

ENVIRONMENTAL- ECONOMIC ACCOUNTING

**Transport performance and energy
consumption in road transport
2002 – 2013**



2015

Federal Statistical Office of Germany

Published by: Statistisches Bundesamt (Federal Statistical Office), Wiesbaden

Homepage: www.destatis.de

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www.destatis.de/kontakt

Central Information Service
Phone: +49 (0) 611 / 75 24 05

Periodicity: Non recurrent
Published on 31 July 2015
Order number: 5850023-13900-4 [PDF]

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Abbreviations

EB	=	Energy balance
LDT	=	Light duty trucks
EEA	=	Environmental-Economic Accounting
NA	=	National Accounts

Measures

km	=	kilometer
veh.-km	=	vehicle-kilometer
t	=	tons
tkm	=	tons-kilometer
l	=	liter
mill.	=	million
bn.	=	billion
PJ	=	Petajoule

Signs and Symbols

›	=	more than
‹	=	less than
–	=	no figures or magnitude zero
%	=	per cent

Introduction

The transport sector – especially the motorized road transport – is a significant consumer of energy. According to the national energy balance (source: Arbeitsgemeinschaft Energiebilanzen) in 2013 road transport had a share of 23.1 % of total final energy consumption. In the energy balance fuel consumption of road transport is only reported in one aggregate. Anyhow a more precise knowledge of the sub-sectors, e.g. by type of vehicles, is essential for the determination of the causes of pressures on the environment like air emissions and greenhouse gases. Additionally this is needed for outlining policy measure for the limitation and reduction of environmental burdens.

Within the Environmental-Economic Accounting (EEA) accounting methods were developed to link environmental burdens with the economic activities of industries and consumption of private households. Here particularly data from the National Accounts (NA) are used with regard to domestic output and to final use of goods. Detailed results from EEA on the use of environmental resources like energy, raw materials and water and on environmental burdens like air emissions and greenhouse gases are reported annually in the publication “Economy and use of environmental resources – tables on Environmental-Economic Accounting” (part 2 comprises data on energy consumption, part 6 on transport and environment;

<https://www.destatis.de/EN/Publications/Specialized/EnvironmentalEconomicAccounting/TablesEEA.html>

The residents’ concept is used within the NA when accounting for economic activities. This means that the economic performance is measured for residents of the national territory. Concerning transport this means that all transport activities of domestic units are recorded, also including activities outside the national territory.

Due to the close relationship of the EEA to the NA the residents’ concept is also used in the present study. This is related to the accounting of mileage, transport performance and related fuel consumption of residents.

Deviating from this concept fuel consumption in the national energy balance is related to fuel consumption on the territory, regardless of who – residents or non-residents – is doing the refueling (territorial or domestic concept). – Source for data in the energy balance see: Bundesamt für Wirtschaft und Ausfuhrkontrolle (BAFA), amtliche Mineralölzeiten für die Bundesrepublik Deutschland, Tab. 7: Inlandsablieferungen nach ausgewählten Verwendungssektoren.

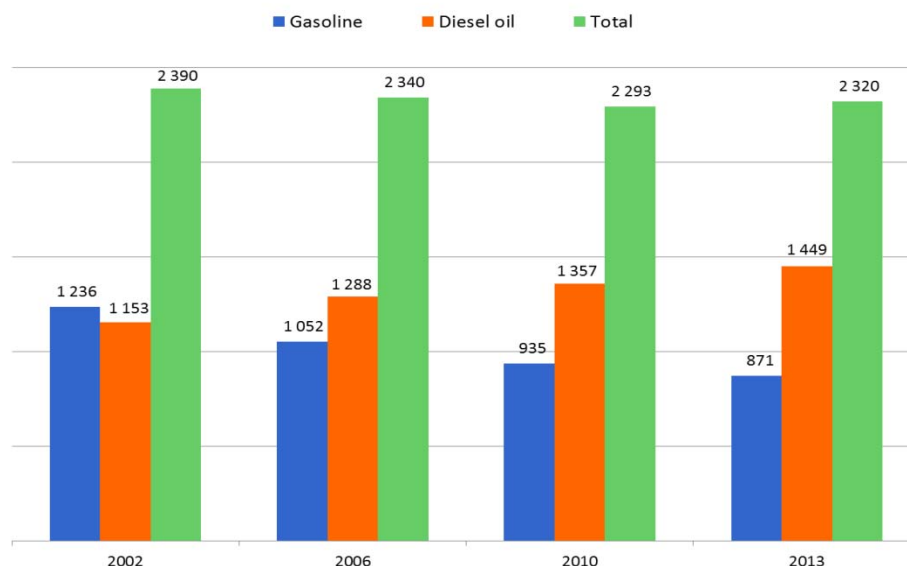
The accounts for fuel consumption include not only data according to the residents’ concept but also bridging items which allow the transition to the territorial concept. The detailed results are reported in the fore mentioned report of the EEA.

