WHITE PAPER

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THE AUTOMOTIVE SECTOR IN TURKEY

A BASELINE ANALYSIS OF VEHICLE FLEET STRUCTURE, FUEL CONSUMPTION AND EMISSIONS

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EXECUTIVE SUMMARY

Turkey is one of the largest vehicle manufacturing countries in the world. Given the strong dependence of the Turkish economy on the automotive industry, it is of particular importance to ensure that this industry sector is ready to meet current and future challenges, such as local air pollution, climate change, and energy security, by offering innovative vehicles that can compete on the global market. An extensive set of policy measures can help drive forward the necessary innovations.

A main objective of this report is to provide a transparent assessment of the current vehicle market in Turkey to domestic policymakers and stakeholders as well as to an interested international audience. Thus, in a first step, the current status of vehicle production and sales and its impact on fuel consumption and emissions in Turkey are studied and compared in particular to the situation in Germany, given that the automotive industry plays such a vital role in both economies. Vehicle statistics for Turkey are compared to the EU-28 market as well as other key automotive markets worldwide.

Passenger cars and light commercial vehicles account for three-quarters of the vehicle fleet in Turkey. It was found that the level of efficiency for new cars and light commercial vehicles is similar to the efficiency of comparable vehicles in Germany and the EU. This means that the fuel consumption and CO_2 emission level is similar when taking into account differences in fleet characteristics, such as vehicle weight, size, and engine power (see Figure 1 and Figure 2). In some instances it was found that the level of technologies to reduce CO_2 emissions applied to vehicles in Turkey is slightly lower than in Germany and the EU.

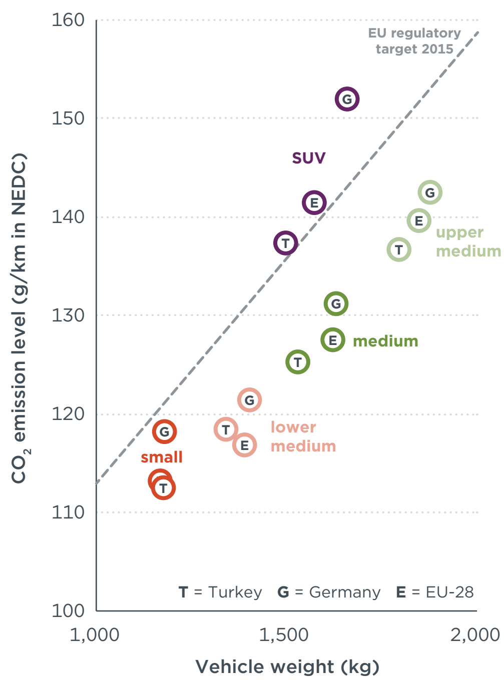

Figure 1. Average CO_2 emission level of new registrations passenger cars (2014), all vehicles by vehicle segment and weight. *Data source: (ICCT, 2015a).*

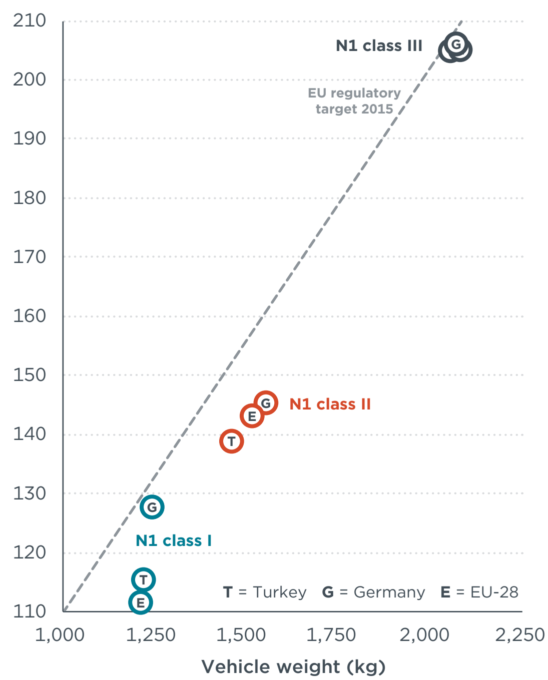

Figure 2. Average CO_2 emission level of new registrations light commercial vehicles (2014), all vehicles by vehicle segment and weight. *Data source: (ICCT, 2015a).*

Modeling a business-as-usual scenario, it was estimated that CO_2 emissions from road transport in Turkey would approximately double by 2030. As CO_2 emissions and fuel consumption are directly linked to each other, this would also mean roughly doubling oil consumption over the next years.

Turkey is one of the few key automotive markets worldwide not yet having introduced mandatory CO_2 standards for cars and light commercial vehicles. Beyond vehicle CO_2 standards, additional measures, such as vehicle taxation based on CO_2, as well as mandates and incentives for electrified vehicles and alternative fuels, could complement and leverage the effects of CO_2 vehicle standards.

Heavy-duty vehicles account for only about one-tenth of the market in Turkey, but at the same time are responsible for more than half of fuel consumption and CO_2 emissions. Some regions, such as the United States, Canada, China, and Japan, have already introduced mandatory efficiency standards for new heavy-duty vehicles, and it is likely that the EU will be moving in this direction as well. Given the particular importance of the production of trucks and buses, not only for the local vehicle market in Turkey but also for the export market, the introduction of efficiency standards could be a viable approach for Turkey as well.

About half of all new cars in Turkey are first registered in the Istanbul area. This highlights the importance of cities, and in particular the city of Istanbul, with respect to the deployment of innovative vehicle technologies. Urban areas are typically most affected by the negative impacts of road transportation, such as high levels of local air pollutants. At the same time, these urban areas can take complementary action, in addition to any policy measures at the national level, to incentivize the deployment of low-emission vehicles. Examples for such measures include an improved infrastructure for alternative fuels and electricity as well as restrictions for high-emission vehicles when entering urban areas.

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ABBREVIATIONS

ACEA	Association des Constructeurs Européens d'Automobiles (European Automotive Manufacturers Association)
CAFE	Corporate Average Fuel Economy
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
EU	European Union
EUR	Euro
g/km	Grams per Kilometer
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HDV	Heavy Duty Vehicle
ICCT	International Council on Clean Transportation
IEA	International Energy Agency
IPC	Istanbul Policy Center
KBA	Kraftfahrtbundesamt (German vehicle type approval authority)
kg	Kilogram
km^2	Square Kilometer
kW	Kilowatt
l/100km	Liters per 100 Kilometers
LCV	Light Commercial Vehicles
LDV	Light Duty Vehicles (passenger cars and LDV)
LPG	Liquefied Petroleum Gas
MJ	Megajoule
Mt	Million metric Tons
NEDC	New European Driving Cycle
NO_x	Nitrogen oxides
OSD	Otomotiv Sanayi Dernegi (Turkish Automotive Manufacturers Association)
PM	Particulate Matter
PPP	Purchasing Power Parity
TL	Turkish Lira (≈0.3 EUR)
USD	U.S. Dollar
RDE	Real-Driving Emissions
VDA	Verband der Automobilindustrie (German Automotive Manufacturers Association)

1 INTRODUCTION

If Turkey was part of the European Union (EU), it would not only be the largest EU country in terms of surface area but also the second most populated right after Germany (Table 1). Both in Turkey as well as in Germany, the automotive sector is the backbone of the national economy, with numerous production plants and employees in the vehicle and vehicle parts manufacturing industry. In fact, in both countries automotive manufacturing is the largest sector when it comes to export volume. Despite having about the same population, the total number of vehicles on the road in Turkey is only about one-third of that in Germany. Given its relatively young population and its continued growth in gross domestic product (GDP), the Turkish government predicts a further expansion of vehicle sales in Turkey in future years (Prime Ministry, 2015).

Table 1. Comparison of country-level characteristics for Turkey and Germany.
Data sources: (ACEA, 2015a), (CIA, 2015), (KBA, 2015), (TUIK, 2015).

	Turkey	Germany
Population (million)	79	81
Area (thousand km^2)	784	357
Population density (per km^2)	100	227
GDP per capita (in thousand USD, PPP[1])	20	46
Vehicles on the road (million)	17	52
Passenger cars per 1,000 capita	118	548

It is yet to be questioned though whether Turkey could and should follow the development pathway that Germany has taken in the past. Instead, facing significant challenges, such as local air pollution, global climate change, and energy security, the automotive sector in both countries will need to focus on developing clean technologies and innovative pathways for future economic growth.

It is the objective of this report to provide the basis for further analysis of the potential development pathways for the automotive industry in Turkey. Thus, in a first step, the current status of vehicle production and sales and its impact on fuel consumption and emissions are studied and compared in particular to the situation in Germany, given that the automotive industry plays such a vital role in both economies. Vehicle statistics for Turkey are compared to the EU-28 market as well as other key automotive markets worldwide. As part of a Fellowship research project, the results of this baseline analysis will then allow for a detailed assessment of future policy options in a subsequent report. This subsequent analysis is not within the scope of this baseline report.

Section 2 of this report examines the vehicle fleet structure in Turkey in more detail for passenger cars and light and heavy commercial vehicles, and compares it to the respective fleet structure in Germany as well as the EU and other key automotive markets worldwide. Section 3 then takes a closer look at fuel consumption and vehicle emissions in Turkey and provides an outlook on the expected future development using emission modeling. Section 4 summarizes the key results and conclusions and provides an outlook on further steps planned.

1 Expressed taking into account Purchasing Power Parity (PPP)

2 VEHICLE FLEET STRUCTURE

This section examines the road vehicle fleet structure in Turkey. The baseline year for the analysis is 2014. Where possible and applicable, the results are provided separately for passenger cars and light and heavy commercial vehicles. For purposes of comparison, the vehicle fleet structure in Germany is presented as well as is, in some cases, the fleet structure in the EU-28 overall and other key automotive markets worldwide.

2.1 OVERALL VEHICLE STOCK AND NEW VEHICLE FLEET

In Turkey, there are about 17 million vehicles currently on the road. This is only about one-third of the total vehicle stock in Germany (52 million) despite both countries having about the same population. Passenger cars account for 85% of road vehicles in Germany but only 57% in Turkey (Figure 3 and Figure 4). In return, light commercial vehicles (also called “light trucks”) are significantly more popular in Turkey than in Germany (18% vs. 4%). A key underlying reason is the fact that light commercial vehicles in Turkey are subject to a drastically lower vehicle sales tax than passenger cars. For example, minivans are subject to a 4-15% “Special Consumption Tax” compared to 45-145% for passenger cars, thereby providing a strong incentive for manufacturers to define passenger car derived models as light commercial vehicles (ACEA, 2015b). Motorcycles are also more popular in Turkey, accounting for 16% of vehicles in Turkey but only 8% in Germany. Furthermore, it is remarkable that there are about ten times more buses on Turkish roads than on German roads, with minibuses being particularly popular in Turkey. The total number of vehicles per 1,000 capita in Turkey is around 230, but the number is only around 120 when solely counting passenger cars.[2] In comparison, the total number of vehicles per capita in Germany is around 640, and around 550 when focusing on passenger cars.

2 Author’s own calculations based on vehicle stock and population data. Other sources refer to a figure of 165 cars per 1,000 people in Turkey, most likely counting also light commercial vehicles (Prime Ministry, 2015).

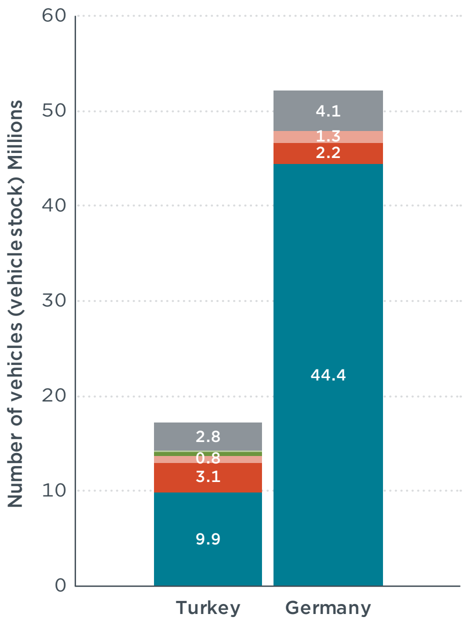


Figure 3. Vehicle stock[3] (2014), differentiated by vehicle type, in absolute numbers. *Data sources: (ACEA, 2015a), (KBA, 2015), (TUIK, 2015).*

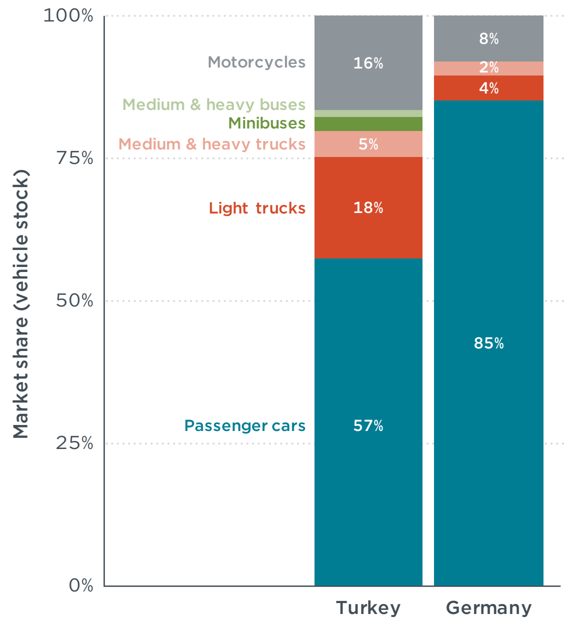


Figure 4. Vehicle stock (2014), differentiated by vehicle type, in percentage *Data sources: (ACEA, 2015a), (KBA, 2015), (TUIK, 2015).*

In Turkey, the number of passenger cars per 1,000 inhabitants has quickly increased, from around 17 in 1980 to 50 by 1995 and 118 by 2014. The average annual growth rate in vehicle stock was around 8% in the 2000-2014 timeframe (Figure 5). In Germany, the total number of vehicles and the number of passenger cars per 1,000 inhabitants increased particularly quickly in the aftermath of the unification of East and West Germany, from around 333 cars per 1,000 inhabitants in 1985 to 521 by the year 2000. From 2000-2014, however, the average annual growth rate in vehicle stock was only around 0.3% (Figure 6).

3 Agricultural vehicles are excluded from the analysis within this report.

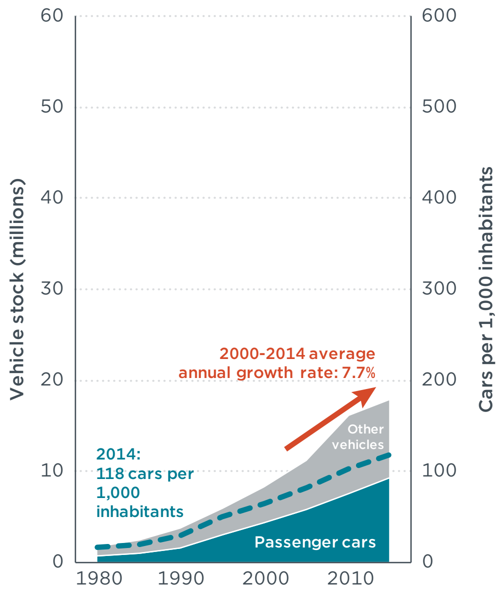


Figure 5. Historic development of vehicle stock in Turkey. *Data source: (TUIK, 2015).*

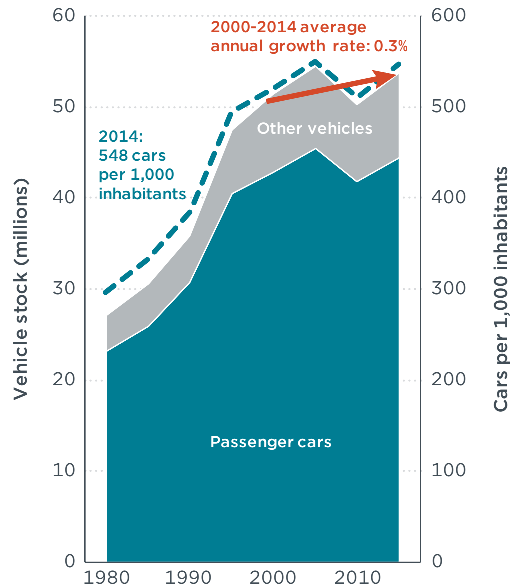


Figure 6. Historic development of vehicle stock in Germany. *Data source: (KBA, 2015).*

Looking at new vehicle registrations, there are about 1 million new vehicles registered in Turkey every year compared to 3.5 million in Germany. The distribution of new vehicle registrations by type is roughly the same as for the vehicle stock, with passenger cars accounting for the majority of new sales (60% in Turkey vs. 87% in Germany) (Figure 7 and Figure 8).

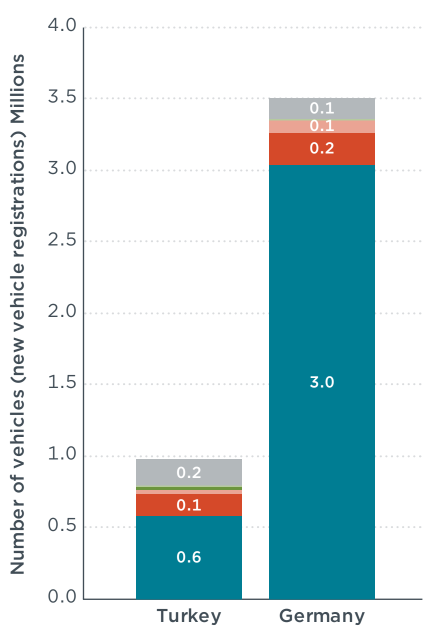


Figure 7. New vehicle registrations (2014), differentiated by vehicle type, in absolute numbers. *Data sources: (ACEA, 2015a), (KBA, 2015), (TUIK, 2015).*

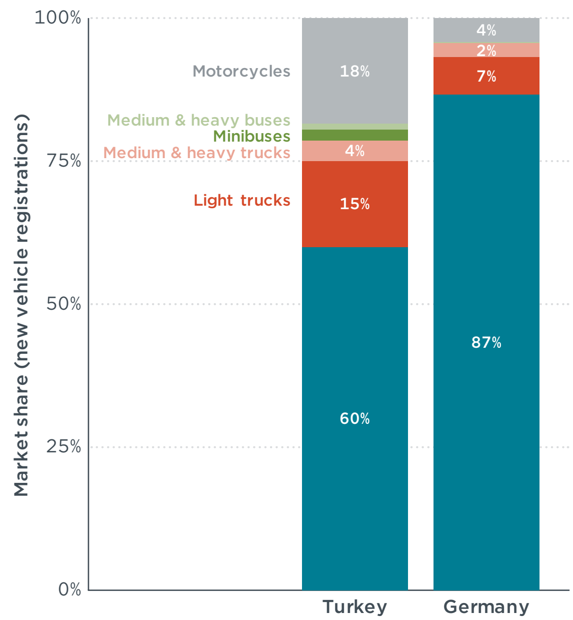


Figure 8. New vehicle registrations (2014), differentiated by vehicle type, in percentage. *Data sources: (ACEA, 2015a), (KBA, 2015), (TUIK, 2015).*

2.2 VEHICLE PRODUCTION, IMPORTS AND EXPORTS

Of the 0.6 million passenger cars newly registered in Turkey in 2014, about 0.4 million (73% of total registrations) were imported from abroad, the other 0.2 million being produced locally in Turkey. In total, 0.7 million cars were produced locally in 2014, with 0.6 million (79% of total production volume) being exported. For comparison, 57% of total new registrations in Germany were imported, while 77% of the 5.6 million passenger cars produced in Germany were exported abroad (Figure 9 and Figure 10). The share of new vehicle registrations nationally produced in Turkey is around 30%. For comparison, in Germany this figure is about 40%.

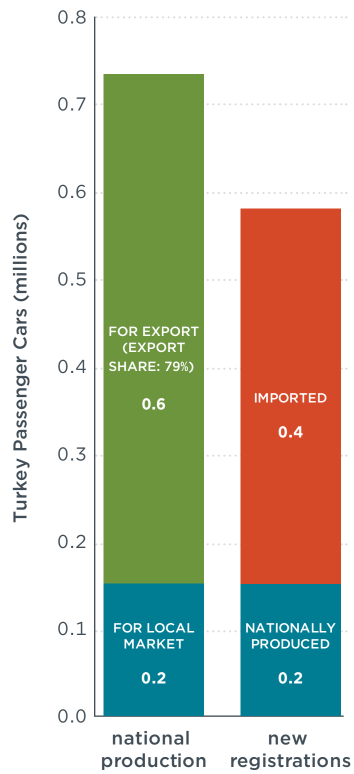


Figure 9. New passenger cars (2014), production in Turkey, imports to Turkey, exports from Turkey and new registrations in Turkey. *Data source: (OSD, 2014)*.

