CALCULATION OF EMISSIONS FROM TRANSPORT SERVICES AND THEIR USE FOR THE INTERNALISATION OF EXTERNAL COSTS IN ROAD TRANSPORT

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Summary:Impact of transport operations on the environment is an important criterion of quality services. Requirements for environmental acceptability has recently escalated, manufacturing and trading companies require the carriers to declare the impact of their activities on the environment. Area of concern are the emission factors used for calculating emissions and their unification. For this reason it was accepted norm STN EN 16258, which deals with the methodology of calculation and declaration of energy consumption and greenhouse gas emissions from transport services. Existing emission calculators do not allow the calculation of the external costs of transport services in the area of transport services impacts on the environment. Article deals with the design and application of the calculator of external costs of transport services as an extension, respectively another important function, emission calculator for field of transport services.

Key words: emissions, road transport, transport service, external costs, internalisation

INTRODUCTION

Nowadays, environmental friendliness and energy efficiency become an important criterion of quality services. Increasingly, suppliers of services required to declare impact of their activities on the environment and through the issuing of documents containing specific amounts of pollutant emissions from traffic, especially carbon dioxide (CO2) as the most widespread greenhouse gas. Different approaches to calculate energy consumption and greenhouse gas (GHG) emissions from traffic have led to the need to standardize their methodologies.

In 2012 was the European standard EN 16258 Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers) approved by the European Committee for Standardisation (CEN). This standard has been taken over in september 2013 by slovak standardization system in the slovak language under the name STN EN 16258: 2013 The methodology of calculation and declaration of energy consumption and greenhouse gas emissions from transport services (freight and passenger traffic).

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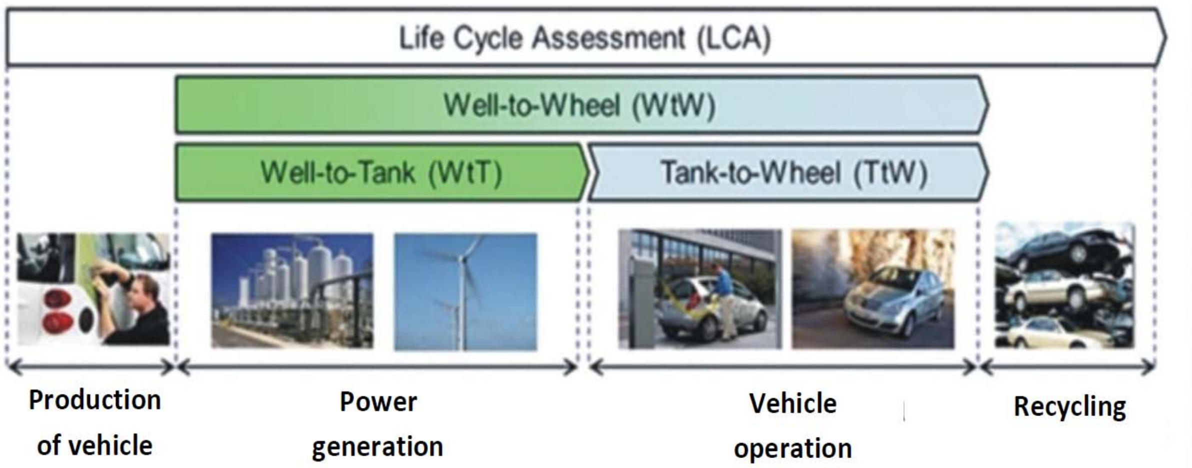
The purpuse of this standard is to make it widely applicable across the transport sector and accessible to a very diverse user group. The use of standards provides a common approach to the calculation and declaration of energy consumption and emissions for transport services, irrespective of the difficulty of transportation technology and transportation process. The standard ensures that the declarations have greater consistency and transparency, and that the energy consumed and emissions produced correspond to the load, respectively occupancy of vehicles.

1. DIRECT AND INDIRECT ENERGY CONSUMPTION AND EMISSION PRODUCTION

Standard specifies requirements and methodology for the calculation and reporting of energy consumption and greenhouse gas (GHG) emissions from transport services. The first edition of the standard focuses primarily on energy consumption and greenhouse gas emissions related to transportation (used on land, water and air) during the operational phase of the lifecycle. However, in the calculations of energy consumption and emissions associated with vehicles it takes into account energy consumption and related emissions and energy processes for fuels and / or electricity used vehicles (including for example the production and distribution of fuel). This ensures that the standard assumes the implementation calculations and in declaring the users of transport services approach "well-to-wheel".

