

Transport share on air polluting emissions in the Czech Republic

Vladimir Adamec, M.Sc., PhD.
Jiri Dufek, M.Sc.

Centrum dopravního výzkumu, Líšeňská 33a, 636 00 Brno, Czech Republic

Abstract

The results of five-year project "*Stabilisation and Gradual Reduction of Environmental Burden caused by Transport in the Czech Republic*" are presented in this paper. Czech Ministry of Transport and Communications, Department of Transport Policy, International Relations and Environment assigned this project. The objective was to quantify total annual production of air polluting emissions from transport in the Czech Republic in 1990 – 2000 years. Specific methodology of calculation and evaluation of emissions production has been developed. The effectiveness of implemented and planned reduction measures has been evaluated. The further step was to predict the emissions production caused by transport to 2015 year, with regards to assumption of implementation of reduction measures.

Keywords:

emission calculation methodology
transport pollution
carbon dioxide
transport scenarios.

Introduction

Exhaust emissions is one of fundamental expression of transport impacts on the environment. Despite the gradual decrease of environmental burden caused by transport (mainly emission production decreases yearly) the transport is one of the main factors which negatively influence environment quality. The data characterising the development of production of transport pollutants that are emitted from private and public road passenger transport, freight transport, rail, water and air transport from 1990 to 2000 including the prediction to 2015 year, are presented in this paper. Monitored emissions are: carbon dioxide (CO₂), carbon monoxide (CO), nitrogen monoxide (N₂O), nitrogen oxides (NO_x), methane (CH₄), non-methane volatile organic compounds (NM VOC), sulphur oxide (SO₂), lead (Pb) and particular matters (PM).

1. Objectives

One of the main objectives of our project named "*Stabilisation and Gradual Reduction of Environmental Burden caused by Transport in the Czech Republic*" was to create credible emissions calculation methodology which suitable data are available for. Consequently, annual emissions of above mentioned pollutants per each year from 1990 to 2000 were calculated. The emissions values of actual year were got exact yearly, according to the actual data. The actual data are: current numbers and composition of Czech roll vehicle stock, annual consumption of petrol, diesel oil, LPG, CNG, biofuels and air fuels, chemical composition of fuels, transport performances, distances gone by passenger cars and trucks and measured emission factors in grams per 1 kg burned fuel.

The further step was the transport emissions prediction to 2015 year, with regards to assumption of implementation of reduction measures. The predictions take into account the effectiveness of mentioned reduction measures and the differences between individual scenarios of transport development in the Czech Republic to 2015 year.

2. Approach

The specific emissions calculation methodology was developed in the frame of the project. The methodology takes into account the not only current logical approaches but also data availability in the Czech Republic. Also, the emission factors are reviewed with a help of special tests at the most used Czech and foreign cars. Cars are split to categories according to used fuel, transport mode and, at car transport, according to the use of catalytic converters. Freight vehicles using diesel oil are split to light duty vehicles (LDV) and heavy duty vehicles (HDV) as well.

Because of the lack of reliable data about the distances covered by cars, we had to use the total consumption of fuel sales, which are very well known in the Czech Republic. Traffic performances of individual car transport, road freight transport, public road transport, rail, water and air transport (passenger and freight) are used for the expression of fuel consumption distribution between transport modes.

Emissions from passenger cars are calculated by specific way. Cars are split to 4 categories: Czech cars with catalytic converters, Czech cars without catalytic converters, non - Czech cars with catalytic converters and non - Czech cars without catalytic converters. Newer cars equipped with catalytic converters cover much more distances than the older ones without these converters. That is why, the annual mileage averages of cars with and without catalytic converters are estimated. The fuel consumption of these 4 car categories is calculated. But there is a control, because the total of all consumption calculated by this way must be the same as a consumption of all cars calculated with a help of distributions of all fuel sale data.

