyclists with not that good skills of road traffic. On the other side there are not financial possibilities to isolate cycling roads and vehicles ´ roads, also it isn't so safe how it can look. For a creation of an optimal functioning of cycling transport is necessary to plan and build cycling road with both way.

The separation of motorized and non-motorized transport should be in areas where is high traffic intensity, mainly in areas with a many attractive goals, but without limitation of straightness, safety and attractiveness of cycling.

5.2.3. The division of cycling routes

The concept distinguishes two kinds of routes, in terms of the purpose of its use: there would be routes for road cycling (transport in cities and cycle tourism), and for cycling in mountain (sports cycling). For better orientation in an area, routes will be signed by different colours, referring to its purpose and difficulty.

5.2.4. Supplementary cycling infrastructure

In general it can be stated that for cyclists, several kind of services (bike rentals, bicycle storage, restaurants and accommodation facilities, hotels, guesthouses, cottages, camps etc.) could be important. The availability and proper siting of these services would encourage cycling, so the concept deals with this matter also.

5.2.5. Implementation

The concept the development of cycling in western Slovakia contains concrete proposals of extending existing cycle routes. Their formation is conditioned by financial aspect.

Important recommendations of the concept:

4. In the enforcement and financing of cycling infrastructure must participate:

– State Administration,

– self-governments (cities, villages, Public territorial whole),

– commercial organizations,

– Non-governmental organizations.

5. The importance to conceptual approach to build of cycle routes,
6. In the draft budget of the construction of bike routes, it is necessary to take into account several sources of financing.

This conception is the first summary material for the area of Slovakia. As appears from the budget for construction and signage of the

suggested network and from the assumption of lasting disinterest of state about cycling transport, is necessary to look for the further partners to co-finance the construction of routes. In order to ensure coherence and completeness network of cycle routes of Europe, national, regional and urban networks and also for reasons of insufficient scale cycling roads (such as a separate and independent from motor traffic) is necessary to use also road and local communications for motor transport. On the common sections of the road and cycling routes is necessary ensuring the safety of vulnerable road users - cyclists.

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APPENDIX – BEST PRACTICES

HUNGARY: DEVELOPMENT OF PUBLIC TRANSPORT

In terms of transport, best practices in Hungary primarily can be found on the field of development of public transport. This is a basic need: the fleets of the public transport companies are outdated; the vehicles are old, loud, energy wasting and directly or indirectly contaminate the environment.

Unfortunately, the frequency rate of replacing the old vehicles with new ones is slow, even with concentrating the available inland and European financial sources to this area. That is why these few examples can serve as best practices.

New trams in Budapest

In 2006, 40 new, modern trams (Siemens Combino) entered into service on the busiest line of Budapest (trams 4-6), which are able to feed the electricity to the grid that is produced by the regenerative braking system. This and other features of the new trams, and also along with the modernisation of the grid (that was supported by the Structural Funds of the EU), resulted in a significant decrease of energy use on this line.[1]

After the success of the Combino, on a new tender (on 37 new trams for the lines 1, 3, 19 and 61 of Budapest tram network) the energy efficiency was along the condition of the tender.[2]

CNG buses of Tisza Volán Zrt.

The Tisza Volán Zrt. operates 43 buses that are run on CNG fuel. This practice was launched in 1996 with 3 buses, and the success of the operation of these buses resulted in the acquisition of further vehicles. The 43 CNG bus means the third of the overall Hungarian CNG autobus fleet.[3]

New trolleys in Szeged

The City of Szeged ordered 13 new trolleys (Ikarus-Skoda Tr187) from a Hungarian-Czech supplier consortium. The last of the new trolleys will enter into service by September 2014.[4]

Solar-powered rail vehicle

By late spring of 2013, a solar-powered railcar entered into service on the Kismaros – Királyrét narrow-gauge line near Budapest. The railcar that was developed by Hungarian companies, beyond the photovoltaic panels mounted on the roof of the car, is also supplied with a regenerative braking system.[5]

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CZECH REPUBLIC: CIVITAS ELAN – SUSTAINABLE DEVELOPMENT IN TRANSPORT

Description

The project aims to support innovative projects in the field of sustainable urban mobility. The City of Brno's partner in this project is the City of Brno Transport Company. The aim of the project is to improve the quality of public transport services, in particular: optimizing power consumption, installation of a diagnostic system in ticket machines and the purchase of minibuses to run on the routes for the disabled. The City of Brno has also built an Integrated Mobility Centre not only to provide information about traffic but also to organize a series of workshops focused on planning intermodal nodes. Several transport studies on the system of urban public transport were also conducted within the project.