Well-to-Wheel (WtW) is an approach to monitor energy consumption and emission production from production of energy to its final consumptions. It consists of two parts:

- ***Well-to-Tank (WtT)*** - energy consumption and emission production during energy production,
- ***Tank-to-Wheel (TtW)*** - energy consumption and emission production during vehicle operation.



Source: processing of authors based on http://www.fuel-cell-e-mobility.com

Fig. 1 - The life cycle of a vehicle

2. WAY OF EXPRESSING QUANTITY OF GHG EMISSIONS

For the calculation of greenhouse gas emissions standard considers the unit of CO_2e (carbon dioxide equivalent) as carbon dioxide represents the largest share of the production of greenhouse gases. CO_2e value indicates the influence of each greenhouse gas on global warming using the conversion amount or concentration of CO_2, which would have similar effects.

Tab.1 - Density and energy factors of fuels

Fuel type	**Density (d)**	**Energy factor**			
		Tank-to-wheels (e_t)		**Well-to-wheels (e_w)**	
	kg/l	MJ/kg	MJ/l	MJ/kg	MJ/l
Gasoline	0,745	43,2	32,2	50,5	37,7
Ethanol	0,794	26,8	21,3	65,7	52,1
Gasoline/Ethanol blend 95/5	0,747	42,4	31,7	51,4	38,4
Diesel	0,832	43,1	35,9	51,3	42,7
Bio-diesel	0,890	36,8	32,8	76,9	68,5
Diesel/bio-diesel blend 95/5	0,835	42,8	35,7	52,7	44,0
Liquefied Petroleum Gas(LPG)	0,550	46,0	25,3	51,5	28,3
Compressed Natural Gas(CNG)		45,1		50,5	
Aviation Gasoline (AvGas)	0,800	44,3	35,4	51,8	41,5
Jet Gasoline (Jet B)	0,800	44,3	35,4	51,8	41,5
Jet Kerosene (Jet A1 a Jet A)	0,800	44,1	35,3	52,5	42,0
Heavy Fuel Oil (HFO)	0,970	40,5	39,3	44,1	42,7
Marine Diesel Oil (MDO)	0,900	43,0	38,7	51,2	46,1
Marine Gas Oil (MGO)	0,890	43,0	38,3	51,2	45,5

Source: processing of authors based on STN EN 16258:2013

Compared with the current approach to reporting greenhouse gas emissions standard provides:

- unification of the calculation methodology used uniform emission factors (unified emission factors are given in Table 1),
- calculation of the production of all greenhouse gas emissions, calculated per unit of CO_2e,
- taking into account both direct and indirect emissions and energy consumption of vehicle operation, allowing an objective comparison of their energy consumption and environmental impact.

Tab. 2 - Emission factors of fuels

Fuel type	GHG emission factor					
	Tank-to-wheels (g_t)			Well-to-wheels (g_w)		
	gCO_2e/MJ	$kgCO_2e/kg$	$kgCO_2e/l$	gCO_2e/MJ	$kgCO_2e/kg$	$kgCO_2e/l$
Gasoline	75,2	3,25	2,42	89,4	3,86	2,88
Ethanol	0	0	0	58,1	1,56	1,24
Gasoline/Ethanol blend 95/5	72,6	3,08	2,30	88,4	3,74	2,80
Diesel	74,5	3,21	2,67	90,4	3,90	3,24
Bio-diesel	0	0	0	58,8	2,16	1,92
Diesel/Bio-diesel blend 95/5	71,0	3,04	2,54	88,8	3,80	3,17
Liquefied Petroleum Gas(LPG)	67,3	3,10	1,70	75,3	3,46	1,90
Compressed Natural Gas (CNG)	59,4	2,68		68,1	3,07	
Aviation Gasoline (AvGas)	70,6	3,13	2,50	84,8	3,76	3,01
Jet Gasoline (Jet B)	70,6	3,13	2,50	84,8	3,76	3,01
Jet Kerosene (Jet A1 a Jet A)	72,1	3,18	2,54	88,0	3,88	3,10
Heavy Fuel Oil (HFO)	77,7	3,15	3,05	84,3	3,41	3,31
Marine Diesel Oil (MDO)	75,3	3,24	2,92	91,2	3,92	3,53
Marine Gas Oil (MGO)	75,3	3,24	2,88	91,2	3,92	3,49