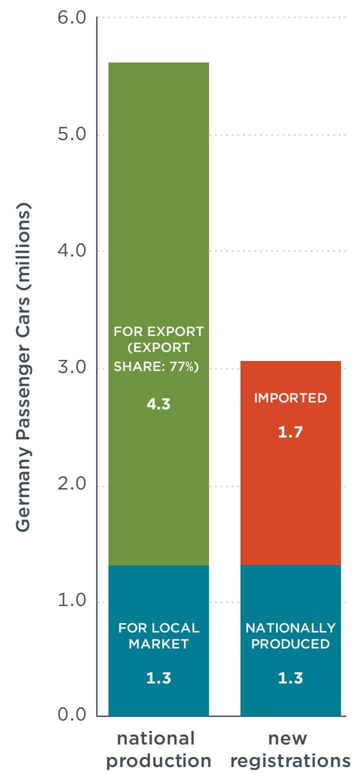


Figure 10. New passenger cars (2014), production in Germany, imports to Germany, exports from Germany and new registrations in Germany. *Data source: (VDA, 2015)*.

In addition to the 0.7 million passenger cars produced in Turkey in 2014, there were another 0.4 million commercial vehicles produced locally. Of these 0.3 million were exported abroad (Figure 11). It is not possible to compare the results for commercial vehicles to the market in Germany, as the German Association of the Automotive Industry (VDA) does not publish detailed data on the production, import, and export of commercial vehicles above 6 metric tons of gross weight (VDA, 2015).

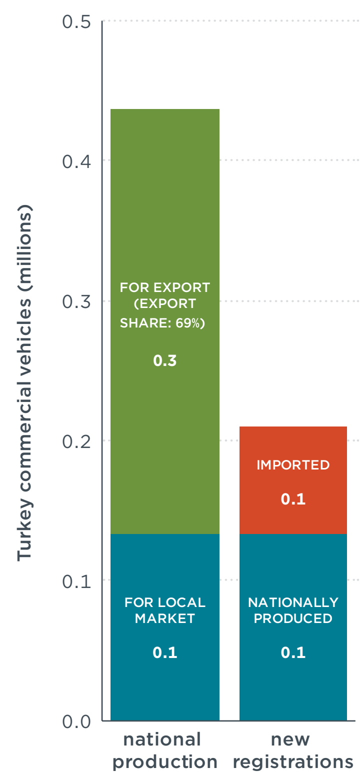


Figure 11. New commercial vehicles (2014), production in Turkey, imports to Turkey, exports from Turkey and new registrations in Turkey. *Data sources: (OSD, 2014), (TUIK, 2015).*

For both Turkey and Germany, the automotive sector is one of the key industry sectors, in particular when it comes to exports. In Turkey, exports from the automotive sector account for about 12% of the country's total export volume (TUIK, 2015). In Germany, it is about 18% of total exports (DESTATIS, 2015), making the automotive sector the number one export sector in both nations. It is estimated that the automotive sector provides employment to around 0.4 million people in Turkey and about 0.8 million people in Germany (BMWI, 2015), (KPMG, 2014).

Vehicle production plants are clustered in the northwestern part of Turkey, with a number of important plants in the Istanbul/Kocaeli and Bursa areas (Figure 12). In addition, there are typically numerous factories of vehicle part suppliers located in the vicinity (not shown in the map). In Germany, the total number of vehicle manufacturing plants is about twice that of Turkey, but a clear clustering pattern cannot be observed. Instead, there are several centers of automotive manufacturing, for example around Stuttgart, Munich, Leipzig, and Hanover (Figure 13).

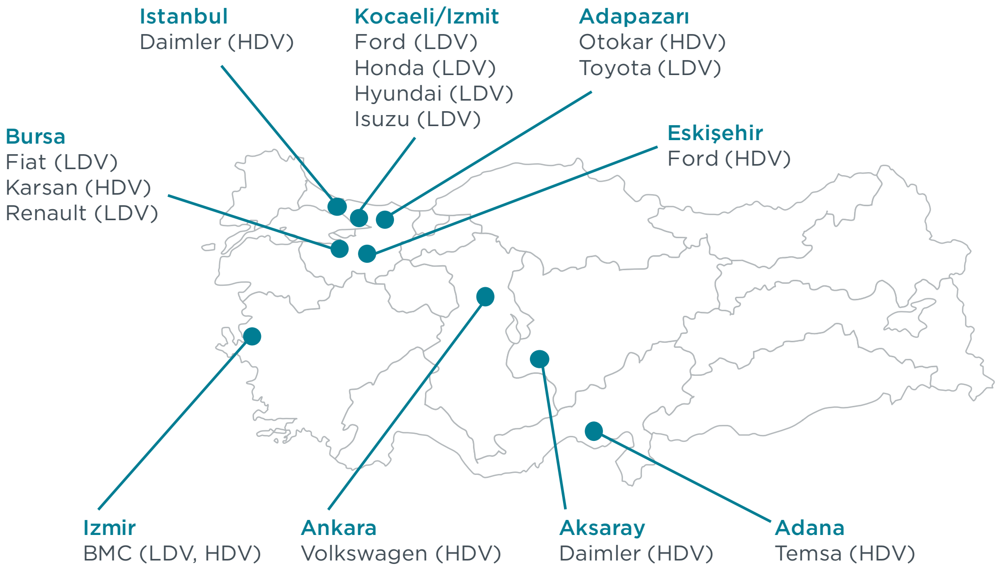


Figure 12. Light-duty (LDV) and heavy-duty (HDV) vehicle manufacturing plants in Turkey. *Data source: (ACEA, 2015a).*

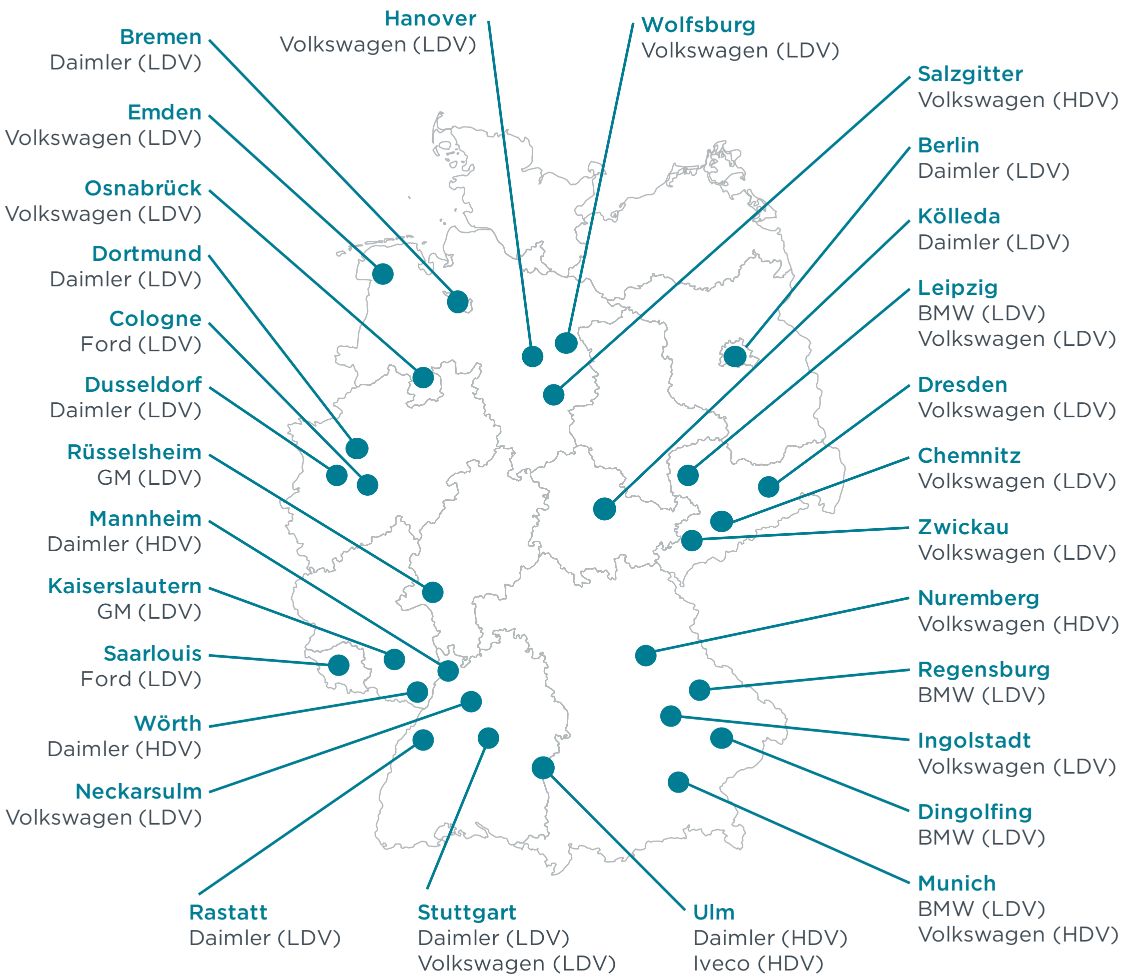


Figure 13. Light-duty (LDV) and heavy-duty (HDV) vehicle manufacturing plants in Germany. *Data source: (ACEA, 2015a).*

2.3 VEHICLE DISTRIBUTION BY REGION

About half of all new passenger cars in Turkey are first registered in the Istanbul area (Figure 14). Another 30% are newly registered in the Aegean, West Anatolia, and Mediterranean regions (around 10% each). This strong dominance of the Istanbul area in terms of new car registrations is partly due to the particularly high number of inhabitants living in and around the city,[4] a higher average income in the region (TUIK, 2016), as well as the fact that the Istanbul license plate code "34" is also often used for company and leasing car registrations.

The statistics show that of the total number of passenger cars on the road only around 23% are still registered in the Istanbul area (Figure 15). This pattern suggests that many vehicles are first registered in Istanbul and then sold as secondhand cars to other regions in Turkey.

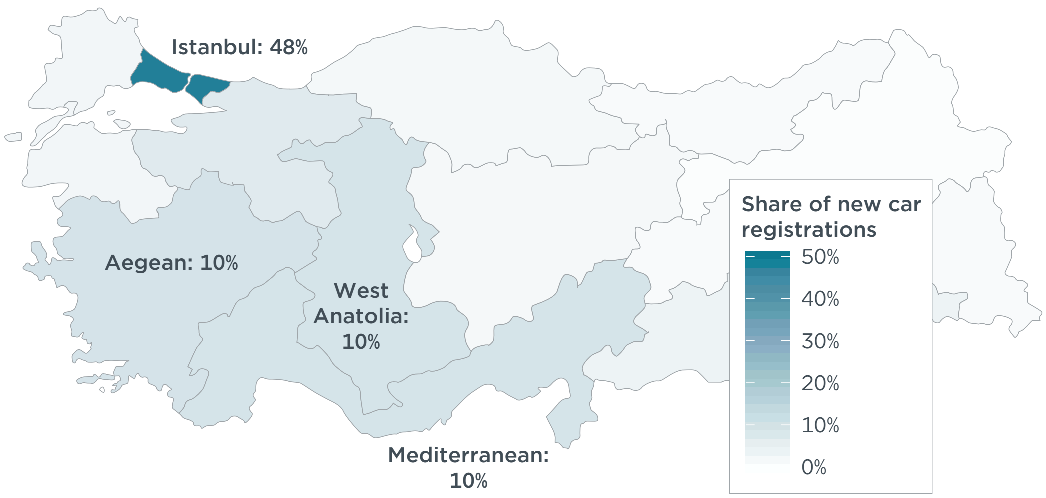


Figure 14. New passenger car registrations (2014) in Turkey by region[5]. *Data source: (TUIK, 2015).*

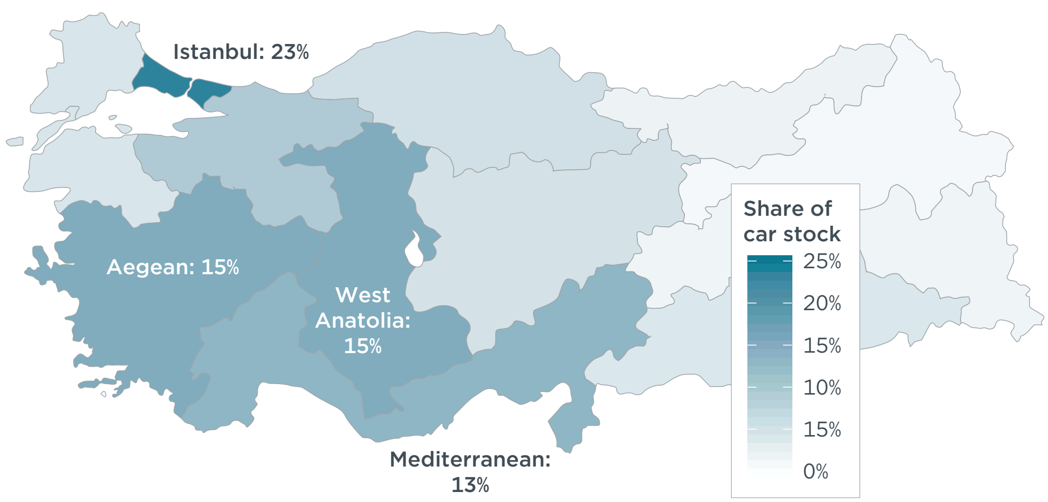


Figure 15. Passenger car stock (2014) in Turkey by region. *Data source: (TUIK, 2015).*

4 Official statistics suggest there are approximately 14 million inhabitants in the city (TUIK, 2015), with real numbers likely being higher.

5 Regions with a market share at 10% or above are annotated in the maps.

In comparison, vehicle registrations in Germany are more evenly distributed, with hardly any regional difference between newly registered cars and all cars on the road. Bavaria has the largest share of new registrations (20%), while North-Rhine-Westphalia accounts for 21% of all passenger cars on German roads (Figure 16 and Figure 17). However, none of the 16 German federal states dominates the vehicle market as Istanbul does in the case of Turkey.

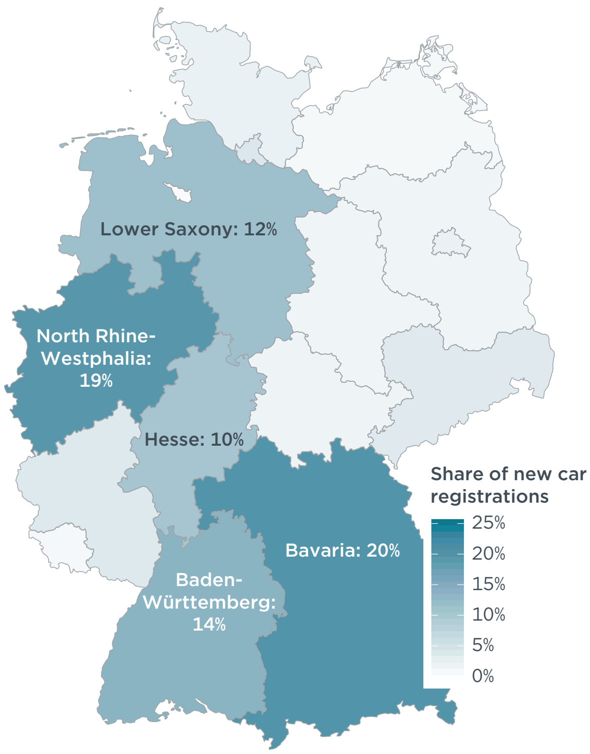


Figure 16. New passenger car registrations (2014) in Germany by region. *Data source: (KBA, 2015).*

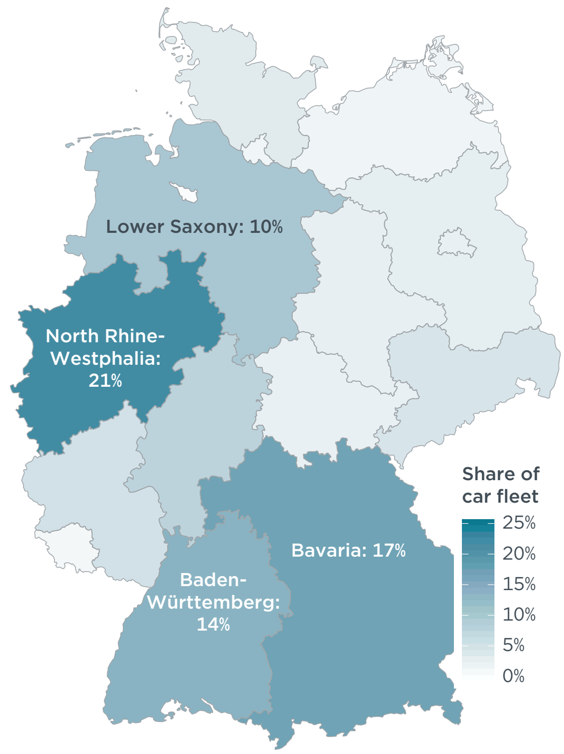


Figure 17. Passenger car stock (2014) in Germany by region. *Data source: (KBA, 2015).*

The portion of passenger cars among all vehicles is slightly higher in Istanbul than the average in Turkey (67% vs. 57%) (Figure 19). The same is true for Berlin, where 86% of all vehicles are passenger cars, compared to 83% for Germany on average. The number of cars per 1,000 inhabitants is estimated to be 153 in Istanbul compared to 118 for Turkey on average (Figure 19). In Germany, there are approximately 548 cars per 1,000 inhabitants. However, in Berlin there are only about 333 cars per 1,000 inhabitants.

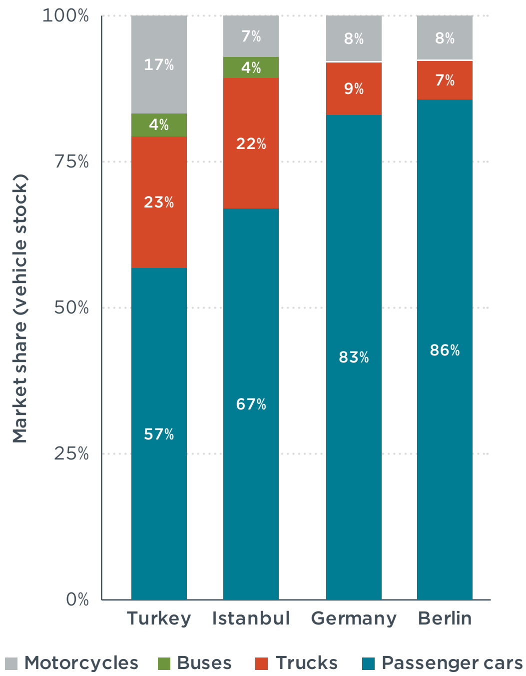


Figure 18. Vehicle stock (2014), differentiated by vehicle type, in percentages. *Data sources: (KBA, 2015), (TUIK, 2015)*.

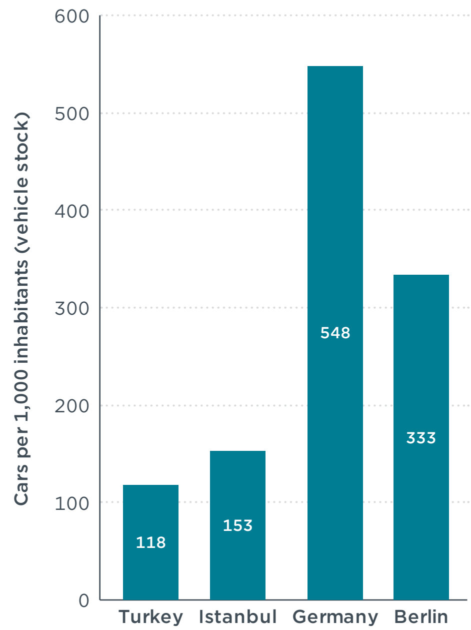


Figure 19. Number of passenger cars per 1,000 inhabitants. *Data sources: (KBA, 2015), (TUIK, 2015), own calculations*.