This report firstly provides an overview on energy consumption of road transport by type of vehicle and by type of fuel for the period 2002 to 2013 (data for 2013 are preliminary). In addition results are presented in a breakdown by operators of vehicles (cf. table 2). The next section presents results on mileage, followed by a detailed analysis on vehicle stock, transport performance and fuel consumption of cars and trucks. Finally for trucks the transition from the domestic concept to the residents’ concept is demonstrated.

1 Energy consumption of road transport

In 2013 road transport – in the definition of the energy balance – had a share of 23.1 % of total final energy consumption. In 2002 the share was even higher – 24.8 %. According to the residents concept energy consumption declined by 2.9 % from 2 390 Petajoule (2002) to 2 320 PJ (2013). According to this definition refueling by residents abroad is taken into account in addition to domestic refueling of residents. In contrary refueling of non-residents on the territory are excluded. The energy consumption according to the domestic concept dropped with a decline of 6.8 % even more steeply (cf. table 1). The reason for the less decline of energy consumption of residents is that refueling abroad has risen rapidly. In that period the refueling by residents abroad increased by 24.0 %, whereas non-residents reduced their refueling on the territory by 40.6 %. This is a consequence of high price differences for petrol between Germany and its neighboring countries.

Figure 1 Energy consumption in road transport (residents concept) 2002 – 2013 in Petajoule (PJ)



Different trends can be observed when looking at the various vehicle types: The energy consumption of cars – according the residents concept – decreased by 4.6 %. Also the consumption of trucks fell slightly (– 2.1 %). At the same time consumption of light duty trucks showed a sharp increase of 16.9 %. The consumption of motor-bikes increased slightly (+ 1.2 %).

1 Energy consumption of road transport

Table 1 Energy consumption in road transport by vehicle type

Vehicle type	2002	2006	2012	2013	2013/2002
	Petajoule				%
Cars	1 574.2	1 521.9	1 486.0	1 501.9	- 4.6
Gasoline engines	1 196.6	1 017.8	858.5	840.7	- 29.7
Diesel engines	377.6	504.1	627.5	661.2	75.1
Motor bikes	21.5	23.3	21.5	21.8	1.2
Light duty vehicles ¹	217.7	225.5	247.0	254.4	16.9
Gasoline engine	12.7	9.3	6.8	6.6	- 48.2
Diesel engine	205.0	216.2	240.2	247.8	20.9
Heavy duty transportation	427.6	456.3	420.0	418.7	- 2.1
Trucks	217.5	207.3	184.5	184.5	- 15.2
Truck-trailers	210.1	249.0	235.5	234.2	11.5
Buses	39.3	37.9	33.9	32.8	- 16.5
Other vehicles ²	109.2	75.5	87.5	90.1	- 17.4
Gasoline engine	5.5	2.0	1.7	1.6	- 71.0
Diesel engine	103.7	73.5	85.8	88.5	- 14.6
Total residents	2 389.6	2 340.3	2 295.9	2 319.8	- 2.9
Refueling of residents abroad	193.6	262.0	263.6	240.0	24.0
Refueling of non-residents on the territory	96.7	77.4	51.4	56.1	- 42.0
Road transport on the territory (EB) ³	2 292.7	2 155.7	2 083.7	2 135.8	- 6.8
Total transport (EB) ^{3 4}	2 671.6	2 614.3	2 558.6	2 612.3	- 2.2
Final energy consumption (EB) ^{3 4}	9 226.4	9 297.0	8 918.5	9 268.5	0.5
% of final energy consumption					
Road transport on the territory (EB) ³	24.8	23.2	23.4	23.0	-
Total transport (EB) ³	29.0	28.1	28.7	28.2	-
Final energy consumption (EB) ³	100	100	100	100	-

