Road transport in Slovenia:
Analysis of the situation and assessment of external costs

(English summary)

An ancient doctor, Hippocrates, concluded that human health largely depends on the environment or the conditions in which the individual lives, so he was aware of the importance of environment for human health. This knowledge has not changed to this day. We cannot imagine the good feeling, healthy and quality life with exposure to a polluted natural environment. The latter is strongly interwoven with the effects of human activity, which means that the factors interact with one another.

Each person consumes a large quantity of air every day, compared to the amount of food or drink consumed. Consequently, the quality of air we breathe is very important. Road transport is a major source of emissions affecting air quality. In terms of environment and health, diesel vehicles are additionally problematic, especially considering that many older vehicles (before EURO 6) do not meet the standards and that their characteristics worsen over the years. In addition, diesel vehicles release more nitrogen oxides and particulates ($PM_{2.5}$) per kilometre than petrol vehicles.

However, as decision-makers, users or consumers, we are rarely aware of the importance of external costs, which arise from personal traffic and remain uncovered by the user.

The modern way of life, based on the use of fossil fuels, location of employment and dispersed settlement of the Slovenian population are the main factors that have caused the length and abundance of trips in the last decades to increase significantly. With labour migration, the municipality of Ljubljana is the most heavily burdened municipality in Slovenia, with more than 122,100 people coming to work from other municipalities on a daily basis, while 20,400 active people from Ljubljana are leaving to work in other municipalities. The transport sector is by far the largest source of greenhouse gas (GHG) emissions, in 2016 as much as 50.8 % of all GHG emissions.

The levels and trends of energy price in the short and long term affect the share of energy and, consequently, the change in demand for different fuels. Slovenia is one of the few countries in the European Union that partially regulates the price of petroleum products. Prices of petroleum products had increased by 4.5 % per year in the period from 1995 to 2007, but the main reason for the growth in the period before and after 2000 is not the same. In comparison with the previous year, a slight drop in the prices of petroleum products is observed. The price of diesel fuel dropped by 1.4 % and the price of petrol fuel by 0.5 %. In 2014, the share of taxes in the price of diesel fuel was 50.5 % and for petrol fuel almost 60 %. In recent years, energy prices have increased, mainly due to higher taxes. In Slovenia, taxes on propellants exceed the EU-28 average.

The average age of passenger cars in Slovenia increased from 6.8 years (in 1992) to 9.4 years (in 2014). The share of passenger cars, older than 12 years, more than doubled in 2015 in

comparison with 2001. The share of cars, older less than three years, fell by almost half. Also, in the last period (especially since 2009), the share of freight motor vehicles and the share of motorcycles and motorcycles, older than 12 years, is increasing, while the growth of such vehicles, less than three years old, is slowed or even negative. The latter means that new technologies are introduced slowly in Slovenia and consequently, the fleet is mostly less environmentally friendly. In passenger cars, 27 % reached the EURO V standard in 2015, and 26 % for light-duty vehicles. In the same year, the EURO VI standard reached 3 % of passenger cars and only 0.9 % of light-duty vehicles. At the end of 2017, 51 % of registered passenger cars were petrol vehicles and 47 % on diesel. The number of "petrol stations" decreased by 2 % compared to 2016, and the number of "diesel engines" increased by 6 %. The number of hybrid passenger cars increased by 59 % and exceeded the limit of 3,000. The number of electric passenger cars increased by 70 %.
Among the fuels, the greatest increase in diesel fuel consumption has been due to the increase in the share of private cars on diesel, both in Slovenia and in the EU, as well as the increase in freight traffic.

Traffic is one of the main causes of discharges of substances, which cause the acidification of soil and water and the formation of terrestrial ozone and particulate matter. In 2014, road transport contributed as much as 52 % to total NO_X emissions. Discharges of acidifying substances into the air were reduced by 46 % in the period 1990–2014 and the release of ozone precursors by 63 %. The particulate emissions from transport have decreased by 18 % in the period 2000–2014.

