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REDUCING VEHICLE EMISSIONS IN TURKEY

POLICY MEASURES TO ADDRESS GREENHOUSE GAS AND AIR POLLUTANT EMISSIONS FROM THE ROAD TRANSPORT SECTOR

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EXECUTIVE SUMMARY

Vehicle sales and vehicle emissions are steeply rising in Turkey. This rise is important not only from an environmental and health protection perspective, but also from an economic and international competitiveness point of view that new vehicles coming into the market in Turkey in future years should be equipped with the best available technology and have the lowest possible emissions. A set of distinct policy measures can help increase the efficiency and reduce the emission levels of the vehicle fleet in Turkey.

Mandatory CO_2 emission standards for new vehicles are successfully applied in other markets but are not yet introduced in Turkey. For the analysis within this report, two scenarios were assessed in more detail, allowing for an annual CO_2 reduction rate of 4% and 6% for newly registered cars and resulting in an average new car fleet CO_2 level of 84 g/km and 69 g/km by 2023, respectively. The required additional investment in new vehicle technologies to meet these future CO_2 targets was found to be reasonably low and to result in a consumer payback period as short as four to five years, thanks to the fuel cost savings associated with lower CO_2 emission levels.

Vehicle CO_2 labeling as a measure for consumer information was implemented in Turkey in 2009. Comparing the current Turkish labeling scheme to those in other markets revealed areas of potential further development, such as revising the current website to allow customers a better overview of available vehicle models and their CO_2 emission labels and adding information on vehicle taxation levels and on-road driving emission levels to the label.

Taxes on the purchase and ownership of passenger cars in Turkey have a strong effect on the sales structure of the vehicle market. However, these taxes currently do not take into account the CO_2 emission levels of new vehicles. Revising the current vehicle taxation scheme in Turkey to be based partly on vehicle CO_2 emissions, ideally in the form of a feebate system, would directly pay manufacturers to install their latest low-emission vehicle technologies and would provide a strong financial incentive for customers to choose more efficient cars that emit less CO_2.

Reliable data on vehicle emission levels is key for all of the discussed policy measures. In order to address the increasing discrepancy between official and real-world emission data, Turkey should introduce the new Worldwide Harmonized Light Vehicles Test Procedure (WLTP) as soon as possible and introduce mandatory on-road emission tests for new vehicle models, both for CO_2 and other air pollutants. As a third pillar of a comprehensive low-emissions policy, regular retesting of the emission levels of in-use vehicles, carried out by the authorities or independent third parties, is strongly advised.

A rough estimate of the expected effect of introducing mandatory CO_2 standards, CO_2-based vehicle taxation, and enhanced vehicle emission testing for new passenger cars in Turkey is provided in Figure 1 and Figure 2. The total CO_2 emissions of the light-duty vehicle fleet in Turkey would increase from about 16 million metric tons in 2015 to 22 million metric tons by 2030 if no further policy measures are taken. With only a mandatory CO_2 standard in place, the emission level would be lower, at 17–19 million metric tons by 2030. Complementing CO_2 standards by also introducing a CO_2-based vehicle taxation scheme and enhanced vehicle emission testing would help to further reduce the emission level to about 14–16 million metric tons by 2030. This level is as much as 36% lower than in a business-as-usual scenario. Similarly, the amount of fuel consumption in the light-duty vehicle sector could be reduced by about the same extent.

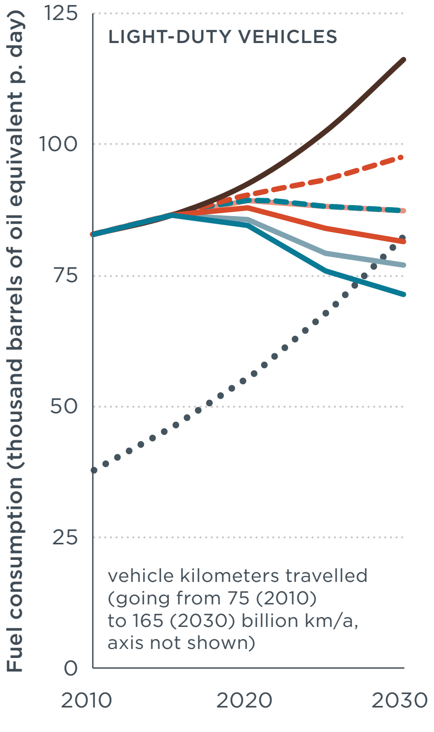

Figure 1. Estimated fuel demand from light-duty vehicles in Turkey (2010-2030).