Gasoline, diesel oil, bio-fuels

1 Net load < 3.5 t.

2 Tractors, excavators, police and similar vehicles, mobile homes.

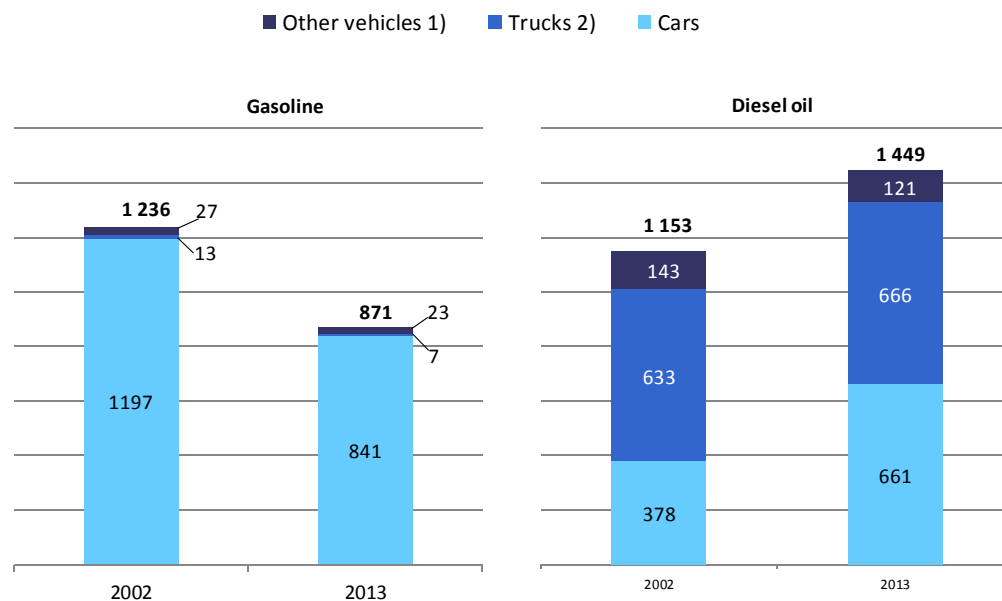
3 EB = energy balance, 2013 preliminary.

4 All energy carriers (inclusive natural gas and liquefied gas).

When looking at energy consumption by engine type, the diagram shows that consumption of gasoline moved in opposite to consumption of diesel oil (cf. figure 2). Whereas consumption of gasoline (including bio-ethanol) dropped by almost 30 %, consumption of diesel oil (including biodiesel) increased by 25.7 %. Whereas in 2002 the share of diesel oil of total fuel consumption was about half of total fuel consumption, in 2013 the share was lying already higher than 60 %.

1 Energy consumption of road transport

Figure 2 Energy consumption in road transport by vehicle type 2002 and 2013



1) Motor bikes, tractors, buses, other. 2) Gasoline: light duty vehicles; Diesel oil: Truck trailers, trucks and light duty vehicles.

The reason for the strong decline of consumption of gasoline is the decline in the fuel consumption of cars due to a decline in the number of cars. In contrary the consumption of diesel oil increased significantly (+ 75 %). In 2002 when looking at all diesel vehicles it shows that the biggest part of diesel consumption (54.9 %) was related to trucks (heavy duty trucks and light duty trucks). This corresponds to an energy volume of 633 Petajoule (PJ). Cars showed a volume of 378 PJ. In 2013 cars consumed already 661 PJ and therefore almost the same amount of diesel oil as trucks (666 PJ).

When looking at energy consumption by vehicle holders table 2 shows that in 2013 almost 85 % of total consumption is related to private households and only 15 % to industries. For heavy duty trucks the biggest part of the energy consumption – 65.6 % – is linked to commercial transport, the remaining part to other holders. The own account transport of the manufacturing sector is also included in this item.