2.4 THE PASSENGER CAR FLEET IN MORE DETAIL

In Turkey, more than half of all new passenger cars are from the *lower medium* segment (Figure 20). About 17% of all new cars in Turkey are estimated to be operational leasing company cars (TOKKDER, 2015)[6]. In the lower medium segment more than 50% of vehicles are estimated to be company cars, with the top-selling company car models being the Renault Fluence and Fiat Linea (TOKKDER, 2015). In Germany, the lower medium segment only accounts for roughly one-third of new car registrations. The Renault Fluence and Fiat Linea models, despite their popularity in Turkey, are not offered in Germany. A reason for this phenomenon might be that Turkish customers highly value trunk space and therefore tend to opt more for sedan type passenger cars than is the case in Germany and other European countries.[7] On the other hand, the VW Golf, the most popular passenger car in Germany, is also available in Turkey but is not nearly as popular in terms of market share as it is in Germany.

The *small* cars segment accounts for about the same market share in both countries, with the VW Polo being among the top three selling models in Turkey as well as in Germany. In Germany, the *mini* vehicle segment accounts for another 7% of the market and covers vehicle models such as the VW up! or smart fortwo. These vehicles are largely absent from the Turkish market though, a possible reason being again the particularly high value for trunk space in the Turkish market.

The market share of the *medium* and *upper medium* segment is again very similar in both markets, and so are the top-selling vehicle models, such as VW Passat and

6 The total market share of company cars is expected to be significantly higher, however only data for the operational leasing company car market was available for this report.

7 Based on personal communication with a Turkish automotive industry representative, Jan 19, 2016.

Mercedes-Benz C-class. The SUV segment has shown strong growth in recent years, accounting now for about 18% of new registrations in Germany and 12% in Turkey. It is notable that the top-selling SUV models in Turkey (Dacia Duster, Nissan Qashqai, Kia Sportage) tend to be slightly smaller than the equivalent top-sellers in Germany (VW Tiguan, Opel Mokka, Ford Kuga). A remarkable difference between the car market in Turkey and Germany is the *others* category that accounts for 9% of sales in Germany but is irrelevant in Turkey. This segment covers passenger cars from the luxury segment as well as sports cars.

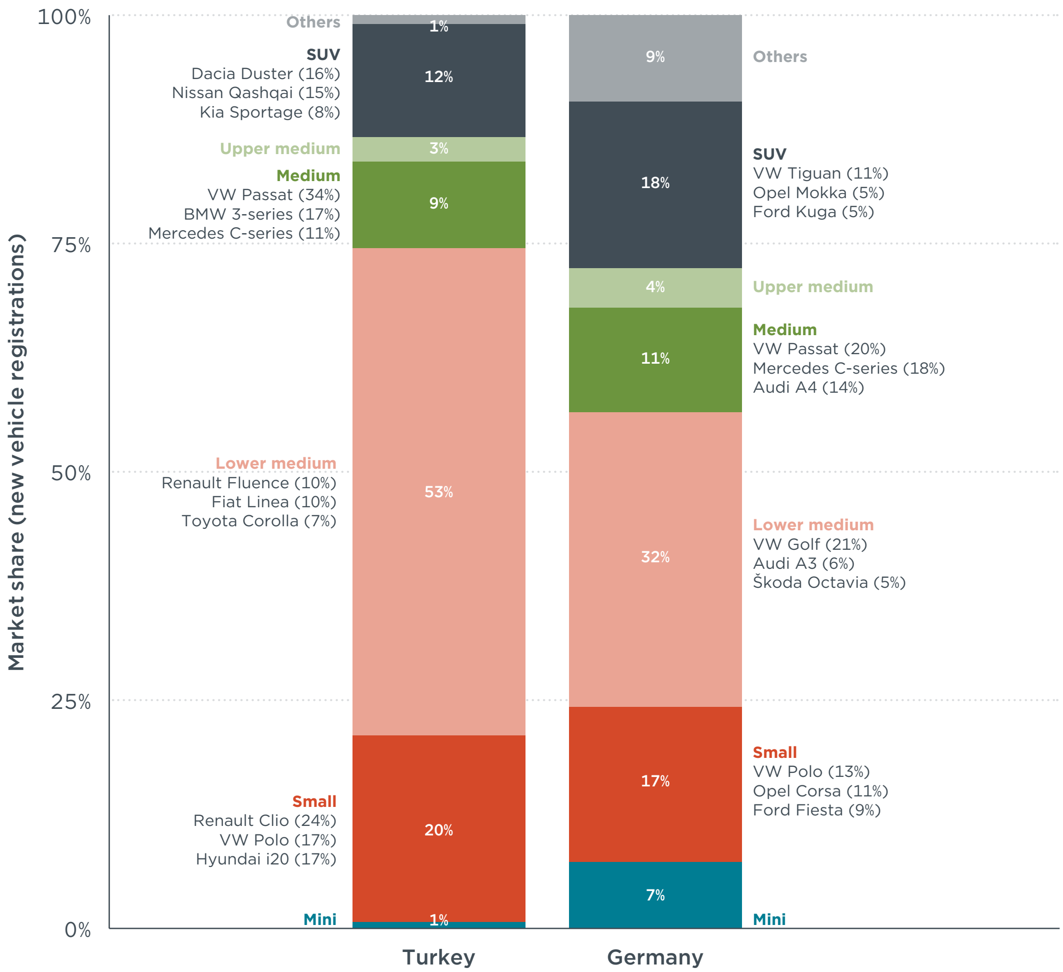


Figure 20. New passenger car registrations (2014) by segment, including top three vehicle models for selected segments. *Data source: (ICCT, 2015a).*

When analyzing new car sales by manufacturer, it can be seen that in Turkey as well as in Germany that the two largest manufacturers account for about 45% of all sales (Figure 21). However, there is a significant difference in the distribution between these two companies. In Turkey, Renault and Volkswagen both account for about 22% of all new passenger car registrations. In Germany, the Volkswagen group alone sells about 40% of all new cars, with Renault accounting for only about 7% of the market. The strong position of Volkswagen in Turkey is particularly notable given that the company does not have any light-duty vehicle production facilities in the country, unlike Renault for example. Hyundai is third in terms of vehicle sales in Turkey, with almost twice the market share than in Germany. Another remarkable difference is the market shares of

Fiat, Toyota, and PSA—all of which are significantly more relevant in terms of car sales in Turkey than in Germany. On the other hand, the premium German manufacturers Daimler and BMW are strongly present in the German automotive market (about 10% market share each), while they play a much less important role in the Turkish market (4% market share each).

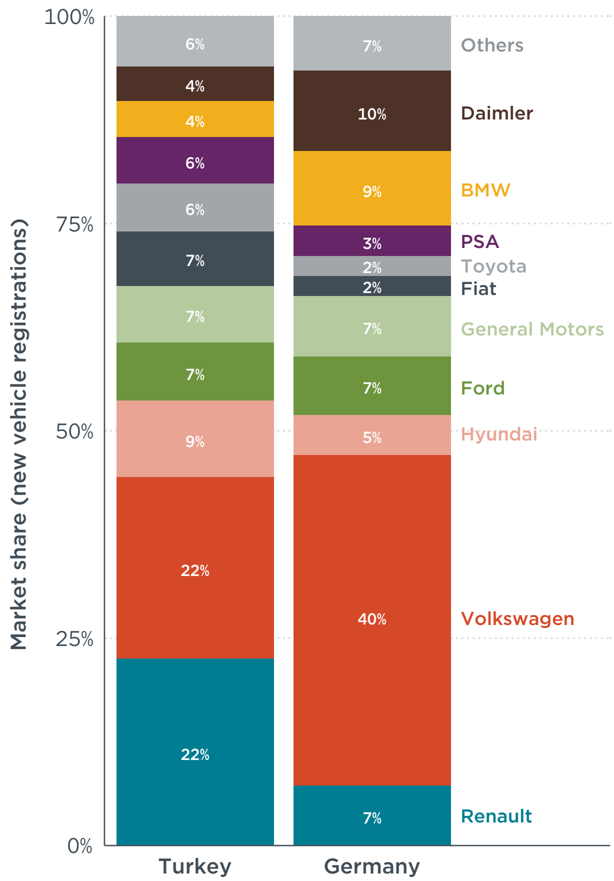


Figure 21. New passenger car registrations (2014) by manufacturer. *Data sources: (ICCT, 2015a), (TUIK, 2015).*

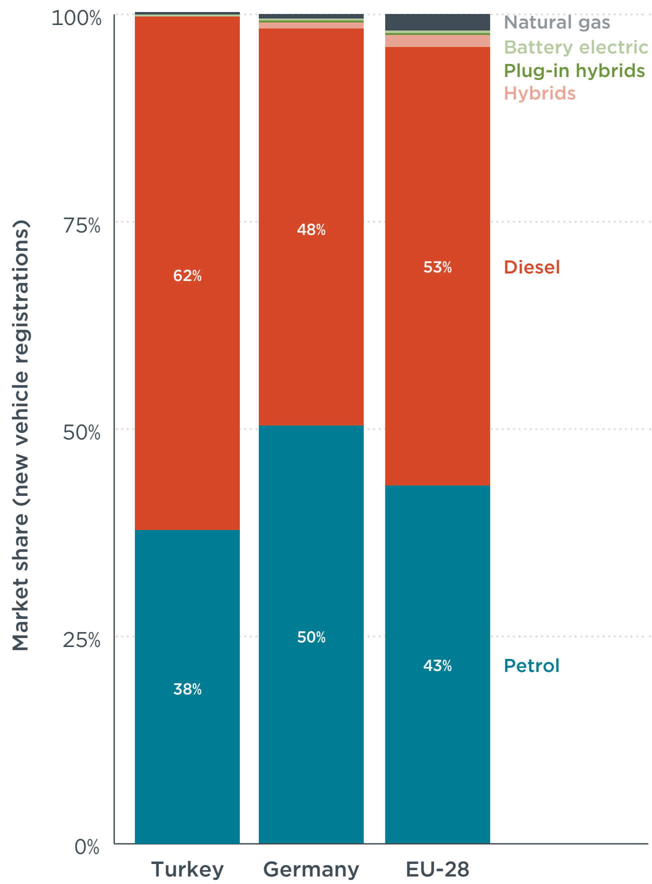


Figure 22. New passenger car registrations (2014) by powertrain. *Data source: (ICCT, 2015a).*

Diesel cars dominate the Turkish new car market, accounting for more than 60% of sales (Figure 22). For new company cars, 94% run on diesel fuel (TOKKDER, 2015). The remaining passenger car registrations are petrol fuel vehicles. It is important to mention though that in Turkey a large portion of petrol cars are converted to run on liquefied petroleum gas (LPG) later on during their lifetime (this is not an option for diesel cars). About 22% of all vehicles currently on the road run on LPG (Figure 23), and for private cars the share reported is even as high as 46% (WLPGA, 2015). The strong growth in diesel and LPG vehicles in recent years is most likely tied to the fact that fuel taxes in Turkey are amongst the highest in the world (GIZ, 2014), thereby providing a strong incentive for vehicles with nominally low fuel consumption figures. Hybrid-electric or full electric vehicles do not play any significant role in Turkey at this point.

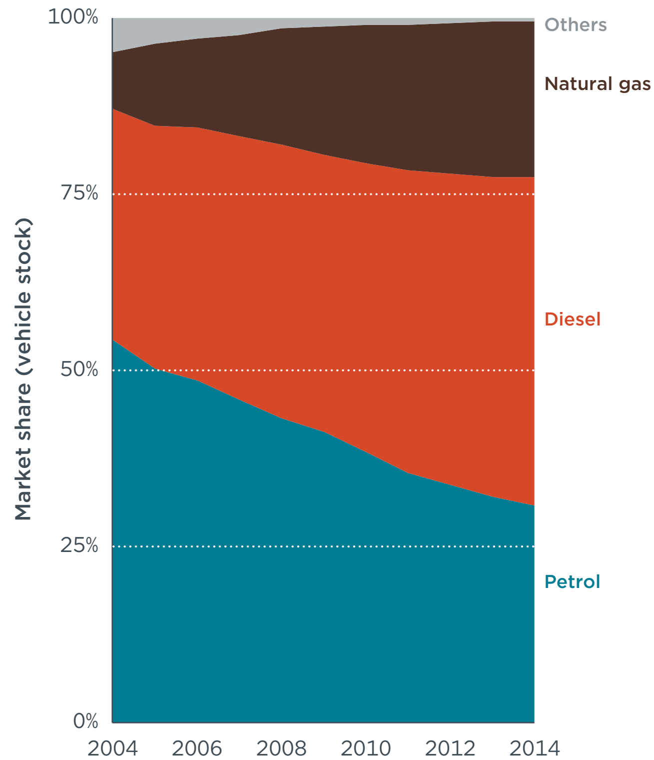


Figure 23. Historic development of vehicle stock (includes all vehicle types) by fuel type for Turkey. *Data source: (TUIK, 2015).*

In Germany, the diesel market share is about 10 percentage points lower than in Turkey, with about half of new cars running on diesel and the other half on petrol. Alternative powertrains and fuels accounted for less than 2% of new car sales in 2014. Retrofitting petrol vehicles to run on LPG or CNG (compressed natural gas) is also observed in Germany but to a much lesser degree than in Turkey (only about 1% of cars on the road run on LPG and CNG). For the EU as a whole, the diesel market share is about 53%. Natural gas vehicles are popular especially in Italy (with about 14% of all new cars running on LPG or CNG). As a result, the overall market share of natural gas vehicles in the EU is around 2% and therefore–for new car registrations–significantly higher than in Turkey and Germany. Hybrid-electric vehicles are relatively popular in some EU member states such as the Netherlands (more than 6% of new cars are hybrid or plug-in hybrid electric vehicles). The overall market share of hybrid-electric and full electric vehicles in the EU in 2014 was about 2%.

Table 2 puts the Turkish new passenger car market in comparison with some other key automotive markets worldwide. Turkey is among the top 20 largest vehicle markets in the world, with 0.6 million passenger car sales per year. In relation, the number of new cars sold every year in China is 15.5 million, in the EU-28 12.5 million, in the United States 7.9 million, in Japan 3.5 million, and in South Korea 1.3 million.

Table 2. International market comparison of new passenger car fleet characteristics.[8] *Data sources: (ICCT, 2015a), (Posada and Façanha, 2015).*

	Turkey (2014)	Germany (2014)	EU-28 (2014)	U.S. (2014)	China (2012)	Japan (2011)	Brazil (2013)	India (2012)	S. Korea (2013)
Sales (million)	0.6	3.0	12.5	7.9	15.5	3.5	3.0	2.6	1.3
Number of cylinders	4.0	4.0	3.9	4.6	—	3.8	4.0	3.6	4.3
Engine displacement (l)	1.5	1.7	1.6	2.5	1.6	1.4	1.4	1.3	1.9
Engine power (kW)	80	103	90	150	86	78	76	55	120
Curb weight (metric tons)	1.3	1.5	1.4	1.6	1.3	1.2	1.1	1.1	1.5
Footprint (m^2)	4.0	4.1	4.0	4.3	3.8	3.7	3.7	3.4	4.2
Power-to-weight-ratio (kW/kg)	0.059	0.070	0.065	0.093	0.066	0.065	0.067	0.052	0.084
Energy consumption - U.S. CAFE (MJ/km)	1.6	1.7	1.6	2.0	2.2	1.8	2.0	1.8	1.9
Current emission standard	Euro 5	Euro 6	Euro 6	Tier 2	Euro 4_{eq}	Euro 6_{eq}	Euro 5_{eq}	Euro 4_{eq}	Euro 6_{eq}
Petrol	38%	50%	43%	93%	99%	86%	6%	56%	46%
Diesel	62%	48%	53%	2%	1%	0%	0%	40%	42%
Hybrid-electric	0%	1%	2%	6%	0%	13%	0%	0%	0%
Others	0%	1%	2%	0%	0%	1%	94%	4%	12%
Manual transmission	54%	70%	77%	5%	60%	1%	83%	98%	9%
Automatic transmission	46%	30%	23%	95%	40%	99%	17%	2%	91%

In terms of average engine displacement (1.5l) and engine power (80 kW), the market in Turkey is most similar to those in the EU-28, China, Japan, and Brazil. In comparison, average displacement and engine power tends to be significantly higher in Germany, the United States, and South Korea. In terms of average vehicle weight (1.3 metric tons) and size (4.0 m^2), new cars in Turkey are most similar to those sold on average in the EU-28 and in China. In Germany, the United States, and South Korea, new cars tend to be heavier and larger. The power-to-weight-ratio is a measure for expressing how powerful the engine of a vehicle is in comparison to its weight. Here the average for Turkey (0.06 kW/kg) is most similar to the average value in the EU-28. The same is true for the average energy consumption of new cars, normalized to the U.S. CAFE (Corporate Average Fuel Economy) test cycle. The average value for the Turkish fleet (1.6 MJ/km) is close to the EU-28 average, with vehicles in China, the United States, and Brazil on[8] average showing significantly higher fuel consumption.[9]

The vehicle air pollutant emission standard in place for new vehicle types in Turkey from 2016 onwards is Euro 6. In the EU, the Euro 6 standard was introduced for new vehicle types in 2014 and has been applicable for all new car registrations since September 2015. In Japan and South Korea, emission standards equivalent to the Euro 6 regulation apply, while for China and India Euro 4 equivalent standards are currently in place. The United States has imposed the Tier 2 standard, which is generally seen as more stringent than Euro 6.

In comparison to other key automotive markets worldwide, the market share of diesel cars in Turkey (62%) is among the highest. Only some EU member states (such as Luxembourg, Ireland, and Portugal) have a higher diesel share than Turkey. Outside of Europe, only India and South Korea have a significant diesel market share among passenger cars. With respect to hybrid-electric vehicles, Japan and the United States are

8 Sales / registration weighted averages; energy consumption data was converted using the methodology described in (Yang, 2015).

9 Energy consumption, fuel consumption and CO_2 emissions of a vehicle are directly linked to each other.

leading markets, while in the EU the current new car market share is only 2%. For Turkey the number of hybrid-electric vehicles is currently insignificant.

In Turkey, about half the new passenger cars are equipped with manual transmission, the other half with automatic transmission. The share of automatic transmission vehicles is therefore higher than the EU average and at about the same level as China. In the United States, Japan, and South Korea, nearly all new passenger cars are equipped with an automatic transmission system.

Figure 24 provides a comparison of the engine power of new passenger cars in Turkey, Germany, and the EU-28. For this, engine power was aggregated into 5 kW bins. About 70% of new cars in Turkey have an engine power of 50-70 kW, with the average being 80 kW. For the EU-28 and Germany, average engine power is higher, but at the same time the distribution is less clustered than for Turkey, i.e. customers purchasing vehicles with a wider range of vehicle power.

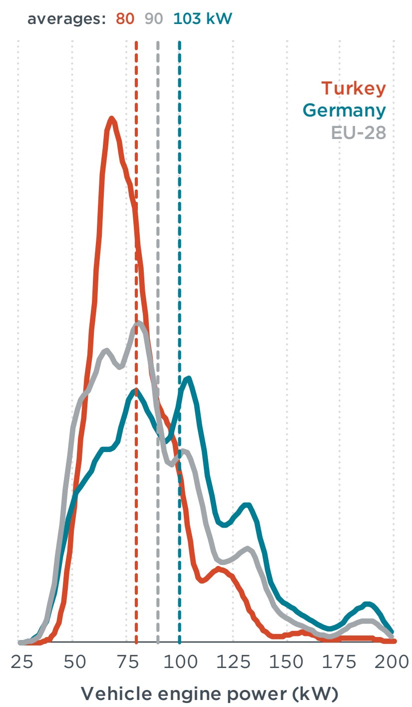


Figure 24. New passenger car registrations (2014) by engine power, estimated probability density function. *Data source: (ICCT, 2015a).*

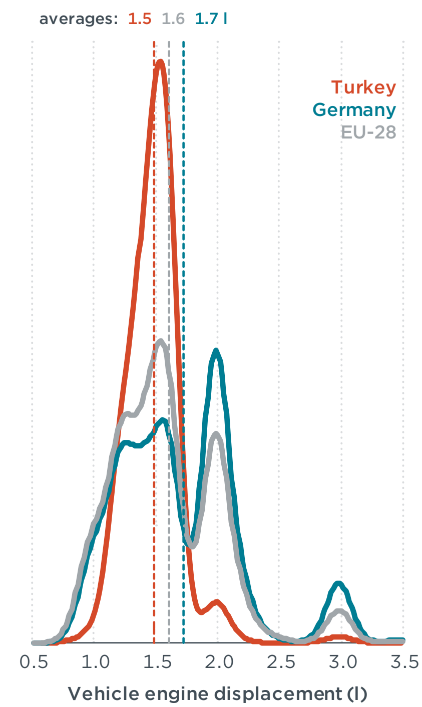


Figure 25. New passenger car registrations (2014) by engine displacement, estimated probability density function. *Data source: (ICCT, 2015a).*

It is remarkable that 95% of all new cars in Turkey have an engine displacement of 1.6l or less (Figure 25). Both for Germany and the EU-28 average, at least 30% of new cars have an engine displacement above 1.6l. Most likely the underlying reason for this phenomenon is the vehicle taxation scheme in Turkey that is based on engine displacement and that includes an important tax threshold at 1.6l engine displacement. Under this system, a vehicle with 1.6l displacement is subject to a 45% "Special Consumption Tax" (calculated based on the net price of the vehicle) while the sales tax for a vehicle with 1.7l displacement is 90% (ACEA, 2015b). The difference, for example, for a 20,000 EUR vehicle amounts to 9,000 EUR and thereby provides a very strong incentive for picking a car with an engine displacement of 1.6l or less. In addition, the annual tax is also based on engine displacement, again with a tax threshold at 1.6l. The difference in the annual tax rate for a 1.6l and a 1.7l displacement vehicle is about 240 EUR. In comparison, while the annual vehicle taxation scheme in Germany is also partially based on engine displacement, it is a linear system without any threshold steps, so that the tax difference between a 1.6l and a 1.7l engine is only 2 EUR (petrol) / 9.50 EUR (diesel) (ACEA, 2015b). The vehicle taxation scheme in Turkey is currently under review, with some likelihood that in the future it will be based on the vehicle's CO_2 emission level instead of engine displacement.[10]

Figure 26 and Figure 27 show the distribution of new cars by weight and size clusters for the three markets. In terms of vehicle size, there is hardly any observable difference, neither for the average values nor for the distribution patterns. In terms of weight, the average new car weight is about 50 kg lower in Turkey than in the EU. At the same time the variance is again wider for the EU, while in Turkey vehicles are clustering more closely around the 1,300 kg weight category.