The most important part – energy savings – was achieved in the following way. The transport company was paying large amounts of money at peak moments of energy consumption by the heating system on trams. Therefore the heating devices were equipped with a system that would allow their operation to be influenced remotely. At peak moments the heating devices were switched off for a moment, the energy consumption decreased and then they were switched on again. Thanks to this system the energy consumption was more stable and costs lower.

Basic data

Name of the example: CIVITAS ELAN – Sustainable development in transport
Location (district/settlement/region/country): City of Brno
Leader/owner of project: The municipality of Brno, City of Brno Transport Company
Implementation: September 2008 – September 2012
Total investment cost in €, if available: 1 007 336
Financial support: EUR 653 308 from EU – 7th Framework Programme, Area 7.2.3.4. Innovative strategies for clean urban transport

Quantified data of effects: within 2 years of installation of the energy-saving heating system in trams, the investment costs were saved

Experiences

It is not common in the Czech Republic to deal with energy efficiency in transport. Even this project, where the energy savings were significant, was initially not motivated by saving the energy but by saving the cost of energy. But in the end it is a nice example which is being implemented in other cities in other countries as well.

Further information

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POLAND: KRAKOW TRANSPORTATION CENTRE

Description

KCK is a complicated public-private enterprise. It has been realized since middle 90 in the surroundings of Krakow Main Train Station. KCK serves as the biggest integrated multimodal node in Poland with international, national, regional and local railway and bus connections, public transport (tram, bus, taxi) and considerable amount of public and commercial spaces. It is also well connected to individual road transport (parking). It is a good practice realized under vague conditions of economical transformation and probably the biggest such type of investment in Middle East Europe. Certainly an exemption from the fact, that PPP in Poland generally does not work.

Busy part of KCK with entrances to roof-top parking and taxi stops (+1), regional bus station (-1), underground tram stops (-1).

Aim of the project, was to create a new commercial district complementary to the Old City of Krakow and an efficient transport center for many tourists and citizens of Krakow. Good transport connections were to attract commerce, and commercial use should bring more passengers to transport. Interesting plot of land formerly was a backstage infrastructure of train station (derelict) and substandard city area with open air market and bus station. It laid on the way from train station to Old Town and served as a miserable welcome for visitors of Krakow. Two buildings - station and old post, were monuments of architecture.

Basic data

Name of the example: Krakow Transportation Centre (KCK) - an intermodal node nearby the heart of Krakow Old Town
Location (district/settlement/region/country): Kraków, Małopolska, Poland
Leader/owner of project: Polish Railways - Polish Railroads Company, The City Council of Krakow, National Treasury with Regional Authorities
Preparation phase: 1990-1995
Starting date of operation: 2008
Entities taking part in implementation/realization: Krakow Transportation Center Limited Company, Tishman Speyer Properties
Operator: Krakow Transportation Center Limited Company
Total investment cost in €, if available: n.a
Financial support: n.a (e.g. EU tenders, share or exact amount, if available)
Quantified data of effects: n.a. (e.g. estimated CO_2 emission reduction, % of modal shift etc.)

Experiences

However not finished, the project can be seen as a considerable success story of PPP realized under changing law background and with considerable mistrust among partners. It is also a positive example of creation of functional multimodal interchange accessible by all known modes of transport (except planes) in the heart of a city over 500.000 inhabitants.

Lessons learned are:
- There is a strong need for vide accepted and detailed plan of a project (in spite of law and political environment), which has to be consequently implemented
- Public partners should not only wait and control if private investor realizes his part of agreement, but also realize its own part

Main obstacles were:
- Mistrust in line public-public partners and public-private partners - the most important problem concerned the plot of land in question and conditions each partner had to give away the land for mutual or private use.
Negotiations on this topic held and postponed realisation of the enterprise for 6 years

- Problems with financing and timing of public investments - City of Krakow part of tram infrastructure was realised much later than agreed with private partner.
- Sometimes too high expectations from public partner to private partner.