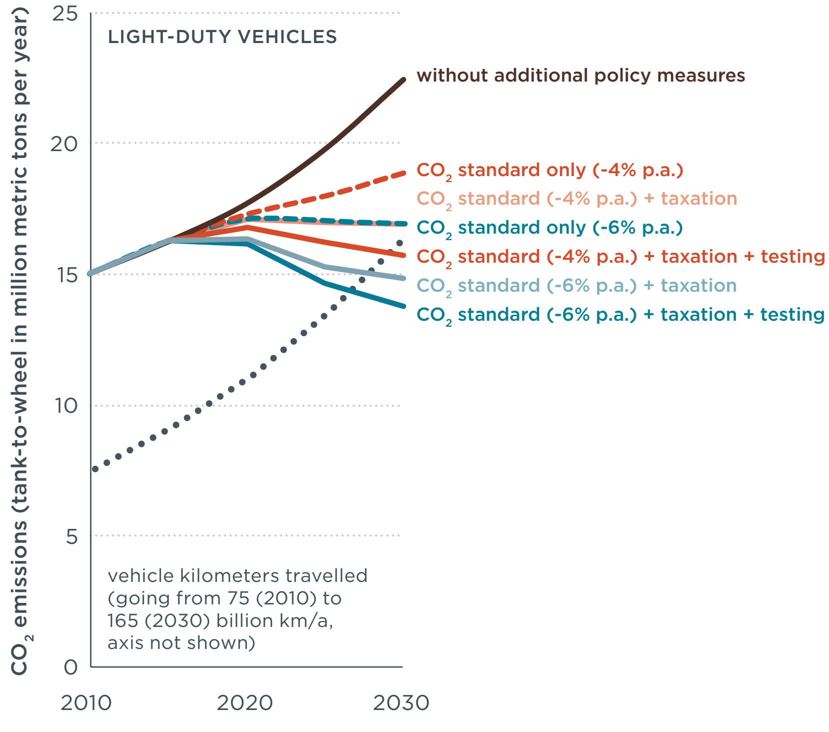

Figure 2. Estimated CO_2 emissions from light-duty vehicles in Turkey (2010-2030).

In summary, the policy measures discussed are expected to result in higher investments in vehicle technologies and less spending on fuel and oil imports, thereby providing benefits for all stakeholders in Turkey, including consumers and the vehicle and vehicle parts manufacturing industry.

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ABBREVIATIONS

ACEA	Association des Constructeurs Européens d'Automobiles (European Automotive Manufacturers' Association)
APEC	Asia-Pacific Economic Cooperation
CO_2	Carbon dioxide
EU	European Union
EUR	Euro
g/km	Grams per kilometer
GFEI	Global Fuel Economy Initiative
GHG	Greenhouse gas
ICCT	International Council on Clean Transportation
IPC	Istanbul Policy Center
KDV	Katma Değer Vergisi (Turkish VAT)
l/100km	Liters per 100 kilometers
LPG	Liquefied petroleum gas
MTV	Motorlu Taşıtlar Vergisi
MPG	Miles per gallon
NEDC	New European Driving Cycle
NO_x	Nitrogen oxides
NTE	Not-to-exceed
OSD	Otomotiv Sanayi Dernegi (Turkish Automotive Manufacturers Association)
ÖTV	Motorlu Taşıt Araçlarına İlişkin Özel Tüketim Vergisi (SCT)
p.a.	per year
PSA	Groupe PSA (formerly PSA Peugeot Citroën)
TL	Turkish Lira (approximately 0.3 euros)
UK	United Kingdom
UNECE	United Nations Economic Commission for Europe
U.S.	United States
RDE	Real-driving emissions
SCT	Special consumption tax
VAT	Value-added tax
WLTP	Worldwide Harmonized Light Vehicles Test Procedure

1 INTRODUCTION

Turkey is among the most important vehicle manufacturing countries in the world. Of the more than 1.1 million vehicles produced in Turkey every year, about three-quarters are currently being exported abroad (OSD, 2014). At the same time, the volume of vehicle sales in Turkey itself is growing quickly—recently at a rate of about 8% per year (TUIK, 2015). As a result, the automotive sector in Turkey is a vital part of the national economy, with numerous production plants and employees in the vehicle and vehicle parts manufacturing industry.

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 in the global and national markets. An extensive set of policy measures can help drive forward the necessary innovations.

An assessment of the current vehicle market in Turkey was provided in an earlier report, as well as a comparison of other key automotive markets worldwide (Mock, 2016). As part of the findings it was shown that the level of efficiency for new cars and light commercial vehicles in Turkey is similar to the efficiency of comparable vehicles in the European Union (EU). Furthermore, it was estimated that in a business-as-usual scenario, oil consumption and carbon dioxide (CO_2) emissions from road transport in Turkey would approximately double by 2030.

It is the objective of this report to build on the previous baseline analysis of the Turkish automotive sector by assessing a set of concrete policy measures that could help drive down fuel consumption and emissions from the road transport sector in Turkey in future years.