Source: processing of authors based on STN EN 16258:2013

3. THE PRINCIPLES OF CALCULATIONS OF ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS

For the calculation, it is necessary to know the operational characteristics of vehicles and transport services, such as fuel consumption of vehicles, transport distance, number of km of non-loaded vehicle, number of passengers, vehicles capacity.

The calculation should include the following characteristics in consumption and greenhouse gas emissions:

- **WtW** consumption of energy (E_W),
- **WtW** greenhouse gas emissions (G_W),
- **TtW** consumption of energy (E_t),
- **TtW** greenhouse gas emissions (G_t).

3.1 Calculations for the vehicle operation system

If the transport service consists of several sections, it is necessary to identify the operation system of the vehicle (Vehicle Operation System - VOS) for individual sections, namely a number of categories, including working hours of the vehicle

The calculation is based on the identification of a vehicle's consumption of a particular vehicle operation system (VOS). Conversion from total fuel consumption for the VOS into quantities of energy consumption and GHG emissions shall be made using following formulas:

- for well-to-wheels energy consumption of the VOS:

$$E_w\,(VOS) = F(VOS) \times e_w \qquad (1)$$

- for well-to-wheels GHG emissions of the VOS:

$$G_w(VOS) = F(VOS) \times g_w \qquad (2)$$

- for tank-to-wheels energy consumption of the VOS:

$$E_t\,(VOS) = F(VOS) \times e_t \qquad (3)$$

- for tank-to-wheels GHG emissions of the VOS:

$$G_t\,(VOS) = F(VOS) \times g_t \qquad (4)$$

where

F(VOS) is the total fuel consumption used for the VOS (examples: F(VOS) equals five thousand litres of diesel; or F(VOS) equals thirty thousand kilowatt hours);

e_w is the well-to-wheels energy factor for the fuel used (example: for diesel, ew = 42,7 MJ/l);

g_w is the well-to-wheels GHG emission factor for the fuel used (example: for diesel, gw = 3,24 kgCO_2e/l);

e_t is the tank-to-wheels energy factor for the fuel used (example: for diesel, et = 35,9 MJ/l);

g_t is the tank-to-wheels GHG emission factor for the fuel used (example: for diesel, gt = 2,67 kgCO_2e/l).

Values for energy and GHG emission factors shall be selected in accordance with Annex A., see Tab. 1. and 2.

3.2 Calculations for the leg of transport services

If the realized transport service consists of several sections (different customers, different numbers of passengers carried, the distance traveled with loaded and an empty vehicle and so on.), It is necessary to implement the conversion of energy consumption and emissions to stretch. The calculation is performed as follows:

- Identifies the VOS used to implement transport service on the field in question
- To quantify the total consumption of VOS
- Calculate the total energy consumption and emission levels for VOS according to formula (1), (2), (3) and (4)
- Calculate the share of energy consumption and emissions attributable to address segment of transport services (a dimensionless number) as the ratio of power attributable to the segment of transport services and power system operation of the vehicle:

$$S(leg) = T(leg) \div T(VOS) \qquad (5)$$

Subsequently, this proportion will be used to calculate energy consumption and greenhouse gas emissions for solving section of transportation services:

$$E_w(leg) = E_w(VOS) \times S(leg) \quad (6)$$

$$G_w(leg) = G_w(VOS) \times S(leg) \quad (7)$$

$$E_t(leg) = E_t(VOS) \times S(leg) \quad (8)$$

$$G_t(leg) = G_t(VOS) \times S(leg) \quad (9)$$

Performance of vehicle operation system (T (VOS)) and the power of stretch of transport services (T (leg)) must be in the same unit terms. The standard recommended for freight and passenger traffic to use transport capacity. That means multiplying the number of passengers and the actual transport distance in terms of passenger kilometers in passenger transport, freight transport multiplying the quantity of transported goods and the actual transport distance in terms of tonne-kilometers.