1 Energy consumption of road transport

Table 2 Energy consumption by owner groups and vehicle type 2013

Owner group	Total	Cars	Trucks, truck-trailers	Light duty trucks	Other ¹
Petajoule					
Agriculture, forestry and fishing ...	62.8	1.4	2.9	2.6	55.9
Mining and quarrying	2.6	0.5	1.6	0.4	0.1
Manufacturing	73.9	39.0	16.4	16.5	2.1
Electricity, gas and water supply ...	62.8	11.5	38.5	9.7	3.1
Construction	51.5	10.1	13.3	26.3	1.8
Wholesale and retail trade; repair of motor vehicles	133.4	41.7	48.0	40.0	3.7
Transport and storage	371.4	16.4	274.3	53.4	27.4
Hotels and restaurants	4.1	2.7	0.2	1.1	0.1
Information and communication ...	29.1	10.9	11.4	5.6	1.1
Financial intermediation, real estate, renting and business activities	109.2	62.9	5.5	34.4	6.5
Public administration and defense; compulsory social security	22.8	5.2	0.3	5.4	11.8
Education	1.9	1.1	0.3	0.4	0.1
Health and social work	11.0	9.1	0.1	1.3	0.6
Other services	46.7	22.2	6.1	15.4	3.0
Industries	983	235	419	213	117
Private households	1.336.5	1.267.3	0.0	41.8	27.3
Industries and private households (residents' concept)²	2 319.8	1 501.9	418.7	254.4	144.8
Balance of refueling ³	- 0.2	- 104.6	- 56.5	- 21.5	0.0
Industries and private households (territorial concept)²	2 137.2	1 397.4	362.2	232.9	144.8
in % of industries and private households					
Agriculture, forestry and fishing ...	2.7	0.1	0.7	1.0	38.6
Mining and quarrying	0.1	0.0	0.4	0.2	0.1
Manufacturing	3.2	2.6	3.9	6.5	1.4
Electricity, gas and water supply ...	2.7	0.8	9.2	3.8	2.1
Construction	2.2	0.7	3.2	10.3	1.3
Wholesale and retail trade; repair of motor vehicles	5.7	2.8	11.5	15.7	2.5
Transport and storage	16.0	1.1	65.5	21.0	18.9
Hotels and restaurants	0.2	0.2	0.0	0.4	0.1
Information and communication ...	1.3	0.7	2.7	2.2	0.8
Financial intermediation, real estate, renting and business activities	4.7	4.2	1.3	13.5	4.5
Public administration and defense; compulsory social security	1.0	0.3	0.1	2.1	8.2
Education	0.1	0.1	0.1	0.1	0.1
Health and social work	0.5	0.6	0.0	0.5	0.4
Other services	2.0	1.5	1.5	6.1	2.1
Industries	42.4	15.6	100	83.6	81.1
Private households	57.6	84.4	0.0	16.4	18.9
Industries and private households (residents' concept)²	100	100	100	100	100

1 Tractors, excavators, police and similar vehicles.

2 Residents concept: incl. refueling of residents abroad, exclusive refueling of non-residents on the territory.

3 Balance of refueling: refueling of non-residents on the territory minus refueling of residents abroad.

2 Mileage in road transport

Total mileage in road transport according to the residents' concept increased from 2002 to 2013 by 3.4 % (cf. table 3). When looking at mileage by vehicle types there are different courses: the mileage of cars increased by 3 %. When looking at the cars by engine type the table shows that mileage has a similar trend as energy consumption: mileage of diesel cars rose sharply by 78 %, whereas mileage of gasoline models decreased by 23.5 %. These changes are due to a switchover of car holders to diesel engines (cf. chapter 3).

Table 3 Mileage in road transport by vehicle type

Vehicle type	2002	2006	2012	2013	2013/ 2002
	mill.km				%
Cars	583.6	582.9	596.2	601.1	3.0
Gasoline engine	431.2	377.7	336.5	329.9	- 23.5
Diesel engine	152.3	205.2	259.7	271.1	78.0
Motor bikes	15.9	17.8	16.9	17.0	6.6
Light duty trucks	44.0	44.0	50.0	51.1	16.1
Gasoline engine	3.1	2.3	1.8	1.8	- 44.2
Diesel engine	40.9	41.7	48.2	49.4	20.8
Heavy duty transportation	27.9	30.2	29.1	29.0	4.0
Trucks	14.2	13.6	12.4	12.4	- 12.6
Truck-trailers	13.7	16.6	16.7	16.6	21.2
Buses	3.6	3.5	3.3	3.2	- 13.1
Other vehicles ¹	12.2	7.8	9.0	9.3	- 23.9
Gasoline engine	1.0	0.3	0.3	0.3	- 69.9
Diesel engine	11.2	7.5	8.7	9.0	- 19.9
Total (residents concept)	687.2	686.3	704.4	710.6	3.4

Inclusive mileage with bio-fuels.