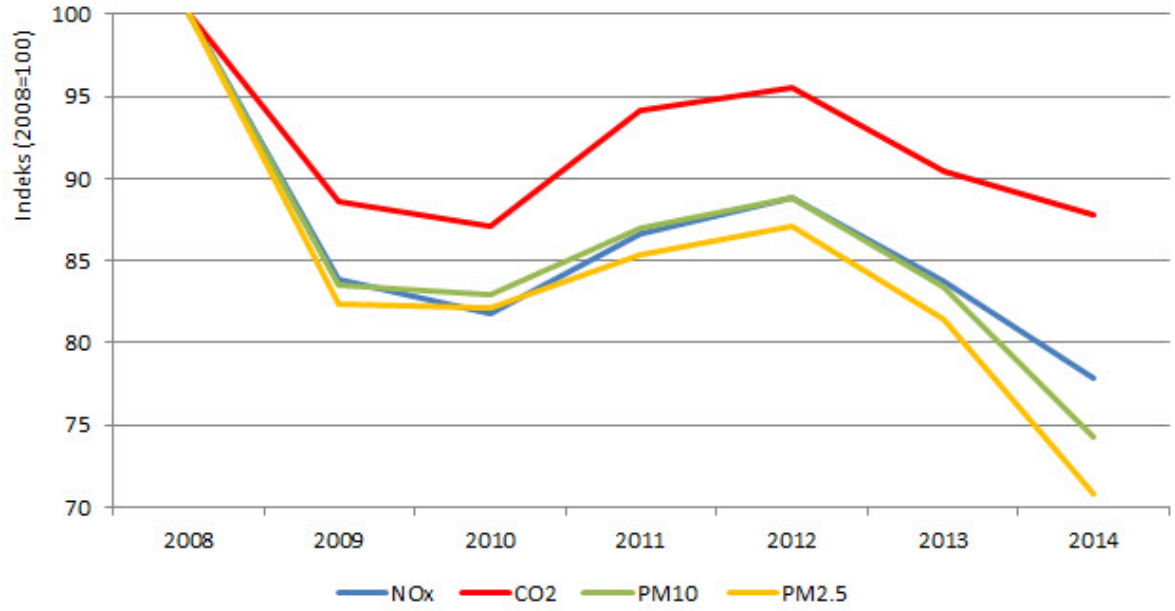

Figure 1: Emissions of air pollutants from automotive transport by individual pollutants, Slovenia, 2008–2014

Road goods transport increased rapidly following Slovenia's accession to the European Union, as the volume of tonne-kilometres of Slovenian carriers in the period 2004–2014 increased by about 80 %. In Slovenia, apart from air transport, its growth continued despite the economic crisis in the European Union. After 2011, the share of road transport stabilized. From the environmental point of view, the growth of road goods transit through Slovenia is concerning due to air pollution and the contribution to greenhouse gas emissions.

The impact of transport on the environment is reflected in different ways: traffic affects the changing of living conditions, traffic safety, and in the event of a higher density for poorer air quality, it causes noise and has effect on health. Due to emissions, the amount of greenhouse gases is generated, which is reflected in climate change.
A mixture of different pollutants is present in the ambient air, which – through pathophysiological mechanisms – has an adverse effect on health. According to the World Health Organization (WHO), 3.7 million people died of exposure to contaminated outdoor air in 2012, accounting for 6.7 % of all deaths. In Europe, about 90 % of the urban population is exposed to excessive values of particles of different sizes, nitrogen oxides (NO_X), ozone (O_3) and benzene in ambient air. Estimates show that between 40,000 and 130,000 people in Europe die each year due to the exposure to the polluted external air due to traffic.