4. THE STRUCTURE AND CONTENT OF THE DECLARATION OF ENERGY CONSUMPTION AND GHG EMISSIONS

The standard does not prescribe the form of the declaration, it only defines the requirements for their content. For declaring the recipient declaration standard user can use any medium that provides unambiguous results and related documents for the calculation such as web site.

Declarations on energy consumption and GHG emissions of a transport service shall include:

a) ***four results (E_W, G_W, E_t, G_t)*** calculated according to previous clauses (when the energy in units of J, or MJ or GJ in CO_2e emissions in g or kg or t)

b) ***supporting information***, which, among other things contain:

- transparent description of the method used, in case other factors of energy consumption and emission factors as listed in Annex A standards, they need to give reasons to justify the need to also use predefined values
- basic description of the services (source and destination of the route, the number of persons transported)
- description of the unit in the implementation of the transport service
- used vehicle operation system (VOS) for each section
- the size of the vehicle fleet, vehicle categories
- converted the resulting power consumption and greenhouse gas emissions per unit of output
- other information necessary for an understanding of the used method

It is possible to develop so-called a simplified declaration which may consist of two parts. The first part contains WtW value of greenhouse gas emissions (G_W) of transport services and the reference to the possibility of acquiring the remaining three values (Ew, Et and Gt), for example on the website. The second part of the declaration comprises the remaining three results and additional information, the second part of the Declaration within a reasonable period available to the beneficiary declaration.

In formal terms, it is possible to create a declaration using the standard STN CEN / TR 14310 freight services. Designation and reporting of environmental performance in freight transport network. Standard is applicable in the Slovak Republic since 1 May 2003 and is compatible with ISO 14000 on environmental requirements relating to the Environmental Management System (EMS). The aim of the standard is to provide guidance for preparing (creating) environmental declarations and reports. It contains recommendations on the content and structure of the documentation and evaluation of the impact of freight on the environment.

5. THE EXTERNAL COSTS OF CARRIER ARISING FROM THE CARRIAGE

The external costs of road freight transport and their internalisation is not in the Slovak republic a very discussed topic and does not pay her enough attention. As they are not processed or any available methodology or concept, which would address the internalisation of external costs and, therefore, procedures which gave instructions on how the external costs quantified. This is the main reason why I want to address the topic and try to identify the possibilities of internalisation suggests the external costs of road freight transport. It is important to also internalize these negative externalities, e.g., using the state regulation, in an attempt to trick the person giving rise to the externalities, to cover losses or damages to the affected person.

5.1 Negative externalities from road freight transport

Transport in connection with the environment is a source of emissions, vibrations, noise, and also creates requirements for the land and causes health and safety risks. The negative impacts of transport on the environment based on the consequences of constant increasing transport requirements of the company in connection with the globalization process. With the aim to ensure sustainable development in the transport sector it is necessary to constantly monitor her impact on the environment.

Externalities, caused by road freight transport are:

- traffic accident record,
- environmental pollution,
- noise,
- vibrations,
- landtake,
- congestion.

5.2 Definition of external costs

The external costs of transport are costs associated with the negative manifestations of the transport activities on the environment and human life, therefore costs associated with the removal of their consequences. In particular, the pollution of air, water and soil, disruption of ecosystems, noise emissions, traffic accidents (parts damage not covered by the insurance), a shot of the territory as well as its capacitive overfilling.

The external costs of transport we can further define as :

- consumption of non-renewable resources in relation to people and the environment,
- unpaid costs of infrastructure and consumption of material resources,
- the cost of interaction of participants of transport, which were not offset by market means (congestion).

Allocation of external costs according to cost categories :

- the cost of traffic accidents,
- the costs of emissions resp. environmental pollution,
- the cost of noise,
- the cost of congestion.

5.3 The breakdown of external costs

To define the external costs were correct, it is important to distinguish between :

- ***Social costs,*** which reflect all the costs resulting from the provision and use of transport infrastructure, such as wear, infrastructure costs, capital costs, congestion costs, the cost of accidents and the cost of environmental protection.
- ***Personal resp. secondary costs***, which are directly borne by the users of transport, such as wear and energy costs for the use of the vehicle, own time costs, travel, taxes and fees.

Procedures for assessment of individual external costs based on manuals Handbook on External Cost of Transport. This guide includes information about how to create value external costs for different external cost categories as a basis for internalisation, i.e. effective pricing.