The basic entry data are: measured emission factors, numbers of vehicles

separated to a few categories, fuel consumption, fuel quality and properties (density, specific energy, Pb, S and benzene content, etc.). Emissions from the combustion of each fuel are calculated separately.

EST scenario (Environmentally Sustainable Transport) and BAU scenario (Business As Usual) as "less optimistic" variety are considered at the emissions prediction to 2015 year. The meet of EURO 3 - EURO 5 standards is supposed at the emissions prediction. The results were used for one of the first SEA in the Czech Republic (Strategic Environmental Assessment of Transport "middle term" strategy).

3. Results and discussion

Table 1: Transport share on total air pollution (%)

Pollutant	Year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO ₂	4,86	5,17	6,20	6,95	7,82	7,73	7,20	7,79	7,63	9,24
CO	31,91	24,35	26,30	30,71	27,81	29,59	27,60	30,71	34,68	35,78
NO _x	25,61	25,20	27,29	33,27	45,81	46,06	40,46	45,55	43,39	46,38
NM VOC	32,56	30,15	34,45	35,84	36,25	44,10	39,31	42,47	42,77	26,72
SO ₂	0,30	0,32	0,40	0,48	0,58	0,68	0,61	0,90	1,11	1,3
particulars	1,33	1,36	1,65	1,93	2,26	3,35	2,90	4,47	5,39	4,8
lead	*	*	*	74,59	71,08	67,78	67,89	65,05	62,25	63,64

* data not available

Source: CHMI, TRC

ICT = individual car transport

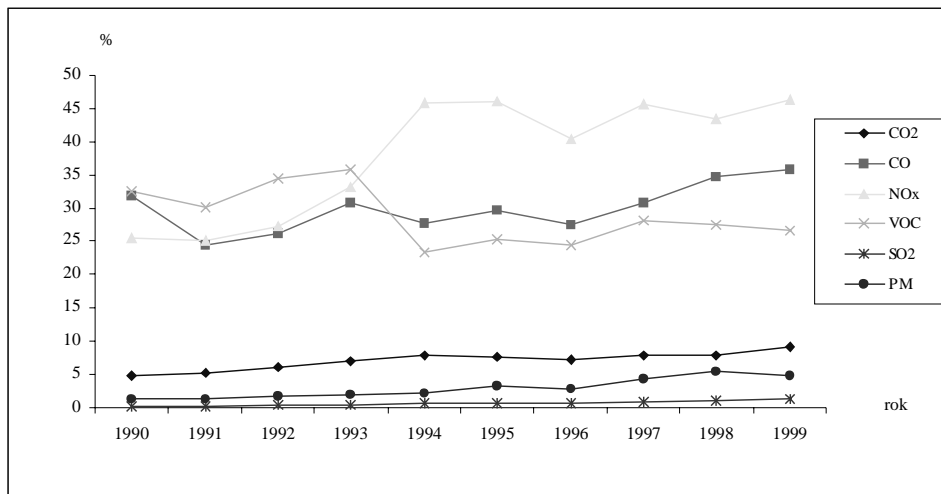
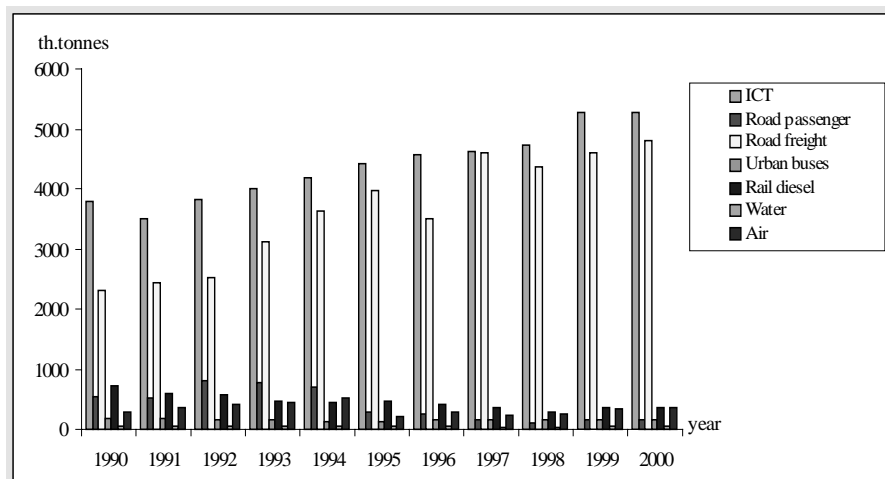