NOTE: From the side of users (passengers) there have been recently not only positive, but also negative reaction. The most important negative remarks are:
- on foot distances between stops of various transport modes are still too long
- high fidelity commercial part of the enterprise is too much isolated from public part of passengers reception infrastructure
Positive remarks:
- there have been created more attractive than before and easy to follow walking passage between Old Town and train station
- measures to limit car usage on the on foot accessible part of train station have been fully implemented

There is a huge potential for replication of such model in Poland, also taking into consideration elimination of drawbacks. Considerable amount of railway areas in Polish cities lay underdeveloped because of mistrust among cities and railway in public sector and in their relation to private sector.

Further information

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SLOVAKIA: MULICA

Short description of the example

MULICA is an independent voluntary society of individuals who want be active in the area of sustainable mobility in town of Žilina in Slovakia. They are connecting with the common view that the town is not only in sense as a car park, but as a place for social living, meeting and expressing. The society is open for all people, who have an interest and liking to cooperate and co-create our mutual space. The MULICA started up as spontaneous reaction for occasion of organising European Mobility Week (EMW) in 2007 and also as an answer to the increasing motorisation and absence of cycling and pedestrian services. MULICA as 'moja ulica' (an abbreviation of my street) supports and interconnects people with active attitude to their own town. The society cooperates with the non-profit sector, expert institutions, the municipality and commercial sector in an endeavour to get and publish information about the sustainable development of transport in town. Through discussions with institutions and citizens MULICA tries to develop the feeling of responsibility for one's own activities and the awareness of their impacts as a global responsibility and sustainable life. Most important and common aim of all of our activities is support of active participation of Žilina s inhabitants in creation of sustainable surrounding, and their global responsibility of our neighbour. Through community projects, ecological events, cultural performances we communicate with politicians, and common people. MULICA, like non-formal group of individuals, not organizations, is team of specialists from culture, social work, mobility and city problematic, economic sphere etc. In our actions we are communicate and inviting individuals, and organization from all of the spheres of humans, local, and international groups.

The long-term plan of MULICA society is sustainability for environmental stability, creation of a healthy town, enhancement of citizen services, publicity of environmental friendly modes of transport and reduction of using personal cars within town.

Basic data

Name of the example: MULICA, Civil Association
Location (district/settlement/region/country): Žilina
Leader/owner of project: Mulica
Preparation phase: 2007
Starting date of operation: 2008
Entities taking part in implementation/realization:
Operator: Mulica
Total investment cost in €, if available: not available
Financial support: GEF/UNDP Small Grants
Fund: not available

Experiences

Mulica goals

– The development of energy saving and alternative modes of transport

– The publicity of environmental friendly modes of transport

– The organization of public cycling rides

– The revitalisation of public places

– Publicity of cycling and walking

– The development and quality improvement of public transport and support of regional integrated public transport system

– Publicity of the project of Rajec and Martin cycling route

– Supporting of environmental and ecological citizen attitudes

– The experts interconnection in the transport problem solving

Mulica activities

– First public bike ride (230 participators)

– Bike rides in the surroundings of Žilina

– Car free day (we close for two days main street in centre of the city for cars, and change her for Sunday boulevard)

– Workshops and lectures for children about road safety

– Discussion with town planner, architects and transportation engineers about transport problems in Žilina

– Ecological festival

– Operation of the ECO-train on Žilina-Rajec railway

– Survey about satisfaction with transport and bike usage

– Open day at the facilities of public transport operator in Žilina (DPMŽ)

– Cultural and society events

– Car free street

– Info flyer about public transport in Žilina

– Signature of the European Mobility Charter

One of the undisputed successes is the fact that Žilina is the only town in Slovakia to have signed the European Mobility Charter. In this charter, the town municipality commits itself to adopt the sustainable measures in areas such as redistribution of public spaces for alternative and environmental saving modes of transport. For example, currently the municipality has asphalted a 7km cycling track on Vodné dielo Žilina (water recreation area). In addition,

the Žilina municipality has adopted a restricting policy for parking in the historical city centre. We have created a contact network and within this network the first measures regarding the sustainable mobility have been realised. One of the examples is the publishing of the "Žilina public transport guide" in Slovak and English. In the field of cycling (transport), the first proposal of cycling track network was developed and will be realised. Hereby we have started cooperation with municipality, which is disposed to support projects and activities related to the mobility improvement in Žilina. Our closed activity will be to campaign again on the issue of cars parked on pavements.

Civic Association mule issued monthly electronic magazine "Cycling" and an annual conference organized by the same name to bring together various experts and promoters of cycling in Slovakia.

Further information

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