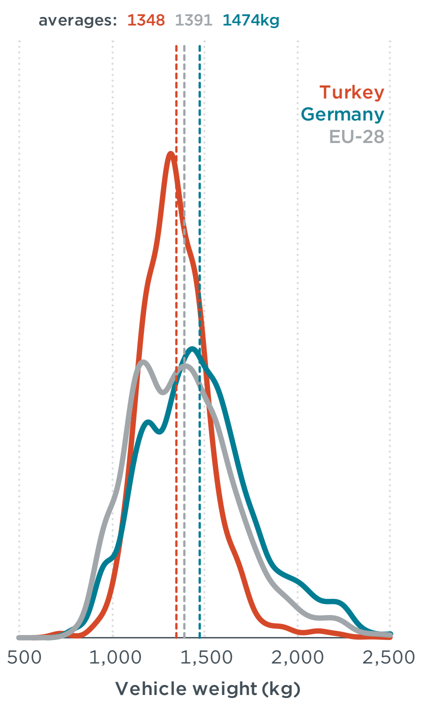


Figure 26. New passenger car registrations (2014) by vehicle weight (mass in running order), estimated probability density function. *Data source: (ICCT, 2015a)*.

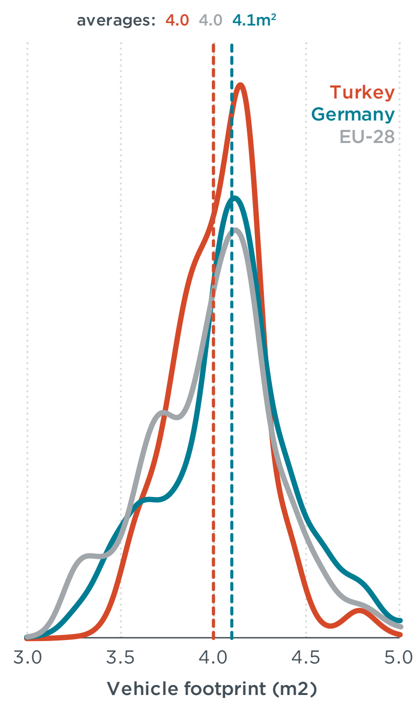


Figure 27. New passenger car registrations (2014) by vehicle size (footprint), estimated probability density function. *Data source: (ICCT, 2015a)*.

Finally, it should be mentioned that the average age of passenger cars in Turkey is 12 years, while it is 9 years in Germany (KBA, 2015), (TUIK, 2014).

10 Based on personal communication with Turkish automotive industry representatives in Dec 2015 and Jan 2016. According to another source from the Turkish automotive industry, no change in the taxation scheme is likely for the near future.

2.5 THE LIGHT COMMERCIAL VEHICLE FLEET IN MORE DETAIL

The light commercial vehicle (also called "N1" vehicles) market in Turkey is split near evenly between the three sub-categories: N1 class I (reference mass ≤1,305kg), class II (1,306-1,760kg) and class III (>1,760kg) (Figure 28). This is similar to the situation in the EU-28 (not shown here) but very different than in Germany. The German light commercial vehicle market is significantly smaller in market volume than in Turkey. Only 5% of all light duty vehicles in Germany are light commercial vehicles, while the share is 24% in Turkey. Furthermore, the light commercial vehicle market in Germany is dominated by N1 class III vehicles, i.e. the heaviest category.

The most common light commercial vehicles in Germany are the Mercedes-Benz Sprinter and VW Transporter. In Turkey on the other hand, it is smaller vehicles, such as the Fiat Fiorino and Fiat Doblò, both assembled in Turkey, that are most popular in the light commercial vehicle segment. In this respect the Turkish market is more similar to markets such as France, where the light commercial vehicle sector also tends to be dominated by smaller, more passenger-like vehicles (not shown here).

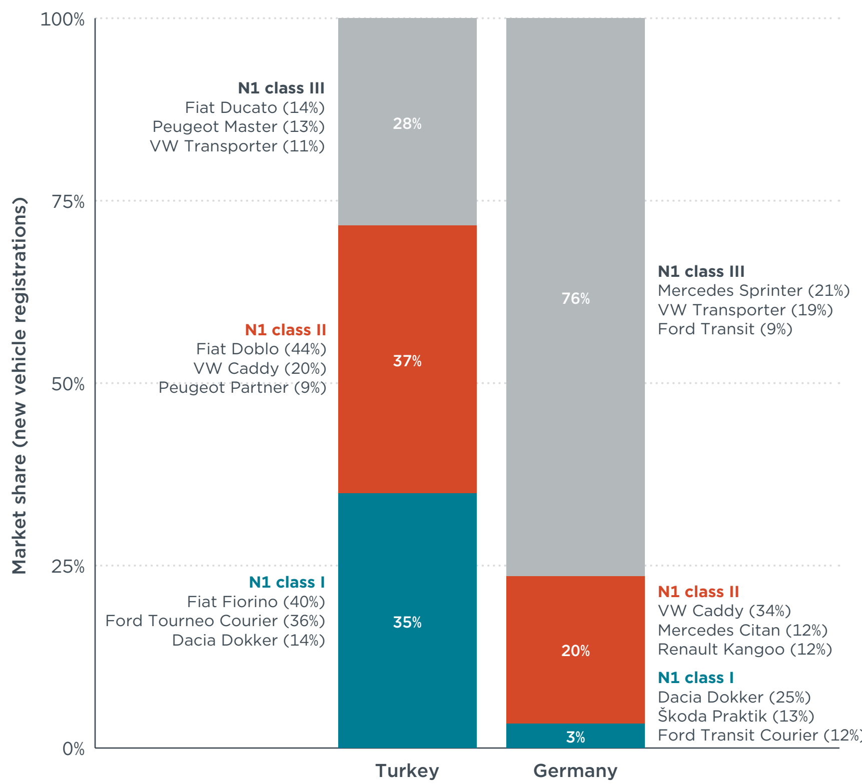


Figure 28. New light commercial vehicle registrations (2014) by segment, including the top three vehicle models per segment. *Data source: (ICCT, 2015a).*

In terms of manufacturer groups, more than half of the light commercial vehicle market in Turkey is dominated by Fiat and Ford (Figure 29). While Volkswagen and Renault are the largest passenger car manufacturers, for light commercial vehicles they are only third and fourth, with about 20% market share altogether. In Germany, Volkswagen not only has the highest market share for passenger cars but also for light commercial vehicles (27%). The second largest manufacturer in Germany is Daimler. The Mercedes-Benz Sprinter is a particularly popular light commercial vehicle in Germany. In Turkey, on the other hand, this vehicle is hardly ever found on the streets.

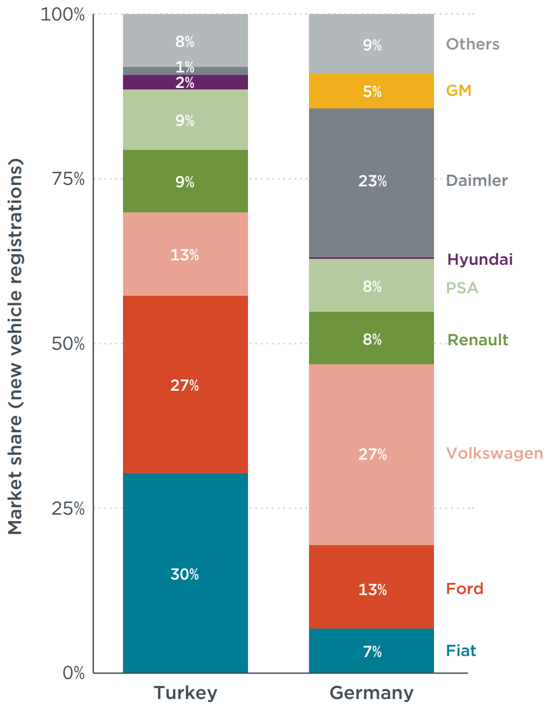


Figure 29. New light commercial vehicle registrations (2014) by manufacturer. *Data source: (ICCT, 2015a).*

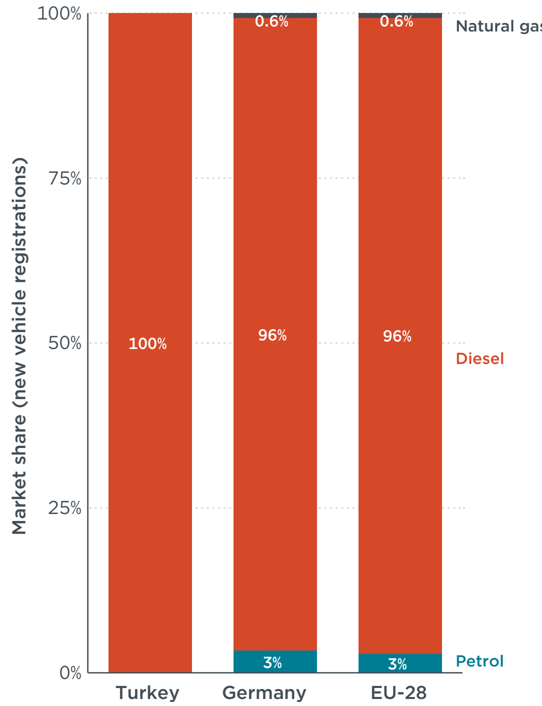


Figure 30. New light commercial vehicle registrations (2014) by powertrain. *Data source: (ICCT, 2015a).*

New light commercial vehicles in Turkey are entirely run on diesel fuel. The situation is very similar in Germany and the EU-28, where there are less than 4% of new vehicles running on petrol or natural gas (Figure 30).

Table 3 compares some of the most important light commercial vehicle markets worldwide. In Turkey, there is about the same number of new light commercial vehicles sold every year as in Germany (0.2 million). In the EU overall, this number is 1.6 million and in the United States 8.7 million. Light commercial vehicles in the United States, on average, have much larger and more powerful engines than in all other markets. The average weight and size is not that different though, thereby resulting in a power-to-weight ratio that is about twice as high in the United States than in Turkey and the EU, and even three times higher than in China. This is partly due to the fact that many light commercial vehicles in the United States are actually minivans or pick-up trucks, not primarily designed for the carriage of goods but rather as high-power passenger vehicles. In terms of technical characteristics, the light commercial vehicle fleet in Turkey is similar to that of the EU average but lighter and smaller than in Germany due to the focus on smaller vehicle models in Turkey.

Table 3. International market comparison of new light commercial vehicle fleet characteristics.[11] Data sources: (CATARC, 2013), (EPA, 2014), (ICCT, 2015a), (Posada and Façanha, 2015), additional ICCT internal databases.

	Turkey (2014)	Germany (2014)	EU-28 (2014)	U.S. (2014)	China (2012)	India (2011)
Sales (million)	0.2	0.2	1.6	8.7	1.3	0.4
Engine displacement (l)	1.8	2.1	1.9	3.8	1.7	1.2
Engine power (kW)	79	93	85	210	46	24
Curb weight (metric tons)	1.6	1.9	1.8	2.2	1.4	1.0
Footprint (m^2)	4.7	5.9	5.2	5.1	3.5	3.1
Power-to-weight-ratio (kW/kg)	0.051	0.048	0.049	0.095	0.033	0.023
Energy consumption - U.S. CAFE (MJ/km)	2.0	2.3	2.1	3.0	2.4	1.9
Current emission standard	Euro 5	Euro 6	Euro 6	Tier 2	Euro 4_{eq}	Euro 4_{eq}*
Petrol	0%	3%	3%	98%	48%	3%
Diesel	100%	96%	96%	2%	51%	86%
Hybrid-electric	0%	0%	0%	1%	0%	0%
Others	0%	1%	1%	0%	1%	11%
Manual transmission	97%	100%	96%	1%	100%	100%
Automatic transmission	3%	0%	4%	99%	0%	0%

* in 30 citites

The vehicle air pollutant emission standard in place for new vehicle types in Turkey from 2016 onwards is Euro 6. In the EU, the Euro 6 standard was introduced for new vehicle types in 2014 and has been applicable for all new car registrations since September 2015. In China, light commercial vehicles are subject to a Euro 4 equivalent standard. In India, the Euro 4 standard applies in 30 cities throughout the country. The United States has introduced the Tier 2 standard, being more stringent than the Euro 6 regulation.[11]

Light commercial vehicles in Turkey and the EU are almost entirely fuelled on diesel. In the United States though, the situation is exactly opposite, with hardly any vehicles being non-petrol driven. In China, petrol and diesel each account for about half the market, while in India again most light commercial vehicles are diesel fuelled.

In the United States, light commercial vehicles usually are equipped with an automatic transmission system, while in all other analyzed markets, manual transmission makes up close to 100% of market share.

Comparing the market distribution patterns by vehicle engine power clusters, it can be seen that the Turkish and the average EU new light commercial vehicle fleet follow a similar pattern, even though the engine power on average for the EU (85 kW) is slightly higher than for Turkey (79 kW) (Figure 31). In Germany, nearly 50% of light commercial vehicles have an engine power of 100 kW or higher, while only 25-30% of new vehicles have 100 kW or more in Turkey and the EU-28.

11 Sales/registration weighted averages; energy consumption data was converted using the methodology described in (Yang, 2015).

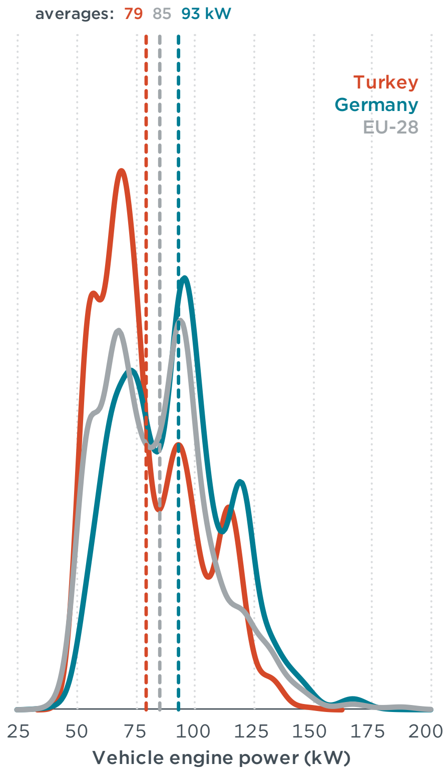


Figure 31. New light commercial vehicle registrations (2014) by engine power, estimated probability density function. *Data source: (ICCT, 2015a)*.

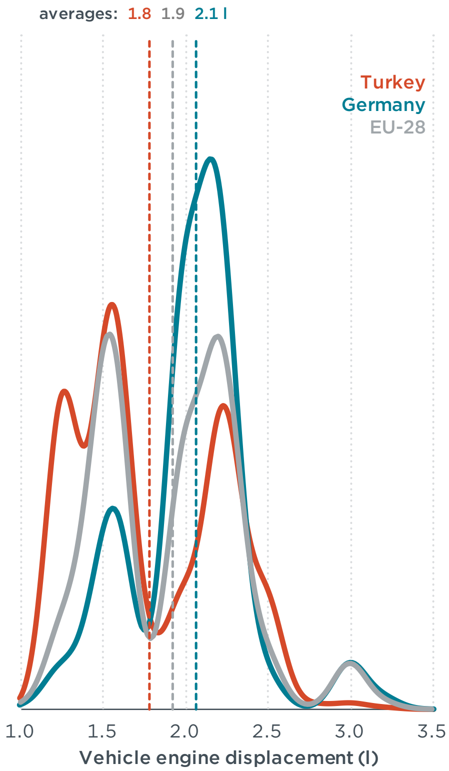


Figure 32. New light commercial vehicle registrations (2014) by engine displacement, estimated probability density function. *Data source: (ICCT, 2015a)*.

About 20% of new light commercial vehicles in Turkey have an engine displacement of around 1.2l—a pattern that is less pronounced in the EU-28 average and in particular for Germany (Figure 32). Other than that, the engine displacement distribution is very similar in all three markets, mostly clustering around 1.6l and 2.2l. The annual vehicle tax for vans in Turkey is based on engine displacement, with a tax threshold at 1.9l. The taxation rates are significantly lower than for passenger cars though.

Approximately 40% of new light commercial vehicles in Germany have a vehicle weight of around 2,100 kg, with all other weight categories being of significantly less importance (Figure 33). For the average EU-28 market, a division between two types of vehicles can be seen: About 40% of light commercial vehicles have a weight of 1,500 kg or below, and 60% are heavier than that. A similar pattern can be observed for Turkey, but with 70% of light commercial vehicles weighing 1,500 kg or less.

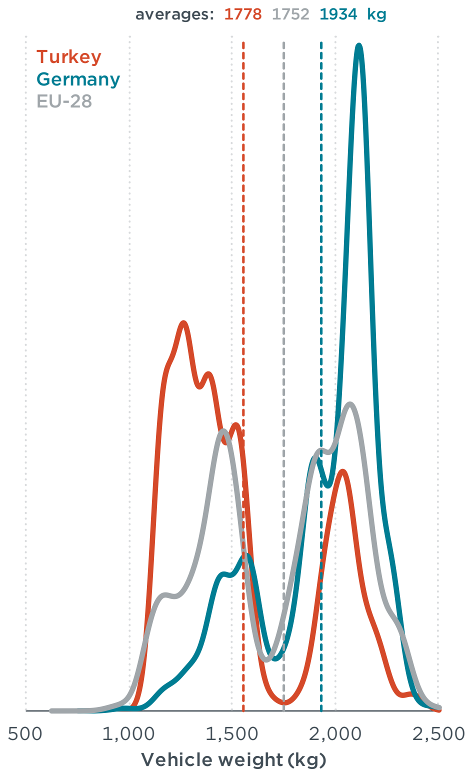


Figure 33. New light commercial vehicle registrations (2014) by vehicle weight (mass in running order), estimated probability density function*. Data source: (ICCT, 2015a)*.

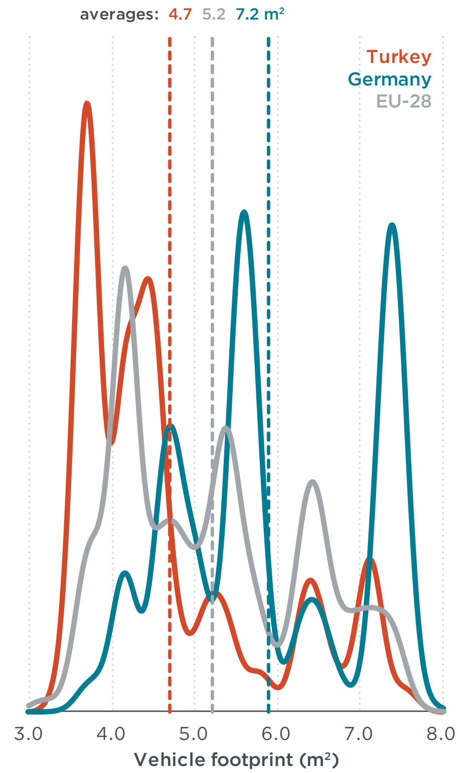


Figure 34. New light commercial vehicle registrations (2014) by vehicle size (footprint), estimated probability density function. *Data source: (ICCT, 2015a)*.