5.4 The external costs of emissions

The cost of air pollution are assessed in the following categories of impacts caused by polluted atmospheres:

- impact on the health status of people,
- inhalation of particulate matter and other pollutants,
- impact on construction and other materials,
- contamination of surface buildings of solid particles and dust and corrosive,
- the loss of agricultural crops and impacts on the biosphere,
- crop ruined by acidic substances,
- the impact on biodiversity and ecosystems.

The height of the external costs of polluted air is dependent on factors such as the emission class of the vehicle, speed of vehicle, fuel type, vehicle weight, cargo, driving style if the relief road.

The approach used to evaluate the external costs of emissions is IPA - Impact Pathway Approach. IPA is considered the most reliable tool for assessing environmental impact. It consists of several steps by which they can quantify external costs.

For road transport is the most widely used source of emission factors and database software tool COPERT, the current version of the COPERT IV. COPERT IV is used worldwide to calculate the emission of air pollutants and greenhouse gas emissions from road transport. The external cost of emissions depend on a number of factors. In particular, mainly related to the speed of vehicles, road types, whether they are urban roads, inter-urban roads and motorways and the emission class. But it must also driving and engine power of the vehicle.

One way of quantifying the external costs of emissions according to the Manual Handbook on External Cost of Transport costs are calculated for a particular issue in a particular EU country. Costs are expressed in € per tonne.

Guide also provides another method of quantifying external costs for emissions in road freight transport. It quantifies the cost depending on the particular category of vehicle and its emission class. Air pollution cost of this depends on the area, which in a particular vehicle transportation passes. Costs are in € c per vehicle-kilometer. The highest cost of emissions are set for the urban area and while the lowest costs are for driving on the highway. The values are listed in Table 3.

Tab. 3 - The cost of emissions in €c/vkm for heavy goods vehicles

Category	**Emission class**	**Urban area**	**Suburban area**	**Rural**	**Motorway**
		€c/vkm	**€c/vkm**	**€c/vkm**	**€c/vkm**
≤ 7,5t	EURO 0	15,4	7,7	5,6	5,9
	EURO I	8,5	4,8	3,8	4,1
	EURO II	6,9	4,6	3,8	4,1
	EURO III	6,1	3,7	2,9	3,1
	EURO IV	3,8	2,5	2,1	2,1
	EURO V	3,7	2,3	1,2	0,8
	EURO VI	1,7	0,6	0,3	0,2
7,5 t – 12 t	EURO 0	20,5	12,4	9,4	9,3
	EURO I	13	7,6	5,7	5,6
	EURO II	10,5	7,2	5,8	5,7
	EURO III	9,1	5,9	4,5	4,3
	EURO IV	5,4	3,9	3,2	3
	EURO V	5,2	3,6	1,8	1,2
	EURO VI	1,8	0,7	0,3	0,3
12 t – 14 t	EURO 0	22,5	13,8	10,3	9,8
	EURO I	14,4	8,5	6,2	5,9
	EURO II	11,6	8,1	6,3	6

	EURO III	10,1	6,8	5,1	4,6
	EURO IV	6	4,4	3,5	3,2
	EURO V	5,5	3,9	2	1,3
	EURO VI	1,8	0,7	0,3	0,3
14 t – 20 t	EURO 0	29	17,8	12,8	11,6
	EURO I	18,3	10,9	7,7	7
	EURO II	14,5	10,4	7,9	7,2
	EURO III	13	8,8	6,4	5,5
	EURO IV	7,3	5,5	4,3	3,8
	EURO V	7,4	5,6	3	1,7
	EURO VI	2,1	1	0,4	0,3
20 t – 26 t	EURO 0	31,8	20	14,2	12,2
	EURO I	23,8	14,3	10	8,6
	EURO II	18,9	13,6	10,1	8,8
	EURO III	16,3	11,2	8,1	7,1
	EURO IV	9,1	7,1	5,6	4,9
	EURO V	8,3	6,3	3,3	2
	EURO VI	2,1	1	0,5	0,3
26 t – 28 t	EURO 0	33,4	21	15	12,8
	EURO I	25	15,1	10,5	9
	EURO II	19,9	14,2	10,6	9,1
	EURO III	16,9	11,6	8,4	7,2
	EURO IV	9,4	7,3	5,7	5
	EURO V	8,4	6,3	3,3	2,1
	EURO VI	2,1	1	0,5	0,4
28 t – 32 t	EURO 0	38,2	24,2	17,4	14,9
	EURO I	28,5	17,4	12,3	10,5
	EURO II	22,8	16,4	12,2	10,6
	EURO III	19,1	13,3	9,7	8,3
	EURO IV	10,7	8,5	6,7	5,6
	EURO V	8,5	6,2	3,3	2,3
	EURO VI	2,1	0,9	0,5	0,4
>32 t	EURO 0	39,2	25,1	17,7	14,8
	EURO I	29,8	18,1	12,5	10,5
	EURO II	23,7	17	12,5	10,6
	EURO III	19,9	13,9	10,1	8,4
	EURO IV	10,9	8,7	6,8	5,8
	EURO V	8,5	6,3	3,4	2,3
	EURO VI	2,1	0,9	0,5	0,4