Sections 2 through 5 of this report examine specific policy options in more detail, including a qualitative description of the context in general and specifically in Turkey, as well as providing a quantitative assessment whenever possible. The scope of policy options selected for the discussion within this report includes vehicle CO_2 standards, CO_2 labeling, CO_2-based taxation, and enhanced vehicle emission testing but is by no means to be seen as complete. Instead, it is meant to cover measures that are commonly applied in other automotive markets worldwide and that were identified as also potentially relevant for Turkey during discussions with stakeholders throughout the duration of this research project. Section 6 summarizes the key findings for the specific policy options and provides an outlook on potential next steps.

2 VEHICLE CO_2 STANDARDS

A CO_2 standard requires vehicle manufacturers to ensure that the emissions of their new vehicles sold are below a certain target value by a certain target year. CO_2 standards typically are applied at the fleet level, which is to say a manufacturer can continue selling some vehicles with emissions above the target value as long as the sales-weighted average for the new vehicle fleet remains below the corresponding target level.

2.1 TURKEY IN COMPARISON TO WORLD MARKETS

Altogether the G20 countries account for more than 80 million new vehicle sales per year, more than 90% of global annual vehicle sales. Half the G20 countries have implemented mandatory CO_2 reduction standards for new passenger cars and light commercial vehicles (Table 1) as of mid-2016.

Table 1. Overview of mandatory CO_2 emission standards for new passenger cars and light commercial vehicles in G20 countries.[1]
Data sources: ICCT, 2016; Kodjak, 2015; OICA, 2015.

Region	Total vehicle sales in 2015		Passenger cars					Light-commercial vehicles				
			CO_2 standard, years implemented			CO_2 reduction		CO_2 standard, years implemented			CO_2 reduction	
			2015	2020	2025	Total	Annual	2015	2020	2025	Total	Annual
China	24,597,583	28%				42%	5.3%				12%	2.5%
U.S.	17,470,659	20%				39%	4.8%				34%	4.0%
EU	15,786,092	18%				21%	3.8%				13%	2.8%
Japan	5,046,511	6%				0%	0.0%				13%	2.7%
India	3,425,336	4%				13%	2.8%					
Brazil	2,568,976	3%				5%	2.8%					
Canada	1,939,949	2%				35%	4.2%				31%	3.6%
South Korea	1,833,786	2%				34%	8.0%				16%	3.3%
Russia	1,437,930	2%										
Mexico	1,351,648	2%				5%	4.6%				5%	4.9%
Australia	1,155,408	1%										
Indonesia	1,031,422	1%										
Turkey	1,011,194	1%										
Saudi Arabia	830,100	1%				18%	4.8%				15%	3.9%
South Africa	617,749	1%										
Argentina	605,933	1%										
All G20 countries	**80,710,276**	**91%**										
All countries	**88,677,983**	**100%**										

The U.S. and Canada currently have the furthest reaching standard in terms of target year. Both markets have set a mandatory CO_2 target for 2025 in which passenger cars require a 35%-39% reduction compared to 2015 levels, which equals an annual reduction rate of 4.2%-4.8%. China requires a 42% reduction, which is 5.3% per year, to meet its proposed 2025 target. South Korea is the market that currently has the most stringent standard in terms of annual CO_2 reduction, having set a mandatory standard for 2020 that will lower new car CO_2 emissions by 34% compared to 2015 at a rate of 8.0% per year. The EU requires new cars to emit on average not more than 95 g/km of CO_2 by 2021, which is equivalent to a reduction of 21% compared to 2015 at an annual rate of 3.8%.[2] Japan also has set a mandatory CO_2 target of 122 g/km for 2020, but it already has been met well in advance; therefore, the current regulation does not require any

1 Although Germany, France, UK, and Italy are members of the G20, for this overview table the EU-28 was included instead.

2 All CO_2 emission targets and reduction rates given are expressed as being measured in the New European Driving Cycle (NEDC) vehicles test procedure. The conversion factors for non-NEDC test procedures can be found in Global passenger vehicle standards (ICCT, 2016). For EU and Japan the actual new vehicle fleet averages for CO_2 emissions were used rather than the original 2015 regulatory target values.

further vehicle improvements. India, Brazil, Mexico, and Saudi Arabia are other G20 countries with mandatory CO_2 emission standards for new passenger cars in place. Most markets with CO_2 emission standards for passenger cars also have similar standards for light commercial vehicles in place.