When looking at vehicle size, the differences between the light commercial vehicle markets in Turkey and especially Germany become most obvious. While in Turkey almost 80% of vehicles have a footprint of 5 m^2 or smaller, for Germany this applies to only about 30% of vehicles (Figure 34). While in Germany, 30% of light commercial vehicles have a footprint of around 7.5 m^2, these large vehicle models are not found at all in the Turkish market.

2.6 THE HEAVY TRUCK FLEET IN MORE DETAIL

The market for heavy-duty trucks (defined as trucks with a maximum gross weight of more than 3.5 metric tons) in Germany is dominated by only two companies. Daimler (Mercedes-Benz brand) and Volkswagen (Scania and MAN brands) together account for 80% of new truck sales (Figure 35). Volvo and Iveco account for another 16% of sales. In Turkey, Daimler accounts for half of all new truck sales and has a similar market position in Germany. The remaining 50% of the market is split up between several companies, with Ford Otosan (owned by Ford Motor Company and Koç Holding) being the second largest truck manufacturer (16% market share) and Volkswagen being third (10%).

In Germany the best-selling Daimler truck is the large size Mercedes-Benz Actros (58% of all Daimler truck sales in Germany). The smaller size Atego (28%) and the smallest Mercedes-Benz truck model, the Axor (2%), account for significantly fewer sales. In Turkey on the other hand, it is the Axor (68%) having the highest market share, with Actros (10%) and Atego (8%) being of less importance.

Figure 35. New heavy-duty truck registrations (2014) by manufacturer, including top-3 vehicle models for Daimler. *Data sources: (ICCT, 2015a), (TUIK, 2015)*.

2.7 INTERIM CONCLUSIONS

- Despite similar population sizes in Turkey and Germany, new vehicle sales in Turkey are one-third of that in Germany. But for Turkey high growth rates are expected for future years. As a result, it is of particular importance to ensure that new vehicles coming to the roads in Turkey are as efficient and clean as possible.
- Passenger and light commercial vehicles account for three-quarters of the vehicle fleet in Turkey. Focusing solely on these vehicle types might be shortsighted though, as heavy-duty vehicles are responsible for a disproportionally high share of fuel consumption and exhaust emissions.
- The automotive sectors in Turkey and Germany are very similar in the sense that both countries have a large number of vehicle manufacturing plants and are exporting a majority of their local vehicle production abroad. This importance of vehicle exports in Turkey is particularly strong for buses and trucks. As a result of the dependence of the Turkish and German economy on the automotive industry, it is of particular importance for both countries to ensure that this industry is ready to reply to current and future challenges, such as local air pollution, global climate change and energy security, by offering innovative products. It should also be noted that due to their strong focus on vehicle exporting, policies aiming at reducing vehicle fuel consumption and emissions in Turkey and Germany are likely to also show spillover effects in other markets.
- Around half of new passenger car registrations in Turkey take place in the region of Istanbul. Vehicles tend to be sold to secondhand owners in other parts of the

country later on during their lifetime. Overall, the average age of passenger cars in Turkey is 12 years, with the vehicle fleet in Istanbul being significantly younger than that. As a result, when tackling vehicle fuel consumption and emissions, regional policies for Istanbul as well as supplementing action at the national level are seen as a promising way of leveraging positive developments and accelerating progress towards clean vehicles.

» More than 60% of new cars in Turkey are equipped with a diesel engine. For light and heavy commercial vehicles, this number is nearly 100%. Given the general health concerns regarding emissions from diesel vehicles and the recent revelations regarding on-road exceedances of emission levels for diesel cars, it should be critically assessed whether the current high market share of diesel in Turkey is desirable from a societal point of view. Of the 40% of new cars that are petrol-fuelled, a large portion is being converted to run on natural gas, taking advantage of tax incentives. For a comprehensive assessment, the entire fuel supply chain needs to be critically assessed to decide whether for Turkey natural gas vehicles are indeed beneficial in terms of well-to-wheel emission reductions and in terms of strengthening national energy security. With respect to electrified vehicles, it must be stated that neither hybrid-electric nor fully-electric vehicles are currently absent from the Turkish automotive market, with a significant potential for uptake both from the vehicles sales as well as the vehicle production point of view.

» In terms of motorization of new vehicles, it is observed that the current taxation scheme has a strong impact in Turkey, with 95% of all new cars being under the tax threshold of 1.6l engine size. Average cars in Turkey also have a lower engine power and weight than the EU average. Furthermore, light commercial vehicles in Turkey tend to be relatively small and are in many cases derived from passenger car models, with the taxation levels for light commercial vehicles being significantly lower than for passenger cars.

3 VEHICLE FUEL CONSUMPTION AND EMISSIONS

This section focuses on the fuel consumption and CO_2 emissions of new passenger cars and light commercial vehicles in Turkey. For heavy-duty vehicles, an analysis of fuel consumption and CO_2 emissions is currently not possible due to a lack of detailed data for these vehicles. The results for Turkey at the fleet and individual vehicle model level are put in comparison to the German vehicle market. Overall trends for fuel consumption and CO_2 and air pollutant emissions in a business-as-usual scenario are also included in this section.

3.1 PASSENGER CAR FLEET AVERAGES

New passenger cars in Turkey in 2014 had an average CO_2 emission level of 121g/km (ICCT, 2015a). The average value for EU-28 in 2014 was 123g/km and for Germany 132g/km. These values are according to the official type-approval test procedure in Europe, the New European Drive Cycle (NEDC). As CO_2 emissions and fuel consumption of a vehicle are directly proportional, the value of 121g/km is equal to a fuel consumption of approximately 4.8l/100km.

In the EU, a mandatory CO_2 emission target for new passenger cars is in place, fixed at 130g/km for 2015 for the average new vehicle fleet. Targets for individual manufacturers depend on the weight of the vehicle fleet though: the heavier a vehicle, the more CO_2 emissions it is allowed to emit. Applying this weight-based target function at country level, the new passenger car fleets in EU-28 and Germany are below their respective 2015 target threshold (Figure 36). It can be seen that the new car fleet in Germany is heavier than for the EU average, thereby resulting in a higher target value for the German car market. New passenger cars in Turkey are lighter than in Germany and also slightly lighter than the EU average. If the EU CO_2 target line would also apply to Turkey, it would have already been met in 2014 as well.

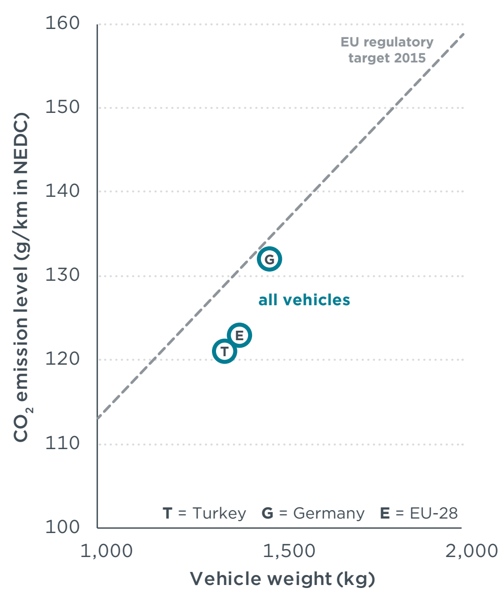


Figure 36. Average CO_2 emission level of new registration passenger car registrations (2014), all vehicles by vehicle weight. *Data source: (ICCT, 2015a).*

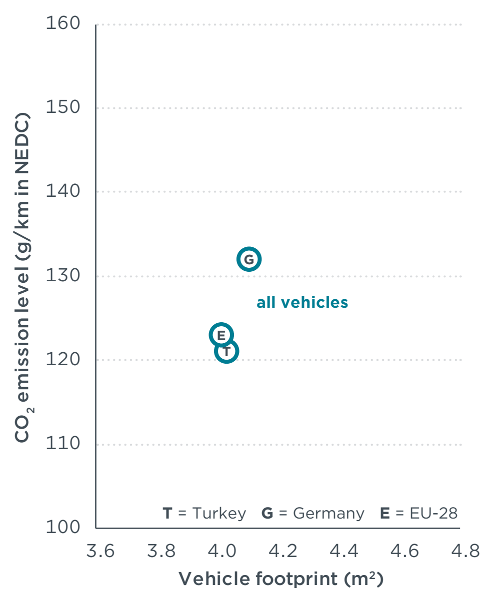


Figure 37. Average CO_2 emission level of new registration passenger car registrations (2014), all vehicles by vehicle size. *Data source: (ICCT, 2015a).*

Figure 37 illustrates the relationship between vehicle size (in terms of vehicle footprint) and CO_2 emissions. It can be seen that new cars in Turkey are about the same size as the EU average but slightly smaller than the German average. While the EU applies a weight-based CO_2 target scheme, in the United States CO_2 targets are based on the size of a vehicle (approximated by its footprint), thereby avoiding negative side effects of a weight-based target system, such as the limited incentive to reduce the weight of a vehicle (Mock, 2011).

A differentiation between vehicles with different fuel types allows for a better interpretation of the data. Figure 38 shows again new passenger car weight vs. CO_2 emissions, with petrol and diesel cars shown separately. It can be seen that petrol cars in Turkey and Germany tend to have nearly the exact same average weight and CO_2 emission levels, while petrol cars at the EU average are about 70 kg lighter and emit about 5g/km less of CO_2. For diesel cars, the differences are much bigger, with these vehicles weighing about 250kg less on average in Turkey than in Germany. Similarly, the difference in CO_2 emissions between average diesel cars in Turkey and Germany is around 15g/km. It is remarkable to see that, despite their absolute differences, the efficiency (in terms of fuel consumption/CO_2 emission level per kg of vehicle weight) of the average vehicle fleets is about the same in all three markets.

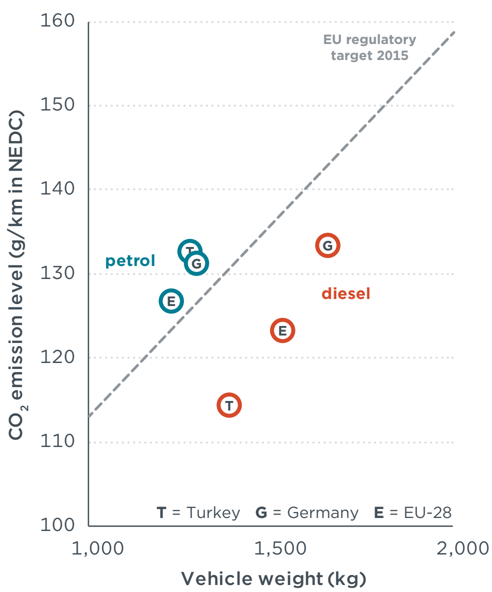


Figure 38. Average CO_2 emission level of new registration passenger car registrations (2014), all vehicles by fuel type and vehicle weight. *Data source: (ICCT, 2015a).*

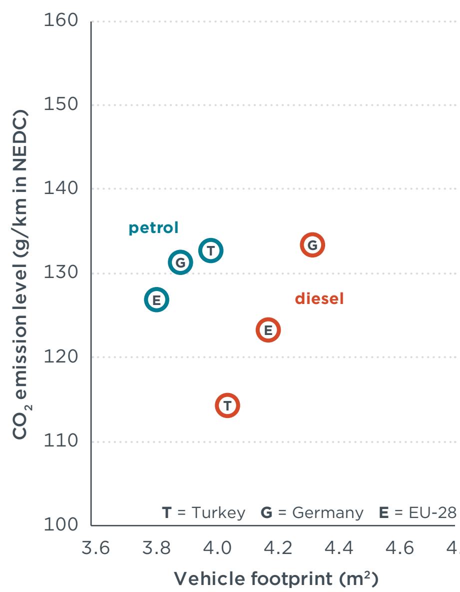


Figure 39. Average CO_2 emission level of new registration passenger car registrations (2014), all vehicles by fuel type and vehicle size. *Data source: (ICCT, 2015a).*

A similar conclusion can be drawn from Figure 39, looking at vehicle size instead of weight. While petrol cars in all three markets, on average, tend to have a similar size and CO_2 emission, diesel cars in Turkey on average are significantly smaller than in Germany and for the EU average. CO_2 emissions of petrol cars are also lower in Turkey, but taking into account their size, the efficiency in terms of fuel consumption/CO_2 per m^2 is similar to that in the EU and Germany.

Figure 40 and Figure 41 provide a further break down into individual vehicle segments. For most of the vehicle segments, the average weight, size, and also CO_2 emission levels are very similar for all three markets. The only exception is the SUV segment, where vehicles in Germany tend to be significantly heavier and larger and emitting higher CO_2 emission levels than in Turkey and the EU average. Again, this is an indication that the efficiency of new cars in all markets is similar and that the resulting lower overall CO_2 emission level in Turkey is mostly due to differences in the fleet mix, i.e. more vehicles from the smaller segments being sold in Turkey.

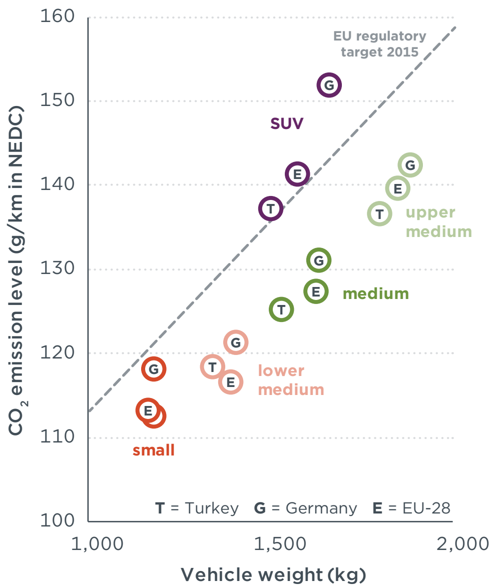


Figure 40. Average CO_2 emission level of new registration passenger car registrations (2014), all vehicles by vehicle segment and weight. *Data source: (ICCT, 2015a).*

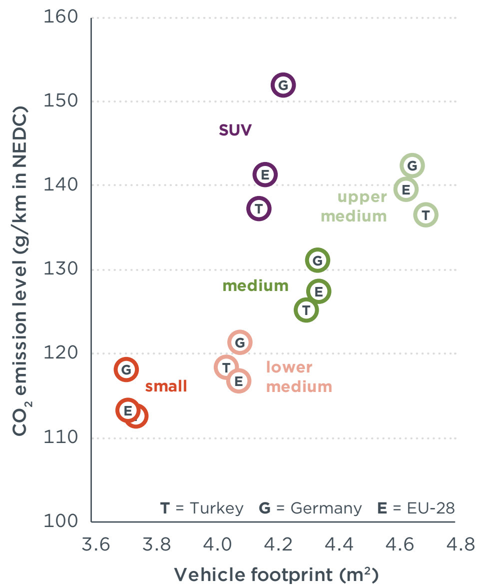


Figure 41. Average CO_2 emission level of new registration passenger car registrations (2014), all vehicles by vehicle segment and size. *Data source: (ICCT, 2015a).*

In Figure 42 and Figure 43 the relationship of vehicle weight, size, and CO_2 emissions is shown for some selected vehicle manufacturers. For most manufacturers, new passenger cars in Turkey tend to be lighter and emit less CO_2 than in Germany and the EU average. Exceptions are Fiat and also Renault. In particular for Fiat it is remarkable that new cars in Turkey, on average, are significantly heavier than for the EU and also for Germany. Similarly, the average size of Fiat cars in Turkey is higher than for the EU, even though still smaller than for Germany. This is most likely a result of the Renault Fluence and Fiat Linea models, both having a relatively large footprint and not being available for sale in Germany and the EU but among the most popular vehicle models in Turkey.

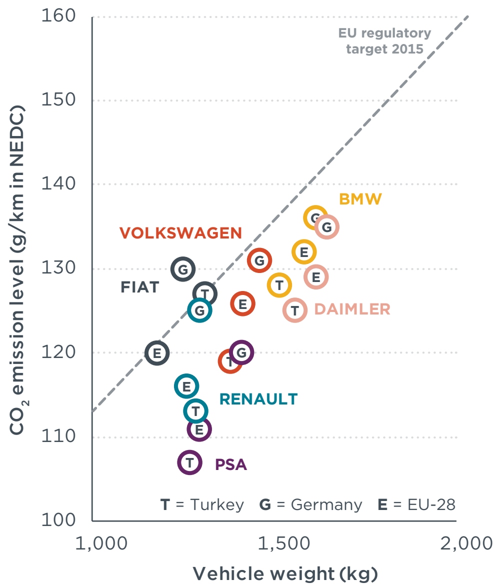


Figure 42. Average CO_2 emission level of new registration passenger car registrations (2014), all vehicles by manufacturer and vehicle weight. *Data source: (ICCT, 2015a).*

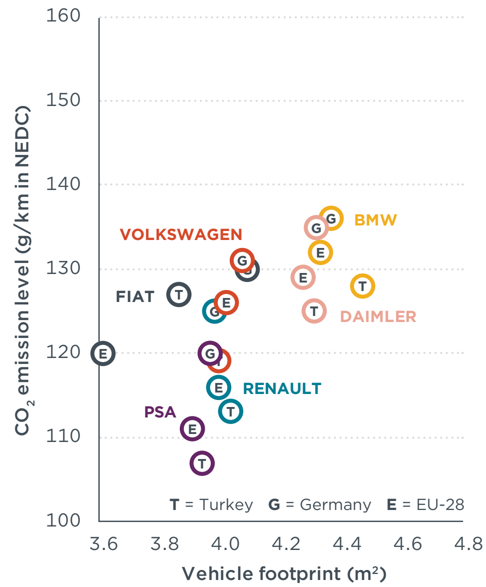


Figure 43. Average CO_2 emission level of new registration passenger car registrations (2014), all vehicles by manufacturer and vehicle size. *Data source: (ICCT, 2015a).*

3.2 INDIVIDUAL PASSENGER CAR MODELS

The following figures (Figure 44 to Figure 48) highlight the similarities and differences between the German and Turkish new car market by focusing on selected individual vehicle models. For each of the vehicle models, the available variants are plotted according to their weight or size and their respective CO_2 emission level. The size of the rings indicated the number of new registrations, i.e. the larger a ring, the more vehicles of that particular model version were registered in 2014.

For the small vehicle segment, the Renault Clio was chosen for the comparison, as it is the top-selling model (24% share of all small cars) in that segment in Turkey. In Germany, the Renault Clio is not among the top three small cars but is available and fairly popular (about 25,000 units sold per year). It can be seen that the top-selling version of the Renault Clio in Turkey is equipped with a 1.5l, 55 kW diesel engine meeting the Euro 5 emissions standard and emitting 95g/km of CO_2 according to NEDC (Figure 44 and Figure 45). This top-selling vehicle version has a weight of 1,200 kg and a footprint of 3.9 m². While the same version of the Renault Clio is also available for sale in Germany, in 2014 it was significantly less popular than in Turkey. Instead, the top-selling Renault Clio version in Germany in 2014 was equipped with a 1.2l, 54 kW petrol engine, meeting the Euro 5 standard and emitting 127g/km of CO_2. This vehicle version has the same footprint as the top-selling Turkish vehicle but is 100 kg lighter.