Source: elaborated by authors on the basis of Handbook on External Costs of Transport

6. THE INTERNALISATION OF THE EXTERNAL COSTS OF ROAD FREIGHT TRANSPORT

The internalisation of external costs is an objectification costs and subsequently attributed to the those entities that cause them and are responsible for them. Internalization is a tool to convert external effects of transport in monetary terms to those who actually cause them. That is why it is important to identify the originator of externalities to determine who and what external influences and effects of transport on the grounds and to proceed with the transfer these costs to producers.

Transfiguration of external costs is producing effects as part of the decision-making process of the transport users. This can be done either directly or indirectly through regulation by providing the right incentives to users of transport, market instruments (e. g. Taxes, charges and emissions trading). The internalisation of external costs could lead to more efficient use of infrastructure, to reduce negative side effects of transport activities and to improve equality among transport users. The EU transport policy is an effort to steady the system, involves infrastructure charging modes of transport.

Internalisation of external costs can be defined as a range of fees expended for the use of transport infrastructure and negative impacts on the environment within the transport prices. A significant number of research projects, including projects supported by the European Commission expects that the implementation of market-based instruments inspired by economic theory the concept of charging limit of the social costs could bring significant benefits. Fair and efficient transport pricing is also advocated in a number of policy documents issued by the European Commission, in particular in the White Book of Transport of 2011 is added as it Directive 1999/62/EC on the charging of heavy goods vehicles for the use of infrastructure in 2006. EU legislator asked the European Commission to present a generally applicable, transparent and comprehensible model for the assessment of all external costs of road transport, including those that led to the other modes of transport. This model was to serve as the basis for future calculations of road user charges. Handbook on External Cost of Transport on the production of external costs is the outcome of studies and provides best practices and methodologies for valuation of the different categories of costs. The emphasis is on marginal external costs of transport activity as a basis for defining policy of internalisation. It is also important to note that transportation as a sector of the national economy is not the only polluter, therefore it is why it would be unfair if the solutions internalisation of external costs in transport remained alone. Transport contributes to pollution of the environment to approximately 20%. The biggest polluters of the environment is industry.

Internalization also is not just a duty for carrier, but also a redistribution of funds raised to the appropriate environmental and health sensitive segments.

7. EXEMPLARY TRANSPORT LINK ŽILINA – HAMBURG

The costs are calculated for route Žilina – Hamburg via Map & Guide software. The route is 926 km long.

Transportation is considered with the following categories of vehicles:

- Truck and Semi-Trailer - an articulated vehicle consisting of a truck with 2 axles and a maximum permissible axle load with 18 600 kg of semi-trailer with 3 axles and a maximum permissible axle load 24,000 kg. Emission class Euro V.

7.1 Cost for emissions

Cost for emissions can be quantified according to the Handbook on External Cost of Transport in two ways. In the first method, the cost of emissions are quantified specifically for each type of emissions in € / t and the second method, the costs are generally calculated in € c per vkm, vkm means vehicle-kilometer.

The table below shows actual amount of emissions produced at transportation Žilina - Hamburg. The emissions are expressed in tonnes.