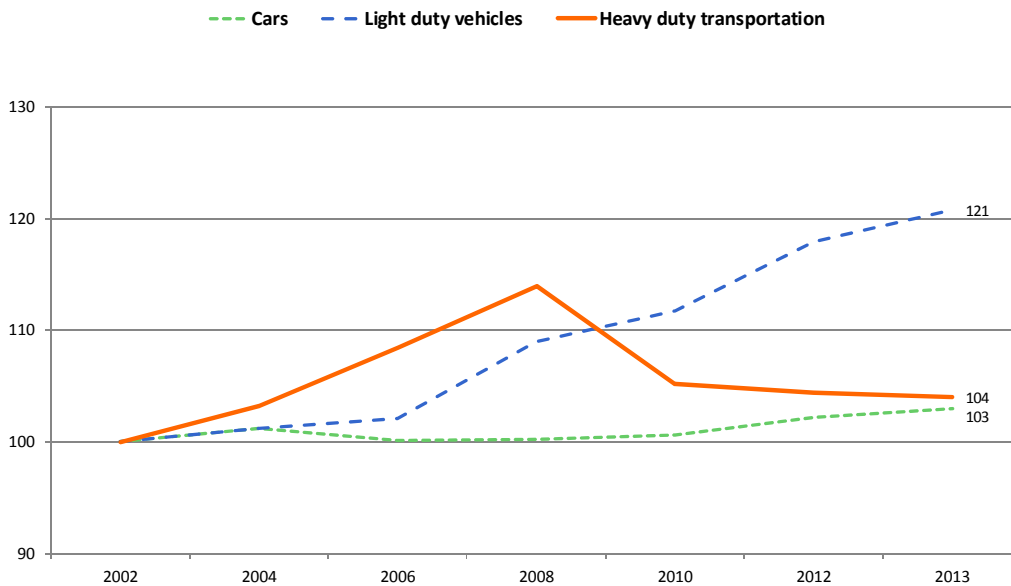
Source: German Institute for Economic Research (DIW – Berlin).

¹ Tractors, excavators, police and similar vehicles, mobile homes; from 2006 on mobile homes are registered with cars.

Mileage in heavy duty traffic increased from 2002 to 2013 by 4.0 %. The rise totally comes from the strong increase of mileage of tractor trucks with semi-trailers (+ 21.2 %). In contrary other trucks showed a decline of 12.6 %. The reason for this change is the shift of transports to trailer trucks which have bigger – and therefore – less costly-transport volumes compared to trucks.

2 Mileage in road transport

Figure 3 Mileage in road transport by selected vehicle types 2002 – 2013
2002 = 100



Mileage in heavy duty transports showed a strong increase until 2008 (+ 14 % from 2002 to 2008). The economic crisis in 2009 stopped this trend abruptly and led to a drop in mileage which continued until 2013. Therefore mileage in 2013 was only little above the volume in 2002. In contrast light duty trucks showed a steady increase in mileage over the whole period (+ 16.1 %).

3 Vehicle stock, mileage and fuel consumption of cars

Data on the vehicle stock are collected by the Kraftfahrtbundesamt (KBA). Due to changes in the survey on stocks for 2013 figures are not fully comparable with figures for 2002. From 2007 onwards KBA has changed the registration of cars taken temporarily off-road. Therefore in table 4 the change between 2002 and 2013 is reported by adding the changes in the sub-periods 2002 to 2006 and 2007 to 2013.

From 2002 to 2006 the number of cars increased by 4.1 %. From 2007 to 2013 the number went up by another 5.1 %. Therefore – on the basis of the results for the sub-period – for the whole period the increase accounts for 9.2 %. The increase is totally due to the rapid growth of the diesel engines. From 2002 to 2006 they jumped up by 43.4 %. From 2007 to 2013 they increased by 31.5 %. In contrast, the number of gasoline engines fell by 3.6 % (2002 – 2006) and 3.5 % (2007 – 2013). Thereby the vehicle holders responded to the jump in fuel prices (according to the consumer price index 2002 – 2013: increase of diesel oil: 70.6 %; gasoline: 52.1 %) by higher purchases of energy saving and therefore less costly cars with diesel engine.