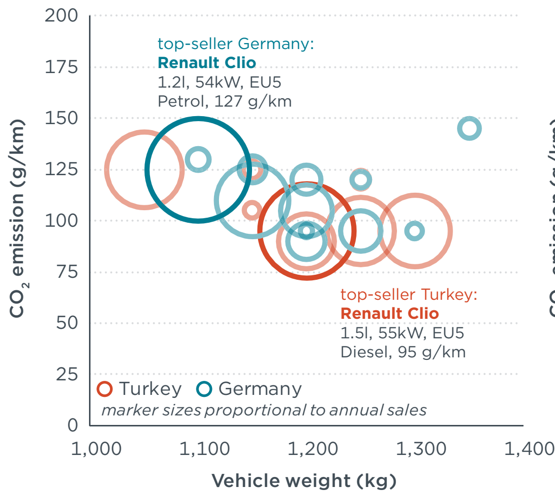


Figure 44. New registrations Renault Clio (2014), by vehicle weight.[12] *Data source: (ICCT, 2015a).*

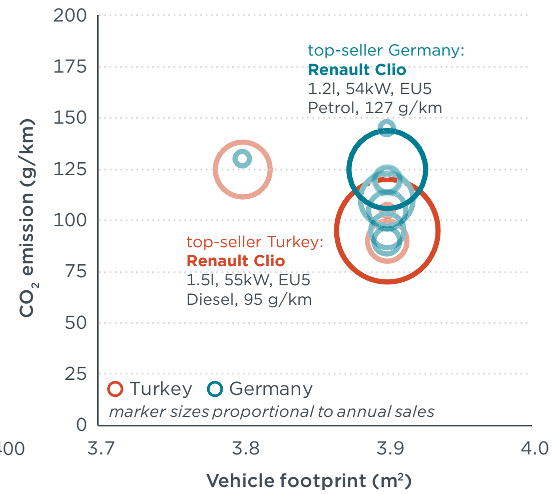


Figure 45. New registrations Renault Clio (2014), by vehicle footprint. *Data source: (ICCT, 2015a).*

For the lower medium size segment, the Renault Fluence was selected for comparison. Again, it comprises the top-selling model in Turkey in this segment (10% of all lower medium cars). In Germany, the Renault Fluence is not available for sale. Instead, the Renault Mégane was selected for comparison, as the Fluence and Mégane share the same vehicle platform and have very similar technical characteristics.

In the case of the Fluence/Mégane, the top-selling model version is the same in both markets, equipped with a 1.5l, 81 kW diesel engine meeting the Euro 5 standard (Figure 46 and Figure 47). Both model versions also have the same footprint (4.2 m^2). At the same time the model version sold in Turkey is 100 kg lighter than in Germany and yet it emits more CO_2 – 114g/km instead of 90g/km. The difference is due to the fact that the top-selling model version in Germany is equipped with start-stop technology. This technology helps to reduce CO_2 emissions in the NEDC test procedure and therefore explains how the 90g/km CO_2 emission value could be reached. In Turkey, the Fluence is not available with the start-stop technology, i.e. the model version with 90g/km cannot be purchased by consumers in Turkey. On the other hand, the 114g/km version, the top-seller in Turkey, is available for sale in Germany but is not very popular among consumers.

12 Defined as mass in running order. The size of the rings provides an indication of the number of new vehicle registrations.

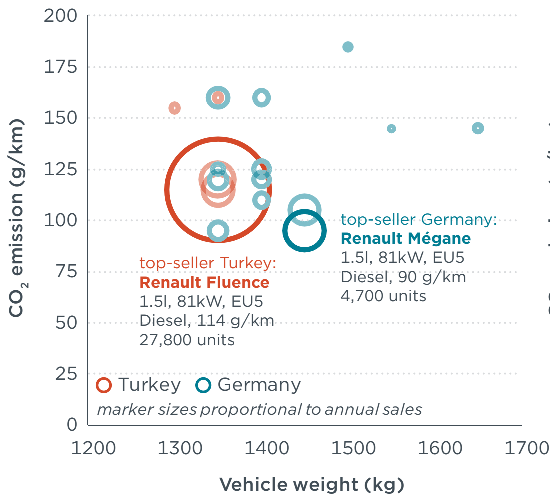


Figure 46. New registrations Renault Fluence/ Mégane (2014), by vehicle weight. *Data source: (ICCT, 2015a).*

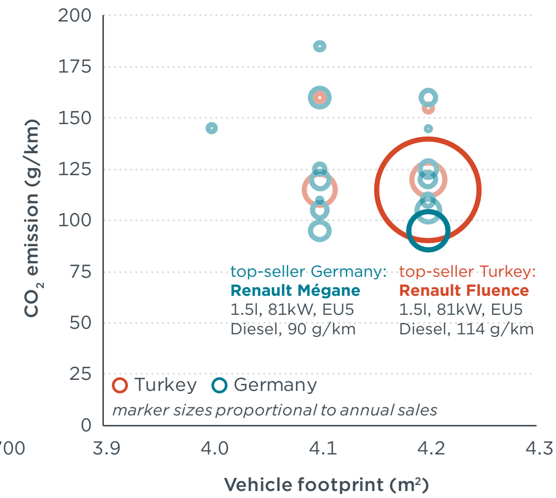


Figure 47. New registrations Renault Fluence/ Mégane (2014), by vehicle footprint. *Data source: (ICCT, 2015a).*

For the medium size vehicle segment, the VW Passat is the top-selling model in Turkey and Germany (34% / 20% of all medium size vehicles being a Passat). The top-selling Passat version in Turkey in 2014 was equipped with a 1.6l, 77 kW diesel engine meeting the Euro 5 standard and emitting 120g/km of CO_2 on NEDC (Figure 47 and Figure 48). In Germany, the top-selling version had a larger engine size (2.0l) and more power (103 kW) and was about 50 kg lighter than in Turkey. The CO_2 emission level for both model variants is nearly the same (119g/km vs. 120g/km). The 77 kW version, being the most popular in Turkey, was also available in Germany at that time and was second in terms of sales. The 103 kW version was available in Turkey but with a much higher CO_2 emission figure (135g/km) and significantly fewer sales than in Germany. The difference in CO_2 emission levels is most likely due to the fact that the vehicles sold in Germany were/are equipped with the Volkswagen BlueMotion technology package,[13] while in Turkey this does not seem to be the case.

13 According to Volkswagen, the BlueMotion technology package includes a "range of innovative energy saving technologies, such as brake energy recuperation, start-stop, low rolling resistance tyres, aerodynamic improvements." For details, see http://www.volkswagen.co.uk/technology/bluemotion-technologies.

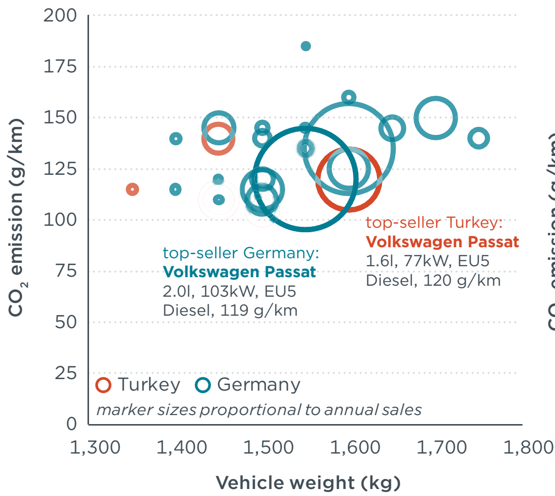


Figure 48. New registrations VW Passat (2014), by vehicle weight. *Data source: (ICCT, 2015a).*

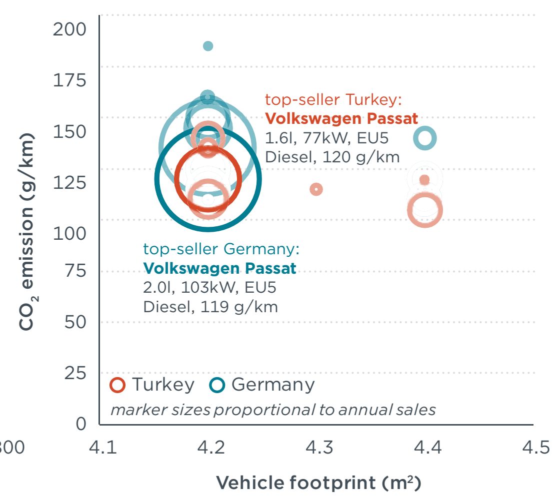


Figure 49. New registrations VW Passat (2014), by vehicle footprint. *Data source: (ICCT, 2015a).*

As a result of the model-level comparison, it can be concluded that at least in the case of the Renault Fluence/Mégane and the VW Passat, the efficiency of the vehicle models sold in Turkey–according to the official NEDC test procedure–seems to be somewhat lower than for the same models available on the market in Germany. In the case of the Fluence/Mégane, the CO_2 emission levels of the top-selling version in Turkey are higher than in Germany, despite the engine characteristics being the same. This is likely due to the absence of the start-stop technology on the Turkish market version. In the case of the VW Passat, the observed CO_2 emission level for the top-selling version is the same, but the Turkish market version is equipped with a lower power and smaller engine. In the case of the Renault Clio this difference could not be observed. Here the same model version is available in both markets, i.e. applying the same level of technologies, and the difference in CO_2 emission levels resulting from the fact that Turkish customers opt for a diesel model version while in Germany a petrol vehicle version is most popular.

3.3 PASSENGER CAR FLEET DISTRIBUTION AND INTERNATIONAL COMPARISON

Figure 50 plots the CO_2 emission levels of new passenger cars in Turkey, Germany, and the EU-28 aggregated to bins of 8g/km CO_2. It can be seen that the principal structure of the market in terms of CO_2 emissions is the same in all three. For Turkey and also the EU-28 average, a slightly stronger shift towards lower CO_2 emission vehicles is observed, while the distribution curve for Germany is more tilted towards the higher-CO_2 emission side. This is reflected in the overall average CO_2 emission levels, which in 2014 were 121g/km for Turkey, 123g/km for the EU-28, and 132g/km for Germany.

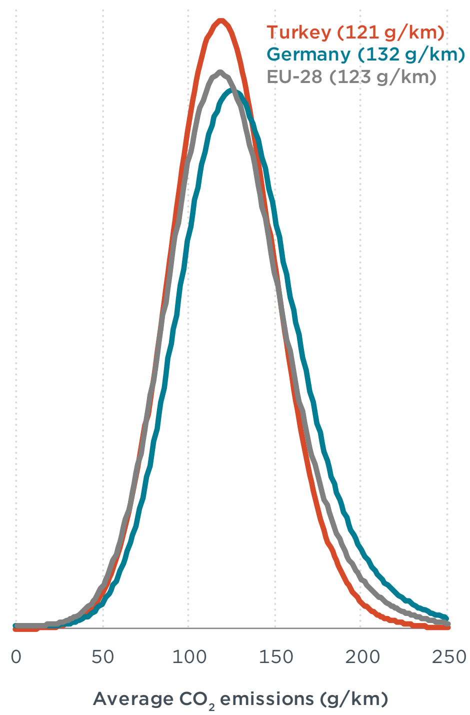


Figure 50. Average CO_2 emissions level of new registrations passenger cars (2014) by CO_2 emission bins, estimated probability density function. *Data source: (ICCT, 2015a).*

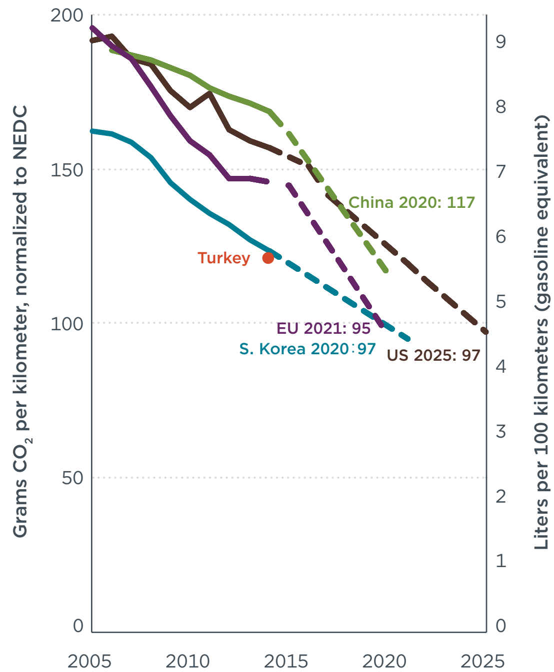


Figure 51. Average new passenger car CO_2 emission levels for selected countries/regions, normalized to NEDC. *Data source: (ICCT, 2015b).*

Internationally, nearly all key automotive markets worldwide have implemented mandatory CO_2 emission standards for new passenger cars as of 2015. A comprehensive overview chart is available online (ICCT, 2015b). Figure 51, for better clarity, depicts only four of these markets: the EU, United States, China, and South Korea. The historic development is shown with solid lines, and target values that were adopted for future years are indicated by dotted lines. The EU's target of 95g/km for 2021 is currently the most stringent one–if based on the official NEDC laboratory test procedure–while the U.S. target of 97g/km for passenger cars for 2025 is the most forward-reaching one. Furthermore, it can be seen that the expected annual CO_2 emission reduction rates are higher in the United States and in particular in China and South Korea when compared to the EU target corridor. When including the market average for new cars in Turkey in 2014, it is very close to the EU's average line. Turkey currently has not imposed a mandatory CO_2 emission target for future years.

3.4 LIGHT COMMERCIAL FLEET AVERAGES

The following figures plot the CO_2 emission levels of new light commercial vehicles in Turkey in comparison to their vehicle weight. Unlike for passenger cars, data on vehicle footprint is not consistently available for all light commercial vehicles, which is why an analysis by vehicle footprint is omitted for this report.

Overall, it can be seen that light commercial vehicles in Turkey emit less CO_2 (157g/km) than in Germany (191g/km) and the EU-28 average (171g/km) (Figure 52). However, all three points lie almost exactly on the 2017 weight-based CO_2 target line for light commercial vehicles in the EU. This shows that new vehicles in all three markets already in 2014 met the upcoming 2017 EU target values. For Turkey, this assessment is purely hypothetical though, as the country has not yet imposed any mandatory CO_2 regulation for new vehicles. It can furthermore be concluded that the efficiency of new light commercial vehicles, in terms of CO_2 by vehicle weight, is very similar in all three markets and that Turkey's lower CO_2 emission level is the result of a lighter/smaller vehicle mix rather than these vehicles being technologically more advanced. This assumption is confirmed by looking at the same data, this time differentiated by light commercial vehicle sub-segment, to reinforce this conclusion. Within each of the sub-segments, the average weight and CO_2 emission levels are nearly identical in all three markets (Figure 53). Hence, the overall lower CO_2 emission level for Turkey is a result of customers opting more for vehicles from one of the lighter N1 sub-segments.

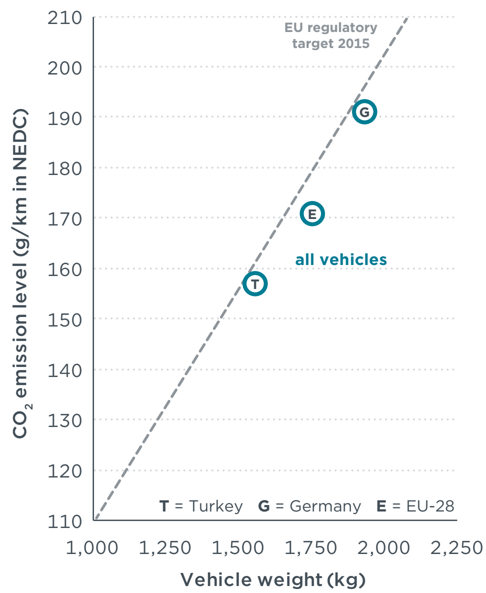


Figure 52. Average CO_2 emission level of new light commercial vehicle registrations (2014), all vehicles by weight. *Data source: (ICCT, 2015a).*

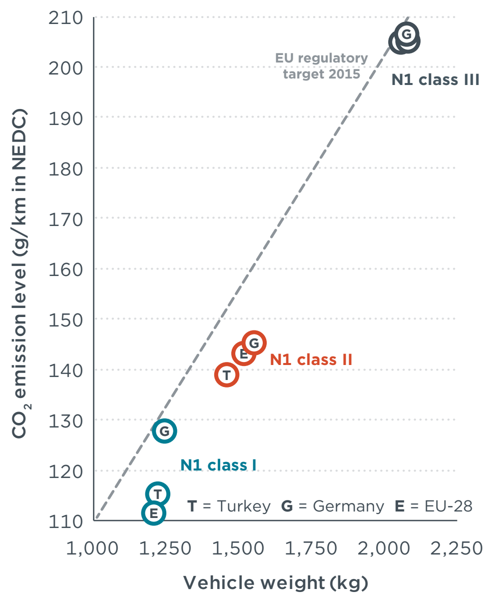


Figure 53. Average CO_2 emissions level of new light commercial vehicle registrations (2014) by vehicle segment and weight. *Data source: (ICCT, 2015a).*

From a vehicle manufacturers' point of view, significant differences among vehicle markets can be observed. For example, while new light commercial vehicles sold by Ford in Turkey on average weigh less than 1,500 kg and emit less than 130g/km, in Germany the Ford light commercial vehicles on average weigh more than 2,000 kg and emit more than 180g/km (Figure 54). This is most likely a result of smaller vehicles, such as the Ford Tourneo Courier, being most popular in the Turkish light commercial vehicle market, while in Germany Ford sales are dominated by the significantly heavier Ford Transit vehicle. Nevertheless, the CO_2 by weight ratio is again about the same for all vehicle manufacturers in all three markets, indicating that the efficiency of the vehicles is comparable in Turkey, Germany, and for the EU average.

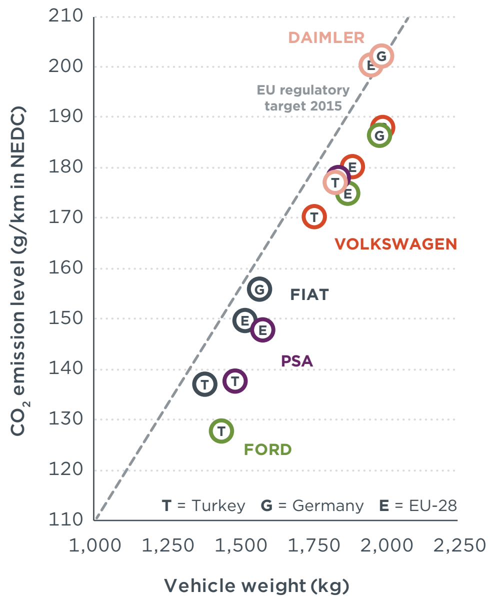


Figure 54. Average CO_2 emission level of new light commercial vehicle registrations (2014), all vehicles by manufacturer and weight. *Data source: (ICCT, 2015a).*

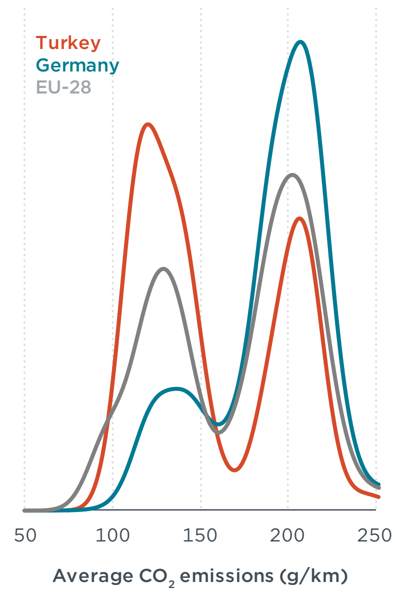


Figure 55. Average CO_2 emissions level of new registrations light commercial vehicles (2014) by CO_2 emission bins, estimated probability density function. *Data source: (ICCT, 2015a).*

Plotting the CO_2 emissions level distribution reveals a striking difference between the light commercial vehicle market in Germany vs. Turkey and the EU average. While in Turkey, and also for the EU average, about half of the vehicles cluster around a CO_2 emission value of 125g/km and the other half around 200g/km; in Germany the lower-CO_2 emission light commercial vehicles account for a much lower fraction of the market (Figure 55).

3.5 LIGHT COMMERCIAL VEHICLE FLEET DISTRIBUTION AND INTERNATIONAL COMPARISON

In recent years more and more countries have introduced mandatory CO_2 standards for new light commercial vehicles. In the EU, for the first time a mandatory standard came into place in 2011, setting a target of 175g/km for 2017 and 147g/km for 2020. The United States currently has the furthest reaching target, equivalent to a value of around 141g/km (normalized to NEDC) for 2025. China and South Korea have set target values for 2020 that are in between the EU and U.S. targets. Including Turkey in this international picture shows how the Turkish light commercial vehicle market on average has a slightly lower CO_2 emission level than for the EU average (Figure 56).