Tab. 4 - Produced emissions in tons, route Žilina – Hamburg

CO_2	CO_{2e}	NO_x	N_2O	PM	SO_2	CH_4
0,88764	0,90456	0,00358893	0,00005667	0,00017	0,00184	0,00000214

Source: elaborated by authors

The table shows that the most are produced CO_2, NOx as well as CO_2e. On the contrary, at least is produced CH_4. Furthermore, based on the amount of actual emissions will be impose costs on emissions.

1. Option

This method of calculating the cost of emissions is based on the cost of emissions and the amount of emissions produced during the transportation. Table 5 shows the costs of emissions in countries through which our transportation leads, while to results we are taking only the resulting average value.

Tab. 5 - Costs of individual emissions in € per ton

Country	$PM_{2,5}$			NO_x	volatile organic hydrocarbons	SO_2	CO_2
	Rural	Suburban	Urban				
Slovakia	54 030	79 270	226 510	21 491	1 709	17 134	4,81
Czech republic	43 028	68 427	215 667	15 788	1 648	14 112	
Poland	47 491	74 215	221 455	13 434	1 678	14 435	
Germany	48 583	73 221	220 461	17 039	1 858	14 513	

average	48 283	73 783	221 023	16 938	1 723	15 049	

Source: elaborated by authors

Costs for emissions were calculated on the basis of prices for individual emissions in € / t, multiplied by the quantity of produced tons of various pollutants in the transport. The sum of the cost of emissions is the sum of the partial cost of emissions for a particular pollutant.

Tab. 6 - The total costs of emissions in €, Žilina – Hamburg

Costs for emissions				Total in €
CO_2	NO_x	PM	SO_2	
4,27	60,789	12,5432	27,6892	**105,29**

Source: elaborated by authors

The result is obtained by calculating the total cost price on emissions at 105,29 €.

2. Option

The second method of calculating the cost of emissions takes into account the distance traveled during transportation and costs are determined depending on the category of vehicle, emission class, and the area through which the transportation is conducted.

Tab. 7 - Costs for emissions in €c/vkm

Category	Emisssion Class	Urban	Suburban	Rural	Motorway
> 32 t	EURO 0	39,2	25,1	17,7	14,8
	EURO I	29,8	18,1	12,5	10,5
	EURO II	23,7	17	12,5	10,6
	EURO III	19,9	13,9	10,1	8,4
	EURO IV	10,9	8,7	6,8	5,8
	EURO V	8,5	6,3	3,4	2,3
	EURO VI	2,1	0,9	0,5	0,4

Source: elaborated by authors

In determining the amount of the cost of emissions are taken into account in terms of area, the highway at 80 % and 20 % of the suburban area, as most transportations is going down the highway and the rest passed through suburban areas. Urban areas were not taken into account as road freight transport vehicles are less likely to go straight through urban areas, while more prevented. The costs were obtained by multiplying the cost of emissions and the number of kilometers traveled particular vehicle over a certain area.

Tab. 8 - The total cost of emissions in €, Žilina – Hamburg

Area	km	cost of emissions (in €)
motorway	741	17,04
suburban	185	11,66
Total	**926**	**28,70**

Source: elaborated by authors

The resulting amount is the cost of emissions in the amount of € 28.70. Here you can see a marked difference between the two ways of calculating the cost of emissions because the second price is lower by € 76.59 for transportation compared to the first method.

CONCLUSION

Operation of the different age categories and different environmentally acceptable vehicles, the existence of several vehicle manufacturers, a variety of operating conditions and the impact of the driver on fuel economy were limiting factors that led to the need to generalize the method for calculating the energy consumption and greenhouse gas emissions from traffic. An important contribution is to unify energy and emission factors, resulting in a possibility to objectively assess energy consumption and environmental impacts of different transport systems. It is appreciable to take into account indirect consumption and indirect greenhouse gas emissions associated with the production of energy for the transport system.

The reason for the introduction of internalisation of external costs is the benefit that the user pays for the negative externalities, which he caused. In Slovakia, to cover external costs are the tools used to internalize external costs but it was not assessed whether the tools are effectively or ineffectively. It is necessary to stressed that certain taxes and fees are tied to the vehicle registration number or location or registry of haulier such as vehicle tax. Furthermore, there are more taxes and fees tied to the location for example, where refueling or vehicle passes. It would be fair to ensure that taxes and charges linked to the place of execution and not the registration of the haulier.

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