Epidemiological evidence indicates that both short-term (hours, days) and long-term exposure to pollutants in ambient air are associated with morbidity and mortality in different population groups. Studies have confirmed that airborne contamination affects the respiratory, cardiovascular, immune, blood and blood-forming organs, reproductive system and development. Most epidemiological evidence is published in conjunction with the effect of airborne pollutants on the respiratory organs (development and worsening of asthma, COPD) and cardiovascular system (atherosclerosis, elevated blood pressure). The latest evidence suggests the association with central nervous system diseases, insulin resistance and type 2 diabetes. In the last decade, there has been an increase in evidence of the effects of various pollutants on negative outcomes in pregnancy (low birth weight, premature birth).

Table 1: Values of external costs for a passenger car

Type of external costs		Cost
Congestion	Rush hour in urban area	0,30 €/km

	A non-rush hour in urban area	0,00 €/km
	Rush hour on regional road	0,10 €/km
	A non-rush hour on regional road	0,00 €/km
Noise	Urban area by day	0,76 €/km
	Urban area by night	1,39 €/km
	Regional road by day	0,12 €/km
	Regional road by night	0,22 €/km
Accidents	Roads in urban area	4,12 €/km
	Roads in rural area	1,57 €/km
Air pollution	Urban area, petrol vehicle	0,17 €/km
	Urban area, diesel vehicle	1,53 €/km
	Rural area, petrol vehicle	0,09 €/km
	Rural area, diesel vehicle	0,89 €/km
Climate change	Urban area, petrol vehicle	0,67 €/km
	Urban area, diesel vehicle	0,52 €/km
	Rural area, petrol vehicle	0,44 €/km
	Rural area, diesel vehicle	0,38 €/km
Costs of infrastructure; energy; construction, use and decommissioning of vehicles	Urban area, petrol vehicle	0,97 €/km
	Urban area, diesel vehicle	0,61 €/km
	Rural area, petrol vehicle	0,65 €/km

	Rural area, diesel vehicle	0,45 €/km
Costs of permanent destruction of fertile soil, damage to the landscape, waters	Built-up area	0,06 €/km
	Undeveloped area	0,46 €/km

Table 2: Costs of air pollution with different diesel motor vehicles

Type of vehicle	Environment	Vehicle emission standard	Cost in € ct/km
Personal car	Urban area	Euro 2	3,3
		Euro 6	0,7
	Suburban area	Euro 2	1,4
		Euro 6	0,3
	Rural area	Euro 2	0,8
		Euro 6	0,2
	Regional roads	Euro 2	0,8
		Euro 6	0,2

Table 3: Potential savings of external costs (replacement of diesel passenger cars with electric cars)

Important externalities	External costs (in € million)	Share	External level savings	Effect (in terms of total external costs)	Savings (in € million)
Congestion	157,7	7,5 %	0 %	0,0 %	0,00

Accidents	739,3	35,0 %	0 %	0,0 %	0,00
Noise	134,2	6,3 %	25 %	1,58 %	33,6
Emission – PM, gasses	412,9	19,5 %	90 %	17,55 %	371,6
Climate change	448,9	21,2 %	50 %	10,60 %	224,5
Costs of infrastructure; energy; construction, use and decommissioning of vehicles	221,3	10,5 %	33 %	3,47 %	73
	2114,3	**100 %**		**33,19 %**	**702,60**

In case of replacement of the entire fleet of diesel vehicles with electric vehicles, the cost of noise is partly reduced. On regional roads, the dominant source of noise is rolling and noise of "air cutting" (this contributes up to 80 % of the noise). With the impact of the replacement of all diesel vehicles with electric ones, we estimated that the noise would be reduced by 25 % (half the fleet reduce noise emissions by half). For a third, we assessed the reduction of environmental damage in the costs of the life cycle of infrastructure, vehicles and the acquisition of the energy. The external costs of particulate matter, gas emissions (by 90 %) and the effects of climate change would be reduced significantly (by 50 %) as a result of the replacement of half of the fleet.

The overall effect of this replacement would be the reduction of external costs from personal road transport by 33.2 % or more than 700 million euros annually.

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