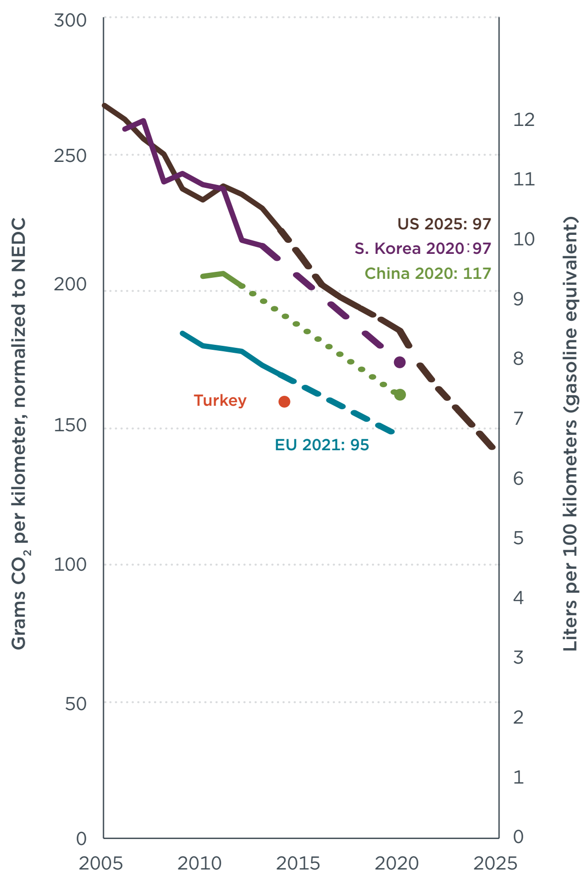


Figure 56. Average new light commercial vehicle CO_2 emission levels for selected countries/regions, normalized to NEDC. *Data source: (ICCT, 2015b).*

3.6 OVERALL OIL CONSUMPTION

The total oil demand in Turkey is estimated to be 670,000 barrels per day (IEA, 2013). Nearly all of this oil is imported, with Iran, Saudi Arabia, and Russia being the main sources (Figure 57). Germany is similarly dependent on oil imports: of the more than 2 million barrels consumed every day, around 40% is imported from Russia (Figure 59).

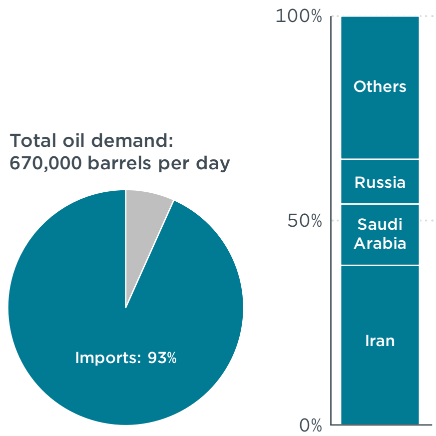


Figure 57. Total oil demand in Turkey (2012), also by import origin. *Data source: (IEA, 2013)*.

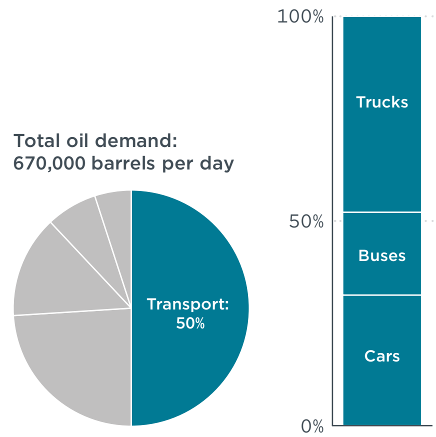


Figure 58. Total oil demand in Turkey by sectors (2012) and by vehicle type for the transport sector. *Data source: (IEA, 2013), own estimates based on (ICCT, 2015c)*.

In both countries, transport accounts for about half of the total oil consumption.[14] In Turkey, currently cars make up around one-third of transport oil consumption, while trucks and buses account for the remaining part (Figure 58). In Germany on the other hand, cars consume more than two-thirds of the oil used in the transport sector (Figure 60).

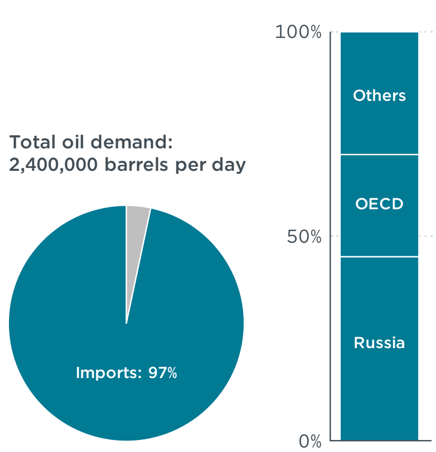


Figure 59. Total oil demand in Germany (2011), also by import origin. *Data source: (IEA, 2013)*.

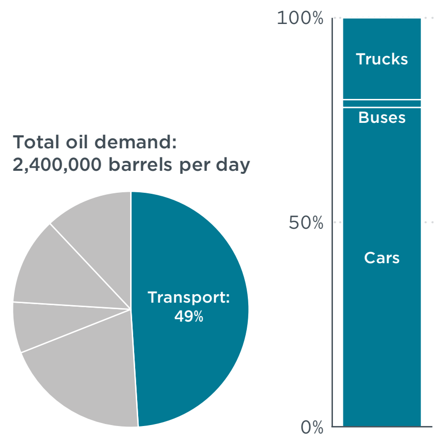


Figure 60. Total oil demand in Germany (2011) by sectors and by vehicle type for the transport sector. *Data source: (IEA, 2012), own estimates based on (ICCT, 2015c)*.

As part of the analysis in this report, a business-as-usual scenario for future vehicle emissions, as well as fuel/oil consumption, in Turkey and Germany was developed.

14 According to the International Energy Agency (IEA), other key oil consuming sectors include industry, residential, transformation/energy, and commercial/agriculture.

It is important to emphasize that the objective of this modeling exercise is not to produce a highly accurate reflection of the current emission situation in both countries and future developments. Instead, the modeling results are intended to allow for approximate estimates and for highlighting similarities and differences between both markets today and in future years.

For the modeling, the ICCT Global Transportation Roadmap Model was applied. The model is publicly available, and a detailed description of it can be found online (ICCT, 2015c). The standard version of the model does not include specific scenarios for Germany and Turkey but instead calculates emissions and fuel/oil consumption at a higher aggregate level for the EU-28 and the Middle East. Within the scope of this report, the model was adapted to include specifically Turkey and Germany as sub-regions, and the model was re-run with the input data collected for these two markets.

Table 4 summarizes the key input data used for modeling the German market. For passenger cars, data on annual vehicle kilometers travelled for the year 2010 was obtained from the same source that is also the basis for the transport emission modeling of the German government (DIW, 2012). For future years, an annual growth rate of 0.5% was assumed to ensure that the resulting annual vehicle kilometers travelled in 2030 are in line with the most recent traffic prognosis of the German government (BMVI, 2014).

For the average CO_2 emission level of new passenger cars, the 2010 and 2014 (as a proxy for 2015) type-approval figures were used (ICCT, 2015a). For future years, it was assumed that the new car fleet in Germany would reduce CO_2 emissions down to 105g/km, which is 10% higher than the EU-wide target value for 2021 given that vehicles in Germany tend to be larger and heavier than for the EU average. For the years beyond 2020, in the baseline scenario an annual CO_2 reduction of 1% was assumed in order to reflect expected improvements in the absence of further regulation. Taking into account recent analyses regarding the discrepancy between type-approval and real-world CO_2 emissions data, an adjustment factor of 30% for 2010 and 40% for future years was furthermore taken into account (Tietge et al., 2015). In the baseline scenario, no strong uptake of electric vehicles was assumed.

For buses and trucks, a simplified modeling approach was pursued, not differentiating between different types of buses or trucks but rather aggregating small, medium, and large size vehicles. Estimates for 2010 vehicle kilometers travelled were obtained from the same source as for passenger cars, and future growth rates were again derived by adjusting to the most recent traffic prognosis for 2025 (DIW, 2012) (BMVI, 2014). The average energy consumption was estimated to be 6.7 MJ/km for buses and 4.6 MJ/km for trucks, being in line with standard input data of the Global Transportation Roadmap Model.

Table 4. Key input parameters used for modeling: Germany

	2010	2015	2020	2025	2030
Passenger cars					
Vehicle kilometers travelled (billion km/a)	599	Annualized growth rate: 0.5%			
New vehicle average emission level (gCO_2/km)	153	132	105	Annual reduction: 1.0%	
"Real-world" CO_2 adjustment factor	+30%	+40%			
Buses					
Vehicle kilometers travelled (billion km/a)	3	Annualized growth rate: no growth			
New vehicle average energy consumption (MJ/km)	6.7				
Trucks (light, medium and heavy)					
Vehicle kilometers travelled (billion km/a)	83	Annualized growth rate: 2.0%			
New vehicle average emission level (MJ/km)	4.6				

For Turkey, annual vehicle kilometers travelled were estimated bottom-up by multiplying the total number of vehicles with an estimation of the annual driving distance per vehicle (Table 5). This approach was necessary as top-down data on annual vehicle kilometers travelled was not available. For Turkish roads under supervision of the General Directorate of Highways, data is readily available but not for all roads/vehicles in the country (KGM, 2010).

For passenger cars, 2010 vehicle stock data (TUIK, 2014) was multiplied with an assumed average annual driving distance of 10,000 km.[15] Furthermore, an annualized growth rate of 4.0% was assumed. Due to a lack of publicly available data, these values provide a best-guess estimate of the situation in Turkey and are expected to be reasonably accurate for an estimation of overall emission level trends. In previous years, the average growth rate in terms of vehicle stock was about 7.7% per year (Figure 5).

For the new car average CO_2 emission level, the 2010 value was estimated based on literature data while the 2014 value is known from the author's own calculations and was applied for 2015 (Körner et al., 2014) (ICCT, 2015a). For future years, in the baseline scenario a 1% per year CO_2 reduction was assumed. This is despite the fact that Turkey currently does not have a CO_2 regulation for new vehicles in place. However, at the same time fuel tax levels are high in Turkey in comparison to other markets worldwide, thereby implicitly providing an incentive for vehicles with low fuel consumption/CO_2 rates. It was furthermore estimated that the gap between official and real-world CO_2 emission levels is smaller in Turkey than in Germany, growing from around 15% in 2010 to 20% thereafter.[16] No uptake of electrified vehicles was assumed in the baseline scenario.

For buses and trucks, total vehicle stock data for Turkey for 2010 (TUIK, 2015) was multiplied by an assumed annual driving distance of 30,000 km for buses and 15,000 km for trucks. In absence of data sources, average energy consumption figures were assumed to be 4.6 MJ/km for trucks (i.e. the same as for Germany) and 6.0 MJ/km for

15 (Özdemir and Tosun, 2015) estimate the annual driving distance for passenger cars in Turkey to be between 8,000-13,000 km. Based on personal communication (Jan 19, 2016) with a representative of the Turkish automotive industry, the average annual driving distance for new car owners in Turkey is around 17,000 km, with lower estimates for the vehicle stock.

16 The estimate is based on a preliminary analysis of about 600 vehicles for which on-road fuel consumption figures are available on the website http://arabamkacyakar.com.

buses (10% lower than for Germany due to a high number of minibuses in Turkey), with no improvement over time in the baseline scenario.

Table 5. Key input parameters used for modeling: Turkey.

	2010	2015	2020	2025	2030
Passenger cars					
Vehicle kilometers travelled (billion km/a)	75	Annualized growth rate: 4.0%			
New vehicle average emission level (gCO_2/km)	145	120	Annual reduction rate: 1.0%		
"Real-world" CO_2 adjustment factor	+15%	+20%			
Buses					
Vehicle kilometers travelled (billion km/a)	18	Annualized growth rate: 4.0%			
New vehicle average energy consumption (MJ/km)	6.0				
Trucks (light, medium and heavy)					
Vehicle kilometers travelled (billion km/a)	47	Annualized growth rate: 4.0%			
New vehicle average emission level (MJ/km)	4.6				

Figure 61 and Figure 62 show the baseline scenario modeling results in terms of fuel consumption (expressed in barrels oil equivalent per day). For Germany, it is expected that overall fuel consumption levels will decrease by about 10% until 2030 to roughly 0.9 million barrels of oil equivalent per day. What is remarkable though is the changing consumption patterns for petrol and diesel vehicles. While the diesel fuel consumption sharply increases, from about 450,000 to 600,000 barrels per day, the petrol fuel consumption decreases from about 600,000 to 350,000 barrels per day. This is despite the fact that in the baseline scenario no fuel shift was assumed, *i.e.* in 2030 diesel cars still account for the same market share than in 2010. Instead, the observed increase in diesel fuel consumption is mostly a result of the expected growth in the number of trucks on the road in Germany.

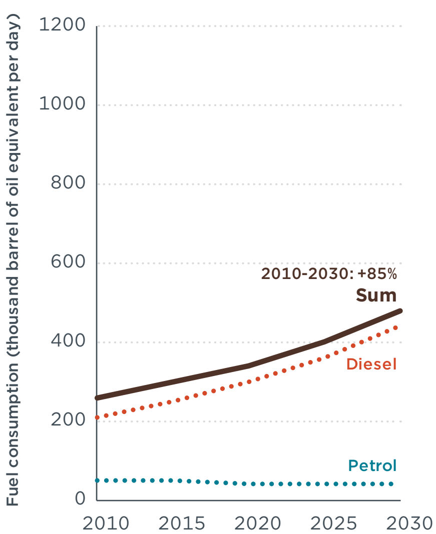


Figure 61. Estimated total road transport fuel demand in Turkey (2010-2030) in a business-as-usual scenario.

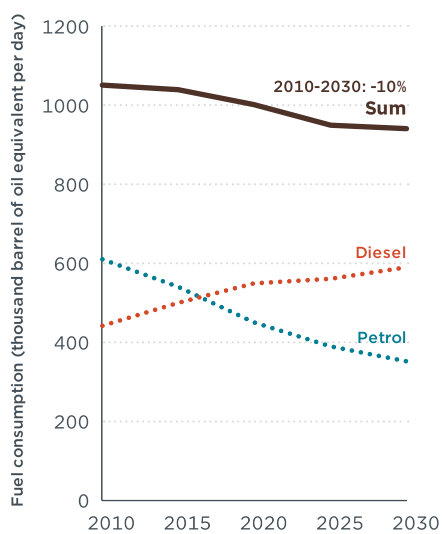


Figure 62. Estimated total fuel road transport demand in Germany (2010-2030) in a business-as-usual scenario.

Similarly, in the business-as-usual scenario for Turkey, diesel fuel consumption is strongly increasing, due to the expected growth in truck and bus traffic, as well as in part due to the fact that about 60% of new cars in Turkey are running on diesel and that for these vehicles also a growth of the fleet is expected for future years. Overall, fuel consumption from the road transport sector in the baseline scenario is estimated to almost double in Turkey in the 2010-2030 time period. Given that virtually all oil consumed in Turkey is imported, this would imply also a doubling in crude oil imports in the next 20 years.

3.7 OVERALL CO_2 EMISSIONS

The transport sector accounts for about 15% of greenhouse gas (GHG) emissions, both in Turkey and Germany, with CO_2 being the highest contributing emissions category. Within the transport sector, more than half of the CO_2 emissions in Turkey come from heavy-duty vehicles, while in Germany it is currently passenger cars that account for the majority of emissions (Figure 63 and Figure 64).

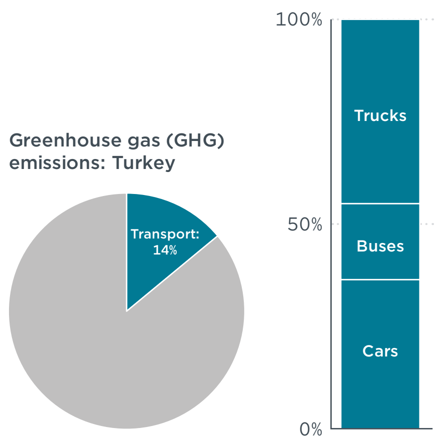


Figure 63. Greenhouse gas emissions in Turkey (2012), also by vehicle type. *Data source: (UNFCCC, 2013a), own estimates based on (ICCT, 2015c).*

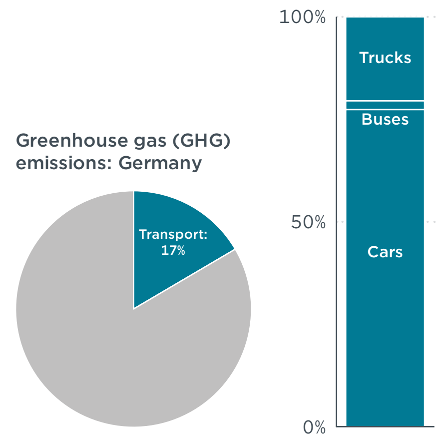


Figure 64. Greenhouse gas emissions in Germany (2012), also by vehicle type. *Data source: (UNFCCC, 2013b), own estimates based on (ICCT, 2015c).*

Applying the input parameters described above and focusing on CO_2 emissions only, it can be seen how in a business-as-usual scenario that emissions in Turkey would increase from about 40 million metric tons (Mt) in 2010 to 79Mt in 2030 (Figure 65). The 2010 starting point value of 40Mt is very much in line with the respective estimate submitted as part of the national GHG inventory report for Turkey (TUIK, 2013). It should be noted that all figures are tank-to-wheel CO_2 emissions only, i.e. emissions produced during the combustion process in the vehicle engine, not taking into account upstream emissions from the processing of fuel. For Turkey it is remarkable how the 91% increase between 2010 and 2030 would be due mostly to trucks and buses, while the CO_2 emissions from passenger vehicles would increase to a lesser extent (going from 15 to 22Mt).

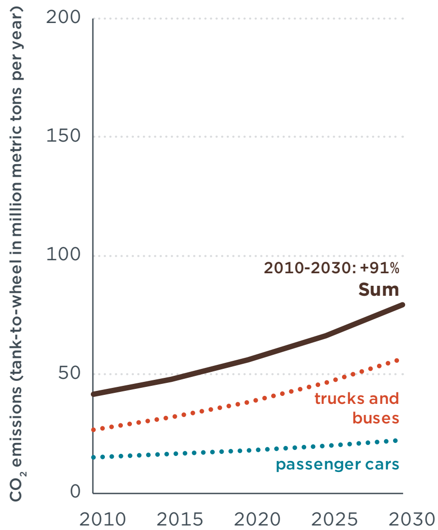


Figure 65. Estimated CO_2 emissions from road transport in Turkey (2010-2030) in a business-as-usual scenario.

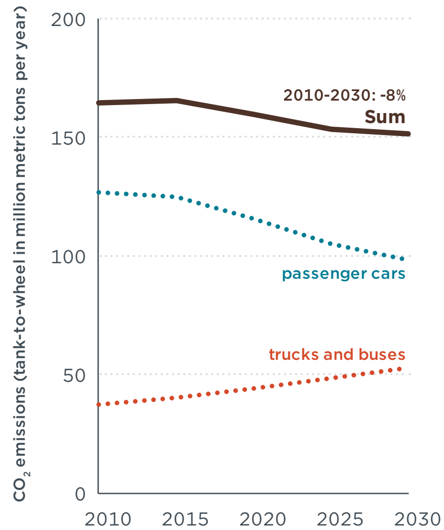


Figure 66. Estimated CO_2 emissions from road transport in Germany (2010-2030) in a business-as-usual scenario.