Table 2: Production of CO₂ by transport

Transport mode	year								
	1990	1992	1994	1995	1996	1997	1998	1999	2000
	thousand tonnes								
ICT	3797	3810	4188	4417	4575	4634	4740	5260	5284
Road passenger	540	814	696	285	257	156	106	150	148
Road freight	2318	2507	3643	3962	3518	4590	4372	4609	4816
Urban buses	185	166	131	136	148	148	143	161	163
Rail diesel	738	561	441	476	410	376	288	368	352
Water	54	51	47	48	51	26	30	50	57
Air	294	412	529	211	277	233	268	346	361
Total	7926	8321	9675	9535	9236	10163	9948	10944	11181

Source: TRC



It is evident from enclosed table and graph that carbon dioxide amount from transport has been increasing permanently. This growth is due to increase of transport volumes and performances of individual car transport, road freight and air transport which fundamentally participate on the emissions production of this greenhouse gas. It is possible to say that both the improvement of fuel quality and more using of alternative fuel have just a minimal impact for the carbon dioxide reduction. Dues to oxidation processes, using of catalytic converters induce first the increase of these emissions.

Table 3: Production of CO by transport

Transport mode	year								
	1990	1992	1994	1995	1996	1997	1998	1999	2000
	tonnes								
ICT	252969	226953	201819	182335	176651	176308	179512	147694	142907
Road passenger	8259	12151	10201	4143	3622	2453	1645	2103	2052
Road freight	35416	37426	53370	57597	49546	77630	72906	81332	84023
Urban buses	2820	2439	1857	1893	1981	1999	1899	2173	2180
Rail diesel	11271	8379	6454	6914	5772	5293	4019	5058	4820
Water	827	764	690	694	718	372	420	686	781
Air	7337	9910	11021	5010	6324	5317	5702	6373	6352
Total	318899	298022	285412	258586	244614	269372	266103	245419	243115