From 2002 to 2013 total mileage increased by 3.0 % from 583.6 bn. kilometer to 601.1 bn. kilometer. Due to technical improvements the average fuel consumption of cars declined. In 2002 the average consumption of cars was 8.1 liter per 100 vehicle-km, in 2013 it accounted for 7.3 liter. This ends up in a decrease of 9.1 %. Therefore despite an increased mileage total fuel consumption fell by 6.3 %.

Table 4 Vehicle stock, mileage and fuel consumption of cars

	Measures	2002	2006	2012	2013	2013/ 2002
		total				%
Total						
Vehicle stock ¹	mill.	44.6	46.4	42.9	43.3	9.2 ²
Mileage per year ¹	1 000 km	13.1	12.6	13.9	13.9	– 6.5 ²
Total mileage	bn. km	583.6	583.9	596.2	601.1	3.0
Specific consumption	l/100 km	8.1	7.7	7.3	7.3	– 9.1
Total consumption	bn. liter	47.2	45.2	43.8	44.2	– 6.3
Diesel engine						
Vehicle stock ¹	mill.	7.3	10.5	12.6	13.2	75.0 ²
Mileage per year ¹	1 000 km	20.8	19.6	20.6	20.5	– 11.0
Total mileage	bn. km	152.3	205.2	259.7	271.1	78.0
Specific consumption	l/100 km	6.9	6.9	6.7	6.8	– 1.6
Total consumption	bn. liter	10.5	14.1	17.5	18.4	75.1
Gasoline engine						
Vehicle stock ¹	mill.	37.3	35.9	30.3	30.1	– 7.1 ²
Mileage per year ¹	1 000 km	11.6	10.5	11.1	11.0	– 16.7 ²
Total mileage	bn. km	431.2	378.7	336.5	329.9	– 23.5
Specific consumption	l/100 km	8.5	8.3	7.8	7.8	– 8.2
Total consumption	bn. liter	36.6	31.2	26.3	25.7	– 29.7
Gasoline engines in % of total						
Vehicle stock ¹	mill.	83.6	77.4	70.7	69.5	– 8.1 ²
Total mileage	bn. km	73.9	64.9	56.4	54.9	– 25.7
Total consumption	bn. liter	77.7	68.9	60.0	58.3	– 25.0

Residents' concept. Inclusive consumption of bio-fuels.

1 Until 2006 incl. vehicles temporarily out of service.

2 Change from 2013 to 2002 is based on changes of 2002 to 2006 and 2007 to 2013.

3 Vehicle stock, mileage and fuel consumption of cars

Fuel consumption changed analogously to changes in stocks. The consumption of diesel oil of cars has increased by 75.1 %. The consumption of gasoline has decreased by 29.7 %. The steeper decline in gasoline consumption compared to the fall in stocks is a consequence of a decline in annual mileage (– 16.7 %) and a reduced average fuel consumption (– 8.2 %).

4 Vehicle stock, transport performance and fuel consumption in heavy duty transport

From 2002 to 2013 the vehicle stock of heavy duty transport declined: from 2002 to 2006 by 4.6 %, from 2007 to 2009 by 4.6 % (cf. table 5). Due to changes in the registration of vehicles vehicle data before 2007 are not fully comparable to data afterwards. After 2009 there was a slight increase of + 5.3 % until 2013. If one looks at the trucks (> 3.5 t net load) separately from the truck trailers, only the number of trucks declined (2000 – 2006: – 12.6 %; 2007 – 2013: – 7.2 %). In contrast the number of truck trailers increased by 12.3 % (2002 – 2006) and 2.1 % (2007 – 2013).

Table 5 Vehicle stock, transport performance and fuel consumption of heavy duty transport