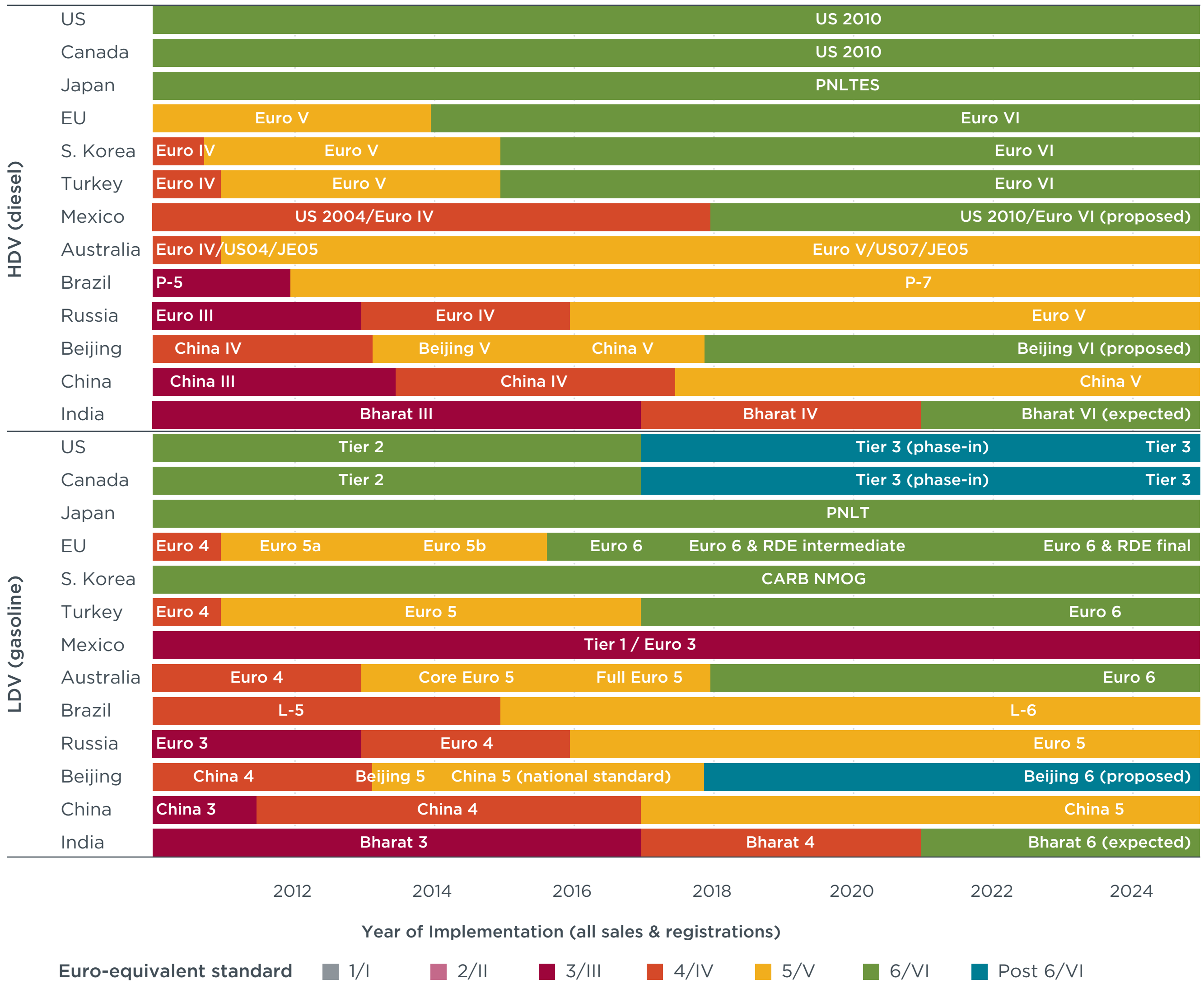
For Germany, the calculations indicate that overall tank-to-wheel CO_2 emission levels would increase from 164Mt in 2010 to 151Mt by 2030, an 8% decrease (Figure 66). The 2010 starting point value is slightly higher than the value from Germany's national inventory report (about 154Mt for 2010), most likely due to differences in assumptions regarding the historic vehicle stock (UBA, 2013). Similar to the situation in Turkey, a strong increase in CO_2 emissions is expected for the heavy-duty vehicles sector, while in Germany CO_2 emissions from passenger cars, even in the baseline scenario, are expected to decrease from 2015 onwards.

3.8 OVERALL AIR POLLUTANT EMISSIONS

Table 6 provides an overview of the emission standards in place for new vehicle sales in selected automotive markets worldwide. For heavy-duty vehicles, it can be seen that Turkey has followed the EU standards timeline with only a one year delay, i.e. the Euro VI standard, which was implemented in the EU in 2014, has applied for new trucks and buses in Turkey since 2015. For light-duty vehicles, i.e. passenger cars and light commercial vehicles, the latest Euro 6 standard is mandatory for all new registrations in the EU since September 2015 and will become mandatory for all new vehicles in Turkey from 2017 onwards.

As a number of recent studies demonstrate, the emission levels, and particularly the nitrogen oxides (NO_x) emissions of diesel passenger cars, are much higher under real-world driving conditions on the road than during laboratory testing (see for example Franco et al., 2014). For this reason, the EU has decided to amend the Euro 6 regulation by introducing mandatory on-road emissions testing, the so-called Real-Driving Emissions (RDE) testing procedure, from 2017 onwards. This measure has not yet been foreseen in Turkey; however, it should be expected, especially for diesel passenger cars, that a similar problem with respect to real-world emission levels exists (Mock, 2015a), (Mock, 2015b).

Table 6. Overview of adopted light- and heavy-duty vehicle emission standards in selected markets.
Adapted from (Miller and Façanha, 2014) – for additional remarks see original source.



About 45% of overall NO_x emissions in Turkey and 37% in Germany come from the road transport sector. In both countries, trucks are responsible for about half of these emissions, with buses being another important source in Turkey (Figure 67). In Germany, the number of buses on the road is much smaller than in Turkey, with diesel passenger cars being the second largest source of NO_x emissions (Figure 68).

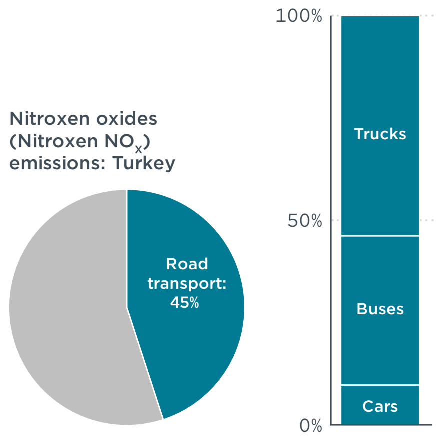


Figure 67. Nitrogen oxides emissions in Turkey (2011), also by vehicle type. *Data sources: (EEA, 2013a), own calculations.*

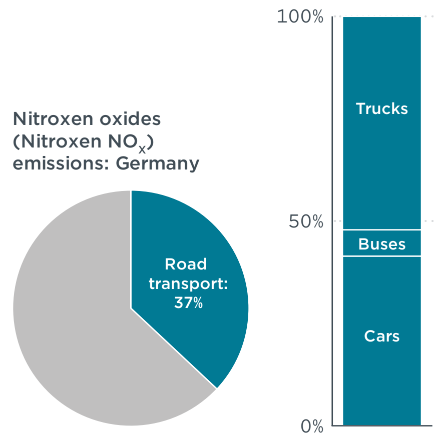


Figure 68. Nitrogen oxides emissions in Germany (2011), also by vehicle type. *Data sources: (EEA, 2013b), own calculations.*

Despite the lower number of vehicles, NO_x emission levels from vehicles in Turkey are only slightly lower in Turkey than in Germany (Figure 69 and Figure 70). Tank-to-wheel NO_x emission levels from heavy-duty vehicles in both markets are expected to decrease from around 300,000 tons in 2010 to around 60,000 / 45,000 tons by 2030. This strong decrease is expected to happen despite an increase in vehicle numbers. It is due to the fact that going from Euro IV and Euro V to Euro VI, average on-road NO_x emission factors are expected to decrease in magnitude (from around 3 to 0.3g/km).[17]

For passenger cars, this is not the case. As a result of the recent VW scandal, the issue of high on-road NO_x emission levels of diesel passenger cars has attracted increased interest. But even before then, emission factors for modeling purposes were adapted to reflect that on-road emission levels generally are not in line with the regulatory limit of 80 mg/km for the Euro 6 standard but in reality can be much higher than that. Hence, the NO_x emission levels from passenger cars in a business-as-usual scenario are not expected to decrease in future years. In order for this to happen, further actions would be required, such as the introduction of on-road testing under a wide range of driving conditions and applying a stringent not-to-exceed factor (ICCT, 2015d).

17 For more details on the on-road emission levels of heavy-duty vehicles, refer to (Muncrief, 2015a).

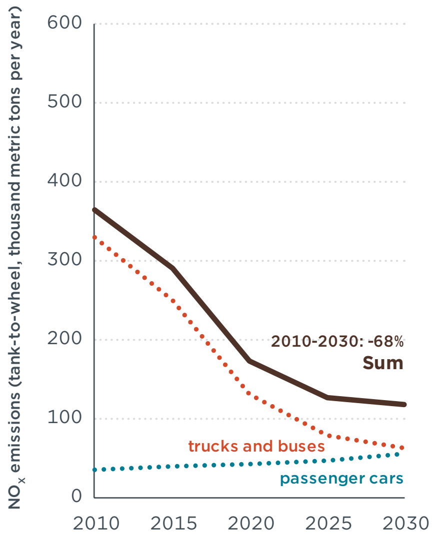


Figure 69. Estimated NO_x emissions from road transport in Turkey (2010-2030) in a business-as-usual scenario.

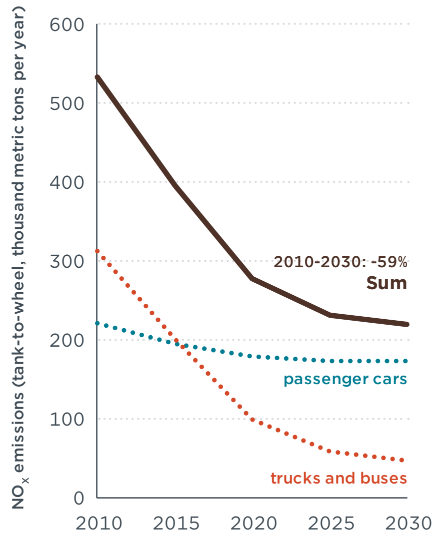


Figure 70. Estimated NO_x emissions from road transport in Germany (2010-2030) in a business-as-usual scenario.

For particulate matter, expressed here as $PM_{2.5}$, in Germany about 21% of overall emissions come from the road transport sector. For Turkey, no such overall statistic is available. It is estimated that in Turkey heavy-duty vehicles account for about two-thirds of particulate matter emissions from road transport, while passenger cars account for the remaining one-third (Figure 71). In Germany, the situation is reversed, with passenger cars accounting for the majority of particulate matter emissions (Figure 72).

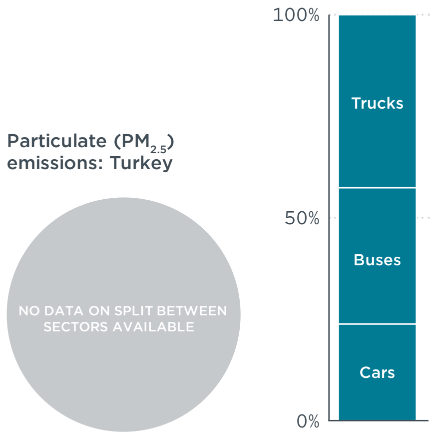


Figure 71. Particulate emissions in Turkey (2011), also by vehicle type. *Data source: own calculations.*

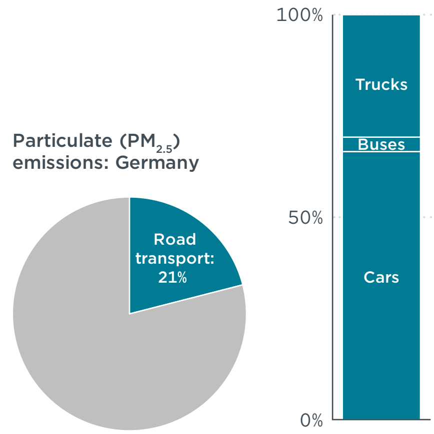


Figure 72. Particulate emissions in Germany (2011), also by vehicle type. *Data sources: (EEA, 2013a), own calculations.*

As a result of the introduction of particulate filters for diesel cars and heavy-duty vehicles as part of the Euro 5/V regulations, particulate matter emissions are expected to strongly decrease in future years both in Turkey and Germany. It should be noted, however, that these expected reductions of overall emission levels are not necessarily observed in hot spots, such as urban city centers, to the same extent both in Turkey and Germany. Furthermore, the success of any vehicle air pollution standard depends very much on the fuel quality. If, for example, minibuses in Turkey were partially fueled using cooking oil, the resulting increase in emissions could counterbalance any emission reductions from other vehicles.

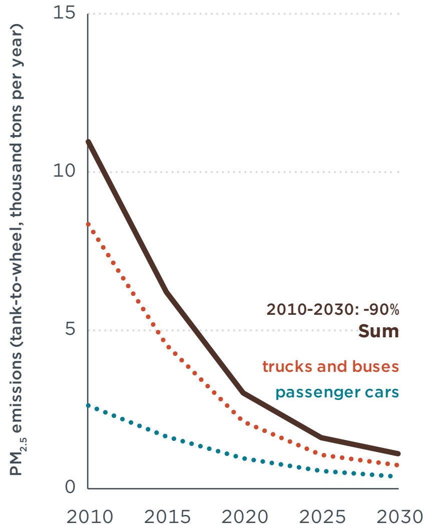


Figure 73. Estimated $PM_{2.5}$ emissions from road transport in Turkey (2010-2030) in a business-as-usual scenario.

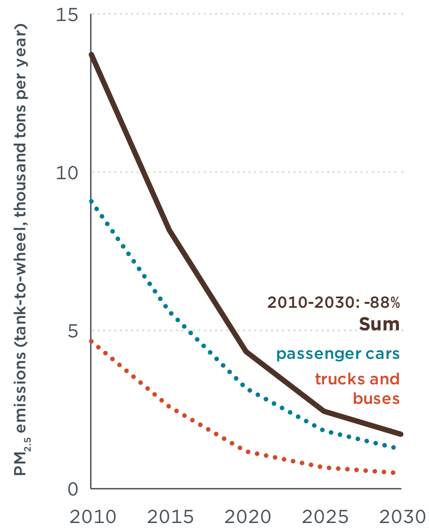


Figure 74. Estimated $PM_{2.5}$ emissions from road transport in Germany (2010-2030) in a business-as-usual scenario.

3.9 INTERIM CONCLUSIONS

» The average fuel consumption and CO_2 emission level of new cars and light commercial vehicles in Turkey is slightly lower than the EU average. At the same time, new vehicles in Turkey tend to have less engine power and are slightly lighter and smaller than the EU average. The energy efficiency of vehicles is about the same for Turkey and the EU-28 average. This is also true when analyzing individual vehicle segments and models. For some vehicle models it was found that the applied level of technology is slightly lower in Turkey than for the German/EU market — for example, stop-start technology not being offered in Turkey.

» Turkey is one of the few key automotive markets worldwide still not having introduced mandatory CO_2 standards for cars and light commercial vehicles. Nonetheless, if the EU targets for 2015 (cars) and 2017 (light commercial vehicles) were applied to the Turkish market, they would have already been met in 2014 or before. This is most likely a result of Turkey indirectly benefiting from the spillover effects of vehicle CO_2 standards in other markets through vehicle imports/exports, as well as the relatively high tax on petrol and diesel fuel in Turkey, which provides an incentive for the purchase of fuel efficient vehicles. As a result, if Turkey were to simply transfer the EU's CO_2 target system, only a limited steering effect is to be expected. There are other regions having adopted more accelerated emission reduction pathways than the EU, thereby potentially offering an alternative approach for a Turkey-specific CO_2 target system.

» In a business-as-usual scenario, fuel consumption of road transport in Turkey is estimated to double by 2030. As Turkey is importing almost all its oil from abroad, this would thereby also implicitly have negative impacts on national energy security. With fuel consumption and CO_2 emissions being directly linked, CO_2 emissions would also roughly double by 2030. The expected increase would be largely caused by heavy-duty vehicles. Even though the number of trucks and buses is relatively small compared to passenger cars, their fuel consumption and CO_2 emissions have a significant effect.

» For air pollutant emissions regulation, Turkey is following the EU's "Euro standard" system. For heavy-duty vehicles, particulate emissions and also nitrogen oxides emissions are expected to significantly decrease in future years as new trucks and buses that fulfill the latest Euro VI emissions standard penetrate the vehicle fleet. For passenger cars, Turkey is introducing the Euro 6 standard from 2016/17 onwards. However, even with Euro 6, real-world nitrogen oxides emissions from diesel cars are expected to remain at high levels. This problem is expected to be even more relevant in Turkey than in the EU, given the particularly high share of diesel cars in Turkey. In order to ensure a significant reduction of nitrogen oxide levels under real-world driving conditions, Turkey will need to take further action, such as implementing systematic on-road testing and stringent not-to-exceed limits for real-world emissions. Furthermore, an increased uptake of electrified vehicles would be beneficial not least from an air pollution point of view and particularly for urban hot spots, such as Istanbul and Ankara.

4 CONCLUSIONS AND OUTLOOK

Despite similar population sizes, new vehicle sales in Turkey are only about one-third of that in Germany; however, for Turkey strong growth is expected in future years. In both countries there is a large number of vehicle manufacturing plants, with a majority of the local vehicle production being exported abroad. As a result of this strong dependence of the Turkish and the German economy on the automotive industry, it is of particular importance for both countries to ensure that this industry sector is ready to meet current and future challenges, such as local air pollution, climate change, and energy security, by offering innovative vehicles that can compete on the global market.

Modeling a business-as-usual scenario for Turkey, it was found that CO_2 emissions from road transport would approximately double by 2030. As CO_2 emissions and fuel consumption are directly linked to each other, this would also mean doubling oil consumption and imports over the next years. With respect to air pollutant emissions, it is expected that in a baseline scenario NO_x emissions from passenger cars would not decrease or even slightly increase in future years, despite the introduction of the latest Euro 6 standard in Turkey in 2016/17. Furthermore, in a business-as-usual scenario, a strong uptake of electrified vehicles is not expected for the Turkish automotive market.

It is not within the scope of this report to analyze and discuss potential policy measures directed to address the challenges mentioned above in more detail. Nevertheless, the findings of this baseline analysis of the Turkish automotive sector allow for some conclusions regarding what policy measures seem promising specifically for the market situation in Turkey and, hence, should be assessed in more detail as part of future research.

Passenger cars and light commercial vehicles account for three-quarters of the vehicle fleet in Turkey. Any effort to reduce fuel consumption and emissions thereby needs to address these two vehicle categories. As part of the analysis within this report, it was found that the level of efficiency for new cars and light commercial vehicles is similar to the efficiency of comparable vehicles in Germany and the EU. In some instances it was found that the level of technologies applied to vehicles in Turkey is slightly lower than in Germany and the EU.

Turkey is one of the few key automotive markets worldwide still not having introduced mandatory CO_2 standards for cars and light commercial vehicles. At the same time, the country appears to indirectly benefit from the spillover effects of vehicle CO_2 standards in the EU and other markets: from the import of lower CO_2 emission vehicles into Turkey from the EU and other markets with high regulations as well as the production of lower CO_2 emission vehicles for export to other markets outside of Turkey. In addition, Turkey imposes relatively high taxes on petrol and diesel fuel as well as the purchase of new vehicles, albeit based on the engine displacement of a vehicle. As a result, if the EU CO_2 targets for new vehicles would simply be transferred to the market situation in Turkey, only a limited steering effect is to be expected. At the same time there are other regions worldwide that have adopted more accelerated emission reduction pathways than the EU. Given Turkey's strong dependence on vehicle exports and with respect to ensuring long-term competitiveness of vehicles exported from Turkey, it should therefore be further assessed whether going beyond the current EU pathway of fuel consumption and CO_2 emission reduction might be more beneficial for the Turkish economy when competing with other global markets. Additional measures, such as vehicle taxation based on CO_2, mandates and incentives for electrified vehicles, and alternative fuels, could complement and leverage the effects of CO_2 vehicle standards and should also be assessed in more detail.

Heavy-duty vehicles account for only about one-tenth of the market in Turkey but at the same time are responsible for more than half of total fuel consumption and emissions. Very little data is available on the fuel consumption and emission levels of trucks and buses in Turkey. It is expected that the average fuel consumption of new trucks in Turkey has not changed significantly in recent years, as it is also the case for the EU.[18] This is due to the fact that there are currently no mandatory fuel consumption and CO_2 emission standards for heavy-duty vehicles, neither in Turkey nor in the EU. Other regions, such as the United States, Canada, China, and Japan, have meanwhile introduced efficiency standards for new heavy-duty vehicles, and it is likely that the EU will be moving in this direction as well. Given the particular importance of trucks and buses not only for the local vehicle market in Turkey but also for the export market, the introduction of efficiency standards should be considered and, therefore, be assessed in more detail.

About half of new cars in Turkey are first registered in the Istanbul area. This highlights the importance of cities, and in particular the city of Istanbul, with respect to the deployment of innovative vehicle technologies. Urban areas are typically most affected by the negative impacts of road transportation, such as high levels of local air pollutants. At the same time, these urban areas can take complementary action, in addition to any policy measures at the national level, to incentivize the deployment of low-emission vehicles. Examples of such measures include an improved infrastructure for alternative fuels and electricity as well as restrictions for high-emission vehicles when entering urban areas. In light of the particular importance of urban areas for the new vehicle market in Turkey, these complementary measures should also be assessed and discussed in more detail.

A main objective of this report is to provide a transparent assessment of the current vehicle market in Turkey to domestic policymakers and stakeholders as well as to an interested international audience. In a next step, specific potential policy measures will then be assessed and discussed in more detail, with the aim of summarizing the results of this policy assessment in a follow-up publication.

18 For more details, refer to (Muncrief, 2015b)

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