Source: TRC

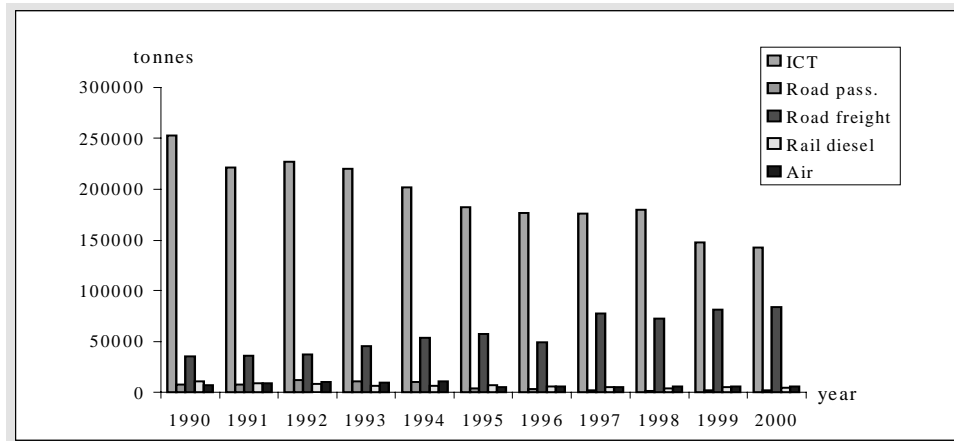
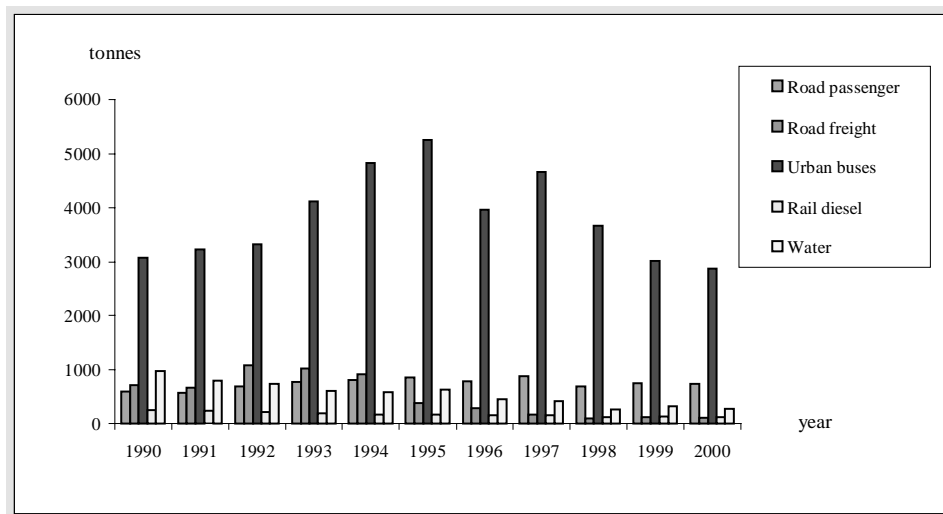


Table 4: Production of SO₂ by transport

Transport mode	year									
	1990	1992	1994	1995	1996	1997	1998	1999	2000	
tonnes										
ICT	594	688	813	861	780	875	696	754	739	
Road passenger	716	1079	923	378	290	165	93	126	114	
Road freight	3072	3323	4830	5253	3964	4656	3659	3008	2873	
Urban buses	245	217	168	173	158	160	126	137	127	
Rail diesel	978	744	584	631	462	423	267	318	281	
Water	72	68	62	63	57	30	28	43	46	
Air	38	54	69	28	35	29	32	34	36	
Total	5715	6173	7449	7386	5746	6338	4901	4420	4216	

Source: TRC

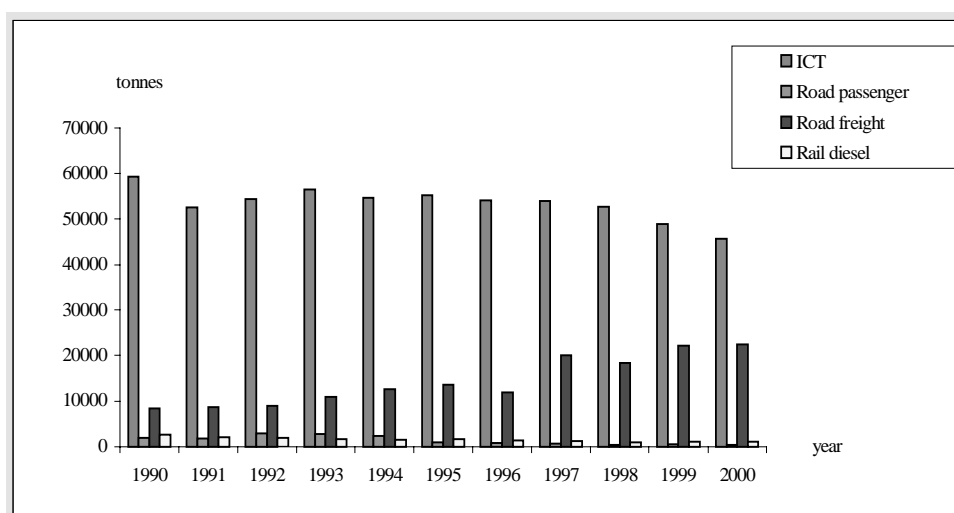


Emissions of carbon monoxide, sulphur dioxide volatile organic compounds and particulates show permanent decrease that is caused by gradual improvement of fuel quality. Production of nitrogen oxides does not change very much, but the essential decrease is predicted due to intensive change in Czech roll vehicle stock.