	Measures	2002	2006	2012	2013	2013/ 2002
		total				%
Total						
Vehicle stock ¹	mill.	2 546.9	2 592.2	2 605.2	2 660.3	14.7 ²
Mileage per year	1 000 veh.km	27.0	27.8	29.7	29.5	– 5.2 ²
Total mileage ³	bn. km	68.8	72.0	77.3	78.4	14.0
Specific consumption	l/100 km	25.7	26.1	22.0	21.9	– 14.5
Total consumption	bn. liter	17.6	18.8	17.0	17.2	– 2.5
Heavy duty transportation ⁴						
Vehicle stock ¹	mill.	562.7	537.0	463.2	466.5	– 8.3 ²
Mileage per year ³	1 000 veh. km	49.6	56.3	62.8	62.2	9.4 ²
Total mileage	bn. km	27.9	30.2	29.1	29.0	4.0
Specific consumption	l/100 km	42.8	42.1	35.4	35.4	– 17.1
Total consumption	bn. liter	11.9	12.7	10.3	10.3	– 13.8
Transport performance per year	1 000 km/ tons-km	504.6	613.9	662.1	654.6	29.7
Transport performance	bn. tons-km	283.9	329.7	306.7	305.4	7.6
Specific consumption	l/100 tons-km	4.2	3.9	3.4	3.4	– 19.8
Light duty vehicles ⁵						
Vehicle stock	mill.	1 984.2	2 055.2	2 142.0	2 193.	20.8 ²
Mileage per year	1 000 veh. km	20.6	20.3	22.5	22.5	– 5.4 ²
Total mileage	bn. km	40.9	41.7	48.2	49.4	20.8
Specific consumption	l/100 km	14.0	14.5	13.9	14.0	0.1
Total consumption	bn. liter	5.7	6.0	6.7	6.9	20.9

Residents' concept. Inclusive consumption of bio-fuels.

1 Trucks > 3.5 t net load, truck-trailers.

2 Until 2006 incl. vehicles temporarily out of service.

3 Change from 2013 to 2002 is based on changes of 2002 to 2006 and 2007 to 2013.

4 Incl. mileage and fuel consumption, which is not included in transport statistics.

5 Light duty vehicles < 3.5 t net load.

The stock of light-duty trucks (LDT) increases for many years now. From 2007 to 2013 the number of LDT increased by 17.2 %. Looking at all trucks, despite a decline of heavy duty trucks, their number went up by 12.9 % for that period.

From 2002 to 2013 total mileage in heavy duty transport increased slightly by 4.0 %, despite the decline in stocks. The utilization rate of the vehicles went up significantly between 2002 and 2006 (+ 13.6 %). However, from 2007 to 2013 the annual mileage per vehicle dropped then again slightly (– 4.2 %). These trends are even more clearly visible when looking at the

4 Vehicle stock, transport performance and fuel consumption . . .

transport performance (in tons-kilometer). Before the economic crisis in 2008/2009 there was a significant increase in the average (annual) transport performance (2002 – 2006: + 21.7 %); from 2007 onwards in contrast the average transport performance decreased slightly. From 2002 to 2013 total transport performance increased by 7.6 %.

From 2002 to 2013 the specific fuel consumption per 100 km declined by 17.1 %. Accordingly the specific consumption per 100 tons-kilometers also dropped significantly by 19.8 %. The reason for this is that more often larger trucks or truck-trailors were used and that the utilization rate was improved. Corresponding to this the fuel consumption fell by 13.8 % in this period. Due to the increased mileage of trucks, the decline in fuel consumption (– 13.8 %) was slightly less than the decline in specific consumption (– 17.1 %).

**Table 6: Transport performance in heavy duty transportation
– Residents and territorial concept –**

	2002	2006	2012	2013	2012/ 2002
	mill. tons-km				%
Residents ¹	285.2	330.0	306.7	305.4	7.5
Residents abroad ²	33.4	41.1	27.1	–	– 18.8
Non-residents on the territory ² ..	102.7	150.2	167.0	–	62.6
On the territory ³	354.5	439.1	446.6	–	26.0

¹ Source: Kraftfahrtbundesamt, Flensburg.

² Own calculations.

³ Source: Bundesministerium für Verkehr: Verkehr in Zahlen 2013/2014.

In comparing transport performance of residents in heavy duty transportation with transport performance on the territory the following trends become apparent (cf. table 6): From 2002 to 2012 transport performance of residents increased by 7.5 %. In the same period transport performance on the German territory has risen by 26 %. The reason for this discrepancy is that non-residents increased their activities in Germany. Their transport performance grew by 62.6 %. On contrary the transport performance of residential transport abroad decreased significantly (2002 to 2012): – 18.8 %. The decrease happened from 2007 on; until 2007 these transports were growing (2002 – 2007: + 29.3 %). The decline of the transport performance between 2008 and 2012 by 32.5 % is obviously closely connected to the economic crisis in 2008/2009.