Gasoline and diesel will continue to dominate in the future of road transport

By Hella Engerer and Uwe Kunert

The transport sector – road transport, in particular – accounts for more than half of world oil consumption. In the future, the transport sector's share of oil consumption will grow even more, primarily due to the increasing use of motor vehicles in developing and emerging countries. Road freight transport will also take on greater significance. And overall, gasoline – and, increasingly, diesel – will continue to dominate the fuel mix. A trend reversal in which road transport moves toward a more intensive use of alternative fuels such as liquefied petroleum gas (LPG) and natural gas, and alternative drive systems such as hybrid cars (HEVs) and battery electric vehicles (BEVs), still cannot be observed – despite government support. Given that gasoline and diesel will also be dominant in the future, additional efforts should be made to reduce CO_2 emissions and improve the environmental friendliness of motor vehicle traffic. Given the deleterious environmental effects of diesel fuel, its preferential tax treatment should be abolished.

With a share of roughly 55 percent, the transport sector is the world's biggest contributor to oil demand. Road transport alone accounts for 40 percent of oil consumption. Demand growth in the transport sector only experienced disruption during the global recession of 2009 — and with roughly 1.8 billion metric tons, the annual demand stood nearly 30 percent higher in 2012 than it did at the beginning of the millennium (Table 1 and Figure 1).[1]

Worldwide demand for fuel continues to rise

If the growth of fuel demand is broken down according to global region and individual country, it becomes clear that there is much variation: While demand in the U.S. and a few other OECD countries decreased after 2007 — and, for this reason, stands at roughly the same level today as it did in 2000 — it has risen sharply in the non-OECD countries, especially in the BRIC countries (Brazil, Russia, India, China). The increase in the non-OECD countries amounted to 80 percent, and their share of the total fuel consumption for road transport has now reached 45 percent. By contrast, Europe's current share in the consumption of global fuel stands at just over 15 percent — and it is decreasing.

If one considers the individual types of fuel, a mixed picture also emerges (Figure 2 to 5): Fuel consumption is dropping in OECD countries, most notably those in Europe. In the rest of the world, it is increasing strongly. Since 2007, diesel consumption has risen only in the non-OECD countries. As a result, the share of diesel in fuel consumption has increased significantly in recent years: It now stands at over 45 percent of total fuel consumption worldwide, and at 70 percent of total fuel consumption in Europe. There has also been a worldwide increase of roughly four percent in the share of

1 All data on fuel consumption according to region sourced from IEA Oil Information Statistics, which are currently available, broken down by consumption sector, up until 2012. Annual demand including biogenic shares and LPG.

Table 1

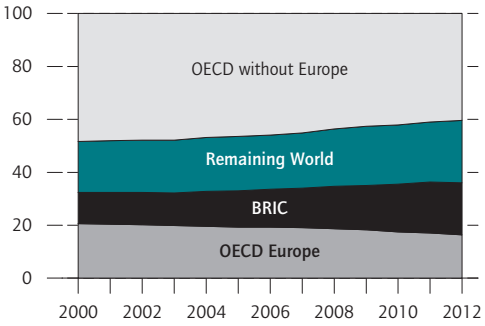
Fuel consumption in road traffic
In kiloton (kt)

	2000	2005	2010	2012
Fuel consumption total				
World	1,369,483	1,548,426	1,725,379	1,788,194
None-OECD	424,383	530,320	696,908	773,888
BRIC	161,245	211,161	311,455	352,264
OECD	945,100	1,018,106	1,028.471	1,014.306
USA	465,540	505,848	502,730	495,958
OECD Europe	282,153	299,219	302,035	292,348
Gasoline incl. Biofuels				
World	827,015	889,725	955,655	966,255
None-OECD	215,099	263,157	336,528	375,595
BRIC	81,108	100,984	140,861	161,341
OECD	611,916	626,568	619,127	590,660
USA	359,657	382,533	387,559	366,552
OECD Europe	131,290	113,829	93,748	84,949
Diesel incl. Biofuel				
World	529,532	642,557	750,735	801,410
None-OECD	208,036	264,110	355,809	393,320
BRIC	79,942	109,281	169,469	189,723
OECD	321,496	378,447	394,926	408,090
USA	105,464	122,913	114,808	127,559
OECD Europe	146,571	180,489	201,755	200,434
Liquid gas (LPG)				
World	12,936	16,144	18,989	20,529
None-OECD	1,248	3,053	4,571	4,973
BRIC	195	896	1,125	1,200
OECD	11,688	13,091	14,418	15,556
USA	419	402	363	1,847
OECD Europe	4,292	4,901	6,532	6,965
for information only:				
Natural gas (CNG) (TJ)				
World	140,325	467,689	1,273,369	1,549,486
None-OECD	105,002	396,177	1,134,038	1,394,656
BRIC	25,703	169,906	480,247	646,192
OECD	35,323	71,512	139,331	154,830
USA	11,730	24,845	30,939	32,505
OECD Europe	16,785	26,057	55,191	62,294

Quelle: OECD.