Table 5: Production of VOC by transport

Transport mode	year								
	1990	1992	1994	1995	1996	1997	1998	1999	2000
	tonnes								
ICT	59311	54364	54654	55202	54064	53879	52744	48857	45708
Road passenger	1948	2889	2422	980	871	617	407	486	469
Road freight	8355	8899	12674	13621	11915	20018	18439	22215	22486
Urban buses	665	580	441	448	476	481	453	491	488
Rail diesel	2659	1992	1533	1635	1388	1273	958	1143	1080
Water	195	182	164	164	173	90	100	155	175
Air	594	844	768	299	372	313	335	382	400
Total	73727	69750	72656	72349	69259	76671	73436	73729	70806

Source: TRC



Methane emissions decrease by the same way as the others hydrocarbons, this fact is a consequence of combustion cycle improvement in new vehicles. N₂O emissions, however, increase very much because N₂O production is bigger at new vehicles than at the old one in the Czech Republic. Individual car transport is the biggest producer of lead emissions. The lead amount permanently decrease from 1993 year, due to substantial decrease of share of cars using leaded fuel. From this year – 2001 – the sale and distribution of leaded fuel is forbidden. That is why lead emissions are inconsiderable from this year.

Conclusions:

Table 6: Relations between transport emissions and the Czech economy development

	year								
	1990	1992	1994	1995	1996	1997	1998	1999	2000
	percentage								
GDP	100	102,53	109,32	118,55	125,35	126,48	125,26	126,19	132,81
CO ₂	100	105,44	122,39	120,67	117,07	128,96	126,14	139,08	142,22
CO	100	93,86	89,73	81,34	77,06	84,95	83,92	77,52	76,91
NO _x	100	100,34	109,03	104,12	95,92	105,87	98,44	99,54	99,54
VOC	100	95,02	98,80	98,43	94,38	104,59	100,18	100,75	96,89
SO ₂	100	108,49	130,68	129,64	101,01	111,54	86,25	62,07	63,52
pevné částice	100	99,30	94,79	79,52	61,60	68,07	55,05	43,59	37,12
Pb	100	91,80	71,68	61,28	58,64	64,17	60,07	44,53	35,40

Source: TRC

Reduction measures have positive impact of carbon monoxide, nitrogen oxides, methane and other organic compounds, sulphur oxide, lead and particulars. It is proved, that the catalytic converters decrease the emission factors of CO, VOC and NO_x by 10 – 15 times.

The main problems in the field of air polluting emissions from transport are carbon dioxide (CO₂) and nitrogen monoxide (N₂O). The CO₂ growth is even higher than the growth of gross domestic products (GDP). The most of reduction measures, i.e. catalytic converters, do not affect green-house emissions in positive way. The part solution could be more intensive utilisation of alternative fuels such as LPG, CNG or solar energy, transport restrictions in sensitive areas, or the improvement of transport organisation and management.

Other problems are Czech old, diesel vehicles that emit excessive amount of CO and particular matters with the content of other health damaging matters: benzene, 1,3, butadiene, polycyclic aromatic hydrocarbons, dioxines, etc.. Procedure of replacement of these vehicles is very slow, mainly due to high prices of these vehicles.

References:

Adamec, V. et al.: Research of environmental burden caused by transport. In Czech. CDV Brno, 2001. 170 pp.

Dufek, J. et al.: Stabilisation and Gradual Reduction of Environmental Burden caused by Transport in the Czech Republic. In Czech. CDV Brno, 2001, 80 pp.