Turkey is one of the few G20 countries not having implemented mandatory CO_2 standards for new cars or light commercial vehicles at this point. For passenger cars, the average CO_2 emission level in Turkey (121 g/km in 2014) is only slightly below the EU-28 average (123 g/km), despite vehicles in Turkey being on average lighter and less powerful than in the EU (Figure 3). For the years 2012 through 2014, in which data on new car CO_2 emissions is available, the annual rate of reduction is similar to that of the EU average. For comparison, in the Netherlands, where the vehicle fleet structure and taxation levels tend to be more similar to those in Turkey, the new car fleet CO_2 level is significantly lower than in Turkey, and the annual CO_2 reduction rate is significantly higher than in Turkey. Other markets, like the U.S., China, and South Korea, come from a higher baseline CO_2 emission level and require a steeper reduction rate than Turkey and the EU in order to meet their respective 2020-2025 emission targets for new cars.

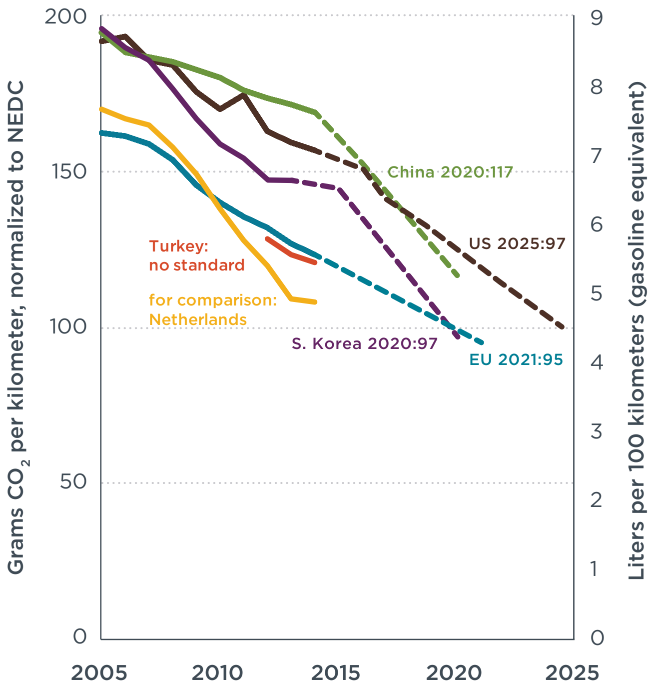


Figure 3. Average new passenger car CO_2 emission levels for selected countries/regions, normalized to NEDC. *Data source: ICCT, 2016.*

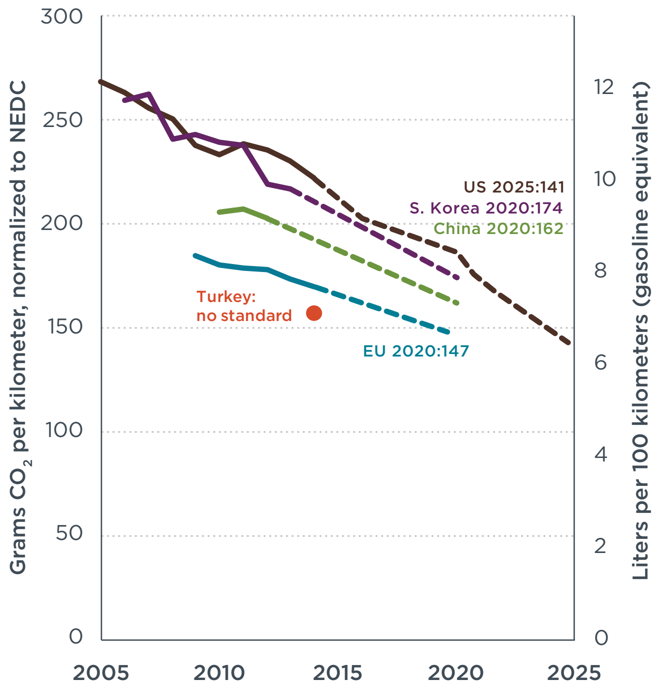


Figure 4. Average new light commercial vehicle CO_2 emission levels for selected countries/regions, normalized to NEDC. *Data source: ICCT, 2016.*

For light commercial vehicles, the average new vehicle CO_2 emission level for Turkey in 2014 was 157 g/km, below the EU average of 171 g/km (Figure 4). Historical data were not available for the analysis within this report. The annual CO_2 reduction rate in the EU, China, and South Korea is at a similar level, with a somewhat steeper reduction pathway for the U.S. market.

Comparing the annual CO_2 reduction rates for new passenger cars, it can be seen that the current estimated reduction rate for countries with mandatory CO_2 standards varies between 2.8% and 8.0%. This is illustrated in Figure 5. For Turkey, despite not having introduced any mandatory CO_2 regulation for new cars at this point, the annual reduction rate of 3.0% is at the lower bound of this range. This is most likely due to the fact that the market in Turkey is indirectly affected by the CO_2 regulations