Figure 1

Worldwide fuel consumption[1] in road traffic
Shares in percent



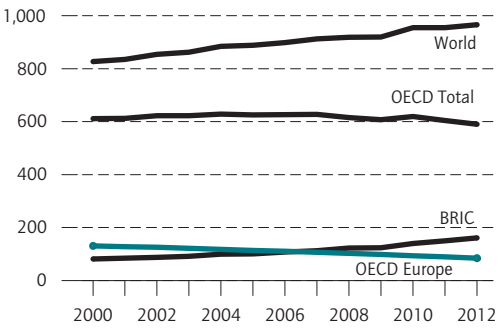
1 Gasoline, diesel, LPG, incl. Biofuels.

Source: OECD

The share of the BRIC countries is growing.

Figure 2

Gasoline consumption[1] in road traffic
In million tons



1 Including biofuels.

Source: OECD.

In Europe gasoline consumption is declining.

biofuels. In Europe, this is due to the increased usage of both biodiesel and ethanol. In the U.S. and Brazil, government aid policies have led to ethanol becoming more prevalent.

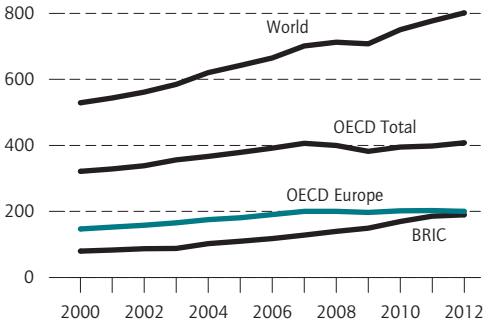
Although an increasing amount of liquefied petroleum gas (LPG) is being used as fuel in road transport, its world market share remains at just over one percent due to a growing demand for fuel overall. Countries outside the European Union (EU) with above-average LPG consumption in road transport include Japan, Turkey, Russia, and Korea. In the OECD countries, compressed natural gas (CNG) is increasingly being used; its share, however, accounts for less than half a percent of all fuel consumption. Outside the OECD, Iran, Pakistan, Argentina, and India are among the countries with larger fleets of natural gas-powered vehicles.[2]

Various factors are responsible for the increasing regional growth in fuel demand: All regions have seen

2 Natural & bio Gas Vehicle Association NGVA, http://www.ngvaeurope.eu/.

Figure 3

Diesel consumption[1] in road traffic
In million tons



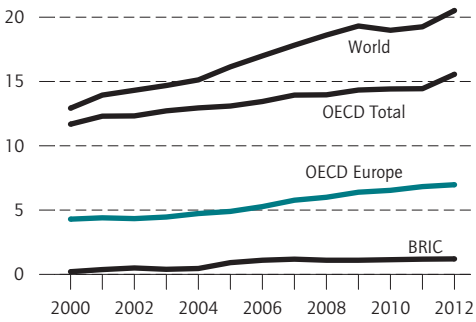
1 Including biofuels.

Source: OECD.

The demand for diesel fuel has increased in all regions.

Figure 4

Liquid gas (LPG) consumption in road traffic
In million tons

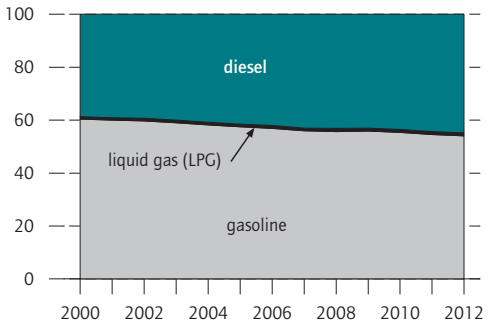


Source: OECD.

In road traffic LPG use increases, the total volume is however still small.

Figure 5

World: fuel consumption in road traffic
By fuel type, in percent



Source: OECD.

For world road traffic the use of diesel fuel is increasing.

an increase in road freight transport, for which diesel is predominantly used.[3] In the non-OECD countries — including the large BRIC countries — the number of cars and thus the total road traffic is also increasing. However, in many OECD countries the demand for passenger transport is stagnating — and in some OECD countries, it is actually declining. In addition to this, more efficient engines that consume less fuel are being used worldwide.[4] Furthermore, passenger cars — especially in Western Europe — are equipped with diesel engines. For this reason, diesel fuel remains dominant in the expanding road freight transport, in all regions of the world. But due to the growth in the non-OECD countries, the demand for gasoline will also continue to grow.

Oil-based fuels will also continue to play a dominant role in the medium- and long-term due to their availability and the slow expansion of alternative fuels. According to current forecasts, global oil consumption will continue to grow, especially in the transport sector, despite the existence of more efficient internal combustion engines and a higher prevalence of alternative fuels.[5] It is expected that transportation's share in oil demand will rise from currently just under 55 percent to 64 percent by 2040 — in addition to air transport, road

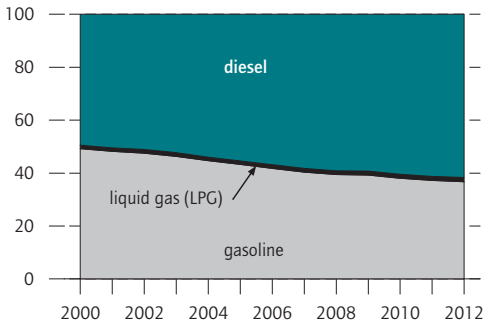
3 OECD/ITF (2015) ITF Transport Outlook 2015, Paris.

4 For example, in the U.S. – which accounts for nearly 30 percent of the consumption – the declining fuel sales over the past few years are mainly due to the decreasing transport demand and, to a lesser extent, to more efficient vehicles as well. See: EOP (2015) "Explaining the US Petroleum Consumption Surprise."

5 This is also a major reason for the predicted production increases. In accordance with the Current Policy Scenario of the IEA and the reference scenario of the EIA, the production of conventional and alternative crude oil will increase in the long term: Under this scenario, it will increase from 87 million barrels per day in 2013 to 113 million barrels per day in 2040. See: International Energy Agency, 2014 World Energy Outlook 2014, Paris, US Energy Information Administration, 2014 International Energy Outlook 2014, Washington D.C. Conventional crude oil (including the LPG derived from oil and natural gas production) and unconventional oil (including tight oil or shale oil, among others), but not biofuels etc.

Figure 6

Europe:[1] fuel consumption in road traffic
By fuel type, in percent

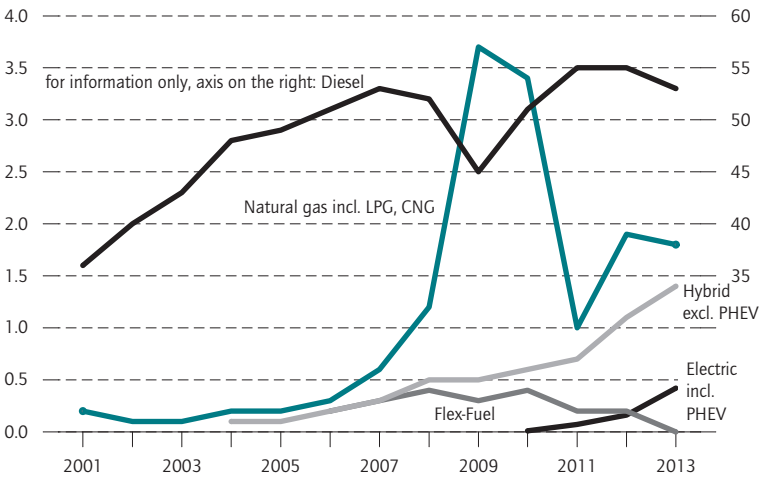


1 21 EU-Countries (EU15 + CZ EE HU PL SK SI) + CH NO IS.
Source: OECD.

Also in Europe diesel fuel share in total consumption is increasing.

Figure 7

Europe: new registrations of cars, share of vehicle technologies
In percent



Sources: ICCT International Council on Clean Transportation; Calculation by DIW Berlin.

Cars with alternative drive systems still have a low share in total new registrations.

transport in particular will increase.[6] This is primarily due to the increased use of motor vehicles — for freight traffic, as well — in emerging and developing countries.

In Europe, however, oil consumption in the transport sector will definitely decrease. But even here, gasoline and diesel will dominate the fuel mix in the long-term.

Europe: The promotion of alternative fuels has little effect on the fuel mix

In 2012, vehicles in European road transport consumed 85 million tons of gasoline and 200 million tons of diesel — that is, road transport accounted for over 97 percent of Europe's total fuel demand. [7] The prevalence of other fossil fuels has increased steadily: LPG's share in fuel consumption reached 2.5 percent, and natural gas's share reached 0.5 percent. Hydrogen and electricity usage in road transport are so minor that they play no significant role as energy sources (Figure 6).

The use of biofuels has been increasing from 2006 onward, but since 2010, the increase has been less dynamic. Contributing to this change was a reduction of the tax benefits. As well, there was uncertainty about how, among other things, the reduction of greenhouse gases will be credited in the future within the EU.[8] In 2012, the energy contribution of biofuels stood at three percent for gasoline, and at just under six percent for diesel. If one uses the sustainability criteria of the 2009 Renewable Energy Directive as a basis, the share of biofuels for the EU decreases from 5.9 percent to 5.1 percent.[9] To date, the increases are not sufficient to reach the EU's 2020 target of ten percent.[10]

In the past, many European countries have introduced measures to promote alternative fuels. Such measures include not only various forms of tax incentives, including tax reductions for certain drive systems or for alternative fuels (Table 2), but also regulatory measures (production standards, emission regulations) as well as other, more unconventional incentives (allowing vehicles with alternative engines the use of bus lanes, or free parking). Nevertheless, alternative fuels such as LPG and CNG and the vehicles that run on them have experienced only moderate success in European markets (Figure 7). However, the share of LPG in transportation fuel has increased signif-

6 In the New Policies Scenario of the IEA, in which the oil production rises considerably less, transport's share in the oil demand will also reach nearly 62 percent by 2040. Unlike the Current Policy Scenario, which is based on energy policies that are currently being pursued and measures that have already adopted, the New Policies Scenario also takes into account planned projects, especially those in support of renewable energies.

7 Consumption figures, including biofuels.

8 EU COM (2015) 293 final, Progress Report *"Erneuerbare Energien."*

9 Certain biofuel production pathways could lead to an increase in greenhouse gas emissions, for example if indirect land use changes through the cultivation of raw materials are taken into account. See: Directive 2009/28/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL from April 23, 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, European Environmental Agency (2014) "TERM 2014: transport indicators tracking progress towards environmental targets in Europe."

10 This includes a recently adopted limit of 7 percent for fuel derived from crops. EU COM (2012) 595 final; European Parliament (2015) Parliament supports shift towards advanced biofuels, Press Release 04.28.2015.

Table 2

Tax benefits for vehicle technology and fuels

	Vehicle Technology											Fuels				
	Elektric	Gasoline	Diesel	LPG	CNG	Biogas	Hybrid	Fuel Cell	E85	Elektric	Gasoline	Diesel	LPG	CNG	Biogas	E85
Austria	•	•		•	•	•	•					•	•	•	•	•
Belgium	•						•	•				•	•	•		
Bulgaria												•	•	•		
Swiss	•				•		•				•		•	•	•	
Cyprus												•	•	•		
Czech Republic							•					•	•	•	•	•
Germany	•	•						•				•	•	•	•	•
Denmark	•							•				•	•	•		
Spain												•	•	•		
Estonia												•	•	•		
France	•			•	•		•		•			•	•	•		
Finland	•											•	•	•		
United Kingdom	•			•	•	•	•		•				•	•		
Greece	•						•					•	•	•		
Hungary	•											•	•	•		
Italy	•			•	•		•		•			•	•	•		
Ireland	•						•					•	•			
Luxembourg	•						•					•	•	•		
Lithuania												•	•	•		
Latvia												•	•	•		
Malta												•				
Norway	•						•	•	•			•	•			
Netherlands		•										•	•	•		
Portugal	•						•					•	•	•		
Poland												•	•	•		
Romania	•						•					•	•	•		
Sweden	•	•		•	•	•	•		•			•	•	•		
Slovakia												•	•	•		
Croatia												•	•	•		
Slovenia		•										•	•	•		

Sources: European Commission; ACEA.

icantly in individual countries. In the Netherlands, the share reached three percent; in Italy, more than four percent; and in Poland, in fact, more than ten percent. CNG is traditionally widespread in Italy, where nearly two percent of cars run on natural gas. In the case of hydrogen fuel, there are as of now only a few market-ready fuel cell vehicles and hardly any fueling stations.

The prevalence of electric cars in most European countries also remains low; for the most part, statistics also include the plug-in hybrids (PHEVs), whose actual electric usage is unknown (Box).[11] At the moment, around 0.4 percent of new registrations in the EU are assigned to electric-powered vehicles (including PHEVs).[12] Major differences, however, exist from country to country: In 2013, electric cars accounted for more than 5 percent of registrations in the Netherlands, where they were given substantial tax breaks. In Germany around the same time, they accounted for only 0.3 percent. The country with Europe's largest share of new electric car registrations is Norway, with almost six percent — thanks to massive government aid.[13]

11 The International Council of Clean Transportation, ICCT (2014) "From Laboratory to Road – A 2014 Update of Official and 'Real World' Fuel Consumption and CO_2 Values for Passenger Cars in Europe."

12 ICCT (2014), European Vehicle Market Statistics, Pocketbook 2014.

13 Japan has the highest share worldwide, with a quarter of all new registrations.

Box

Fuels and vehicle technologies

In the assessment of fuel demand, fuels are differentiated according to type. The fossil fuels, gas and diesel, are labeled "conventional." "Non-conventional" fuels include:

- Liquefied petroleum gas (also called LPG, fossil origin)
- Natural gas (compressed natural gas, fossil origin)
- Electric current
- Hydrogen

A distinction must be made for alternative fuels such as biodiesel and bioethanol, as well as future synthetic biofuels of the so-called "second generation," which are mainly used as an admixture in conventional fuels.

For all fuels, various production pathways that are connected with specific efficiencies and environmental effects are possible. For example, these fuels (excluding LPG) can be produced using electricity.

In the standard approach, the analysis of the entire production chain of fuels for use in vehicles (Well-to-wheels Analysis[1]) is restricted to the required energy consumption and greenhouse gas emissions, although other effects arise. In the case of conventional pathways (for example, the combustion of gasoline in an Otto engine), about 15 percent of the total energy is already required before use in vehicles. In non-conventional pathways, the upstream energy demand is even higher and even off-balance effects are critically assessed.

In the process of type approval, motor vehicles must comply with the emission thresholds specified by EU directives, which have been gradually reduced in accordance with technically viable standards. Limits have been set on the permitted quantities of carbon monoxide, hydrocarbons, nitrogen oxides, and particles (measured in grams per kilometer). According to current and future European emissions standards for passenger cars (vehicle class M1), the limit values for hydrocarbons and nitrogen oxides are higher for diesel drive systems than they are for gasoline engines; the allowable emissions of carbon monoxide are lower and the emitted particle mass had to be limited up to level Euro5 only for diesel engines. Recent studies show that modern diesel vehicles emit multiple harmful nitrogen oxides during operation compared to the official approval values.[2]

LPG and CNG are used in Otto engines, which are designed primarily for the use of gasoline (bivalent drive). Also falling under the category of vehicles with non-conventional drives are hybrid-electric vehicles that derive their motive power exclusively through conventional fuels (HEV). Plug-in hybrids vehicles (PHEV) can also be charged using electric current. Battery electric vehicles (BEV) are operated exclusively with electric current. In fuel cell vehicles, hydrogen is used to generate electricity (FCEV).

1 European Commission – Joint Research Centre – Institute for Energy and Transport (2014) WELL-TO-WHEELS Report Version 4. a.

2 ICCT (2014) a. a. O.

In the EU, the prevalence of alternative fuels and drive systems is still minor.[14] For the prospects of energy sources in the medium-term, the technical design of the existing vehicle stock and new vehicles is crucial. Against this background, the European Union issued guidelines in fall 2014 for the development of infrastructure for alternative fuels.[15] The use of such fuels — including, according to the guidelines, electricity, biofuels, LPG, LNG, CNG, and hydrogen — is hindered, as the EU sees it, by the high cost of the vehicles, low consumer acceptance, small number of charging stations, and low density of alternative-fuel filling stations. As a result, the directive defines minimum requirements for the establishment of infrastructure for alternative fuels: By the end of 2020, the member states are required to have built a sufficient number of publicly accessible charging points for electric cars (meaning one charging point for every ten vehicles, at least in densely populated areas) and a sufficient density of filling stations (one every 150 kilometers, on average, for natural gas). Furthermore, the infrastructure for alternative fuels in the EU should be harmonized in the coming years (for example, through minimum technical specifications for charging points and CNG filling stations). EU member states are also required to submit, by the end of 2016, a national policy framework for the expansion of alterna-

14 Objectives to spread the use of less-polluting fuels and vehicles can be found in European Commission (2011) COM (2011) 144, final. For a current summary of the objectives, see EEA (2014) lc.

15 Directive 2014/94/EU of the European Parliament and of the Raes of October 22, 2014 about the construction of infrastructure for alternative fuels, http://eur-lex.europa.eu/legal-content/DE/TXT/?uri=CELEX : 32014L0094. See also: European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Brussels, 1.24.2013, European Commission, "Clean Power for Transport: a European alternative fuels strategy." "Clean fuels for transport: Member States now obliged to ensure minimum coverage of refuelling points for EU-wide mobility." Press release from September 29, 2014.

tive fuels and the corresponding necessary infrastructure. Still not much is known about it, and a coordination of policies among neighboring countries will not take place before 2017. Some countries have submitted somewhat ambitious targets for the number of electric cars they expect to have registered by 2020. If these figures are examined in relation to the EU proposals, it appears that the infrastructure in most countries would have to be significantly expanded.

It is questionable whether such measures introduced at the European level can help increase the use of alternative drive systems, and thus of alternative fuels, in the EU. It certainly helps that technical standards for charging and gas stations will be harmonized and usage information will have to be standardized, for instance when it comes to comparable price information of different fuels. But infrastructure can only operate economically if the demand is high enough. It is unlikely to succeed if the policy promotes multiple competing alternative energy sources at once. But if the focus were to be on only *one* alternative fuel in a regionally limited manner, there would in turn be fears that the market that arises for such vehicles would not be large enough to offer potential suppliers sufficient incentives for investment in new vehicle technologies.

At the moment, the diesel engine is still dominant in Europe. In 2013, 53 percent of newly registered cars were diesel-powered, with particularly high proportions in Spain, France, and Belgium (with roughly two-thirds).[16] Diesel fuel combustion's impacts on air quality have reached a critical level across Europe: The monitoring of air quality in urban areas of the EU reveals considerable violations of the legal health-protection safety limits of particle concentrations and nitrogen oxides, which are at the same time precursors of ozone formation and can essentially be traced back to the emissions of diesel-powered vehicles.[17]

According the European Commission's forecasts, oil-based fuels, with a share of over 80 percent, will still be the predominant energy source for passenger transport in 2050.[18] Because conventional fuels will continue to dominate, it will become even more important to reduce their environmental impact. At the EU level, the existing fuel quality directive regulates the legally permitted environmentally hazardous fuel components, such as benzene and sulfur.[19] Suppliers will thereby be required, among other things, to reduce the lifecycle GHG intensity of mineral fuels — i.e. emissions that stem from the vehicle production process — by six percent by 2020 over the base year of 2010. In order to create incentives for reducing emissions, those reductions that are achieved by a decrease in flaring and venting at the production site, among other things, will be factored into the emissions calculations. Differentiating greenhouse gas emissions according to their raw material source (such as conventional crude oil, oil shale, or tar sands) has also been proposed. However, the calculation procedure adopted by the EU in the spring of 2015 does not adequately take into account the very different GHG intensities of the various raw material sources.[20]

Germany: Diesel will soon surpass gasoline for automobiles as well

Despite an increase in the number of motor vehicles (by 16 percent) and increasing demand for transport — the mileage increased by nine percent — the total fuel consumption of German automobiles has decreased slightly since the turn of the millennium (by 4 percent).[21] For commercial freight vehicles, significantly greater mileages in conjunction with decreasing specific diesel consumption led to an almost unchanged demand for fuel (Table 3). Meanwhile, however, diesel is used just as often in passenger car traffic. Here, the number of vehicles, mileage, and fuel consumption have more than doubled since 2000 — with hardly any reduction in average consumption (Table 4). The number of gasoline-powered cars, in contrast, has fallen. As a consequence, their total mileage also declined (by a quarter), as did their fuel consumption (by a third). In 2013, the demand for conventional fuels in Germany amounted to approximately 66 billion liters, 60 percent of which were diesel.

After reaching a maximum of 7.4% in 2007, the biogenic share (biodiesel, vegetable oil, bioethanol, biomethane) of all fuel stood at 5.2 percent in 2013.[22] Despite the significant sales slump, biodiesel remains nearly three times as prevalent from an energy perspective as bioethanol (E10), which has great difficulty maintaining its place on the market. Despite significant tax benefits, natural gas and LPG so far cover only 1.5 percent of

16 ICCT (2014) European Vehicle Market Statistics, l.c.

17 EEA (2014) l.c.

18 European Commission, 2013, EU Energy, Transport and GHG Emissions, Trends to 2050, Reference Scenario 2013.

19 EU (2009) Directive 2009/30/EG, Fuel Quality Directive.

20 Directive (EU) 2015/652 of the Council from April 20, 2015 laying out calculation methods and reporting obligations under Directive 98/70/EC of the European Parliament and of the Council on the quality of gasoline and diesel fuels (EU).

21 Between 2000 and the end of 2013. Inventory adjusted for methodological differences, fuel consumption, and mileage according to national concept. See Tables 3 and 4.

22 See: Federal Ministry of Economy and Energy (2014): Renewable Energies in Figures 2013.

Table 3

Germany: road freight transport – vehicles, mileage, fuel consumption

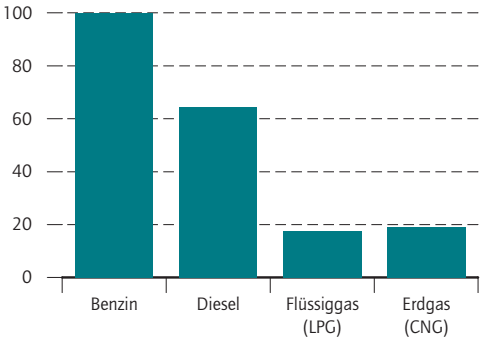
		2000	2005	2010	2013
Vehicles with diesel engine					
Diesel consumption total	Mill. l	19,267	19,200	19,300	19,661
thereof:					
Lorry					
Vehicles	1,000	2,243	2,368	2,282	2,477
Average mileage	1,000 km	24.7	23.0	25.5	24.9
Total mileage	Mill. km	55,468	54,542	58,116	61,766
Average fuel consumption/100 km	Liter	21.5	19.3	19.0	18.6
Total fuel consumption	Mill. l	11,953	10,527	11,059	11,463
Semi trailer					
Vehicles	1,000	162	188	178	184
Average mileage	1,000 km	78.2	83.0	94.9	90.4
Total mileage	Mill. km	12,695	15,512	16,856	16,606
Average fuel consumption/100 km	Liter	36.6	35.8	35.6	34.5
Total fuel consumption	Mill. l	4,646	5,558	6,005	5,729
Vehicles with gasoline engine					
Gasoline consumption total	Mill. l	615	441	274	251
thereof:					
Lorry					
Vehicles	1,000	284	205	136	125
Average mileage	1,000 km	12.0	11.9	14.0	14.0
Total mileage	Mill. km	3,410	2,440	1,904	1,756
Average fuel consumption/100 km	Liter	12.5	12.4	11.5	11.5
Total fuel consumption	Mill. l	426	302	219	202

Sources: KBA; Calculation by DIW Berlin.

Figure 8

Germany: tax rates on road fuels in relation to energy content

Index gasoline = 100



Sources: Energy Tax Law (Energiesteuergesetz); Calculation by DIW Berlin.

In Germany diesel, LPG and CNG are taxed at lower rates than Gasoline.

the energy needs of road transport.[23] At the same time, the government promotes the consumption of diesel through an energy tax rate that is 40 percent lower compared to that of gasoline (Figure 8).

Although the annual registration figures for motor vehicles with alternative drive systems has increased in recent years by more than 50,000, with a total of 745,000 they only make up 1.5 percent of all vehicles registered in Germany.[24]

For Germany, no measures can be found in either the „Action Programme for Climate Protection 2020"[25] or in the „Mobility and Fuel Strategy"[26] — which was conceived as an implementation tool — that could trigger a growing trend away from conventional fuels. Consequently, no additional stimuli are expected beyond the technological trends and regulatory frameworks (particularly EU regulations limiting CO_2 emissions from motor vehicles) that are already in effect. Thus fossil fuels will continue to dominate in various scenarios until 2030 in transport; even in 2050, according to most model calculations, they will cover over half of transportation's final energy consumption.[27] Among the oil-based fuels, the share of diesel will increase and the share of gasoline will decrease. ••

It is not only the technological advantages (such as the high energy density of gasoline and diesel) and path dependencies (including existing filling station infrastructure) that play a role in the persisting dominance of conventional energies: As well, the availability of less polluting alternatives is limited in Germany. Analyses of

23 Through the low energy tax rates on natural gas and LPG, the costs of acquisition and conversion can amortize in few years depending on the mileage of the users. As of now, cars with electric drive systems are exempt from the motor vehicle tax for the first ten years after initial registration; if the initial registration takes place after January 1, 2016, such cars will be exempt for five years. Motor vehicle tax law in the version published on September 26, 2002 (Federal Law Gazette I, p. 3818), last amended December 2012 (Federal Law Gazette I, p. 2431).

24 See Kunert, U., Radke, S. (2013) *Nachfrageentwicklung und Kraftstoffeinsatz im Straßenverkehr: Alternative Antriebe kommen nur schwer in Fahrt.* DIW Wochenbericht Nr. 50/2013.

25 Federal Ministry for Environment, Nature Conservation, Building and Nuclear Safety (BMUB) (2014) Climate Change Action Programme 2020 – cabinet decision from December 3, 2014.

26 Federal Ministry of Transport, Building and Urban Development (BMVBS) (2013) The mobility and fuel strategy of the Federal Government.

27 F. Dünnebeil, U. Lambrecht (IFEU), M. Goletz (DLR), W. Zittel, P. Schmidt (LBST), F. Müller-Langer, K. Naumann (DBFZ) (2013), Analyse aktueller Szenarien zur Entwicklung des Verkehrs in Deutschland und dessen Umweltwirkungen, Kurzstudie im Rahmen der wissenschaftlichen Begleitung, Unterstützung und Beratung des BMVBS in den Bereichen Verkehr und Mobilität mit besonderem Fokus auf Kraftstoffen und Antriebstechnologien sowie Energie und Klima des Bundesministeriums für Verkehr, Bau und Stadtentwicklung (BMVBS) AZ Z14/SeV/288.3/1179/UI40.

the technical and economic conditions of different energy sources anticipate, in the medium-term, a greater potential in the production of various synthetic gases from renewable electricity; these synthetic gases could be made available in the already existing LNG and CNG networks (Power to Gas).[28]

Conclusion

In Europe and in Germany, gasoline and diesel will remain by far the most significant fuels in road transport. Alternative concepts, such as battery-electric or fuel cell drive systems, will continue to play a secondary role — despite government support. The scarcity of refueling infrastructure and low consumer acceptance continue to hamper a faster expansion of alternative fuels and drive systems. Given an expected increase in transport demand, particularly in the case of freight, the focus should be on — in addition to the promotion of alternatives — how to use fossil fuels more efficiently while producing fewer emissions. Contributing to this is the EU regulation that aims to reduce the specific consumption of the vehicles — in the future, with light and heavy commercial vehicles as well. The policy should concomitantly increase the energy taxes on fuels. At present, incentives to buy vehicles with alternative drive systems are low due to the nominally unchanged energy tax rates and the low oil prices.

In particular, the preferential tax treatment given to diesel fuel should be abolished: The specific consumption and low fuel costs create incentives for high mileages. In addition, these cost structures contribute to the continuing rise in the spread of diesel vehicles — even though diesel emissions have far more adverse health effects than the emissions from other fuels.[29]

Table 4

Germany: road freight transport – vehicles, mileage, fuel consumption

		2000	2005	2010	2013
Vehicles with diesel engine					
Diesel consumption total	Mill. l	9,395	13,792	17,092	19,354
thereof					
Cars					
Vehicles	1,000	5,961	9,593	11,267	13,215
Average mileage	1,000 km	19.6	19.5	21.1	20.5
Total mileage	Mill. km	116,612	186,721	237,700	271,143
Average fuel consumption/100 km	Liter	6.0	6.8	6.8	6.8
Total fuel consumption	Mill. l	8,260	12,740	16,149	18,439
Busses					
Vehicles	1,000	85	84	75	75
Average mileage	1,000 km	43.8	41.6	43.5	42.1
Total mileage	Mill. km	3,736	3,500	3,252	3,157
Average fuel consumption/100 km	Liter	30.4	30.1	29.0	29.0
Total fuel consumption	Mill. l	1,136	1,052	943	916
Vehicles with gasoline engine					
Gasoline consumption total	Mill. l	38,818	33,217	28,359	26,406
thereof:					
Cars					
Vehicles	1,000	36,879	36,076	30,545	30,056
Average mileage	1,000 km	12.0	10.9	11.4	11.0
Total mileage	Mill. km	442,855	391,443	349,416	329,927
Average fuel consumption/100 km	Liter	8.6	8.3	7.9	7.8
Total fuel consumption	Mill. l	38,129	32,520	27,724	25,738

Sources: KBA; Calculation by DIW Berlin.

Higher environmental standards are necessary, not only in the vehicles' fuel consumption, but also in the upstream supply chain. At this juncture, however, the EU Commission recently wasted an opportunity by not sufficiently taking into account the greenhouse gas intensities of the different natural resources in its fuel quality directive.

28 DLR et al. (2015) *Erneuerbare Energien im Verkehr, Potenziale und Entwicklungsperspektiven verschiedener erneuerbarer Energieträger und Energieverbrauch der Verkehrsträger*, study for the Federal Ministry of Transport and Digital Infrastructure.

29 ICCT (2014) Real-World Exhaust Emissions from Modern Diesel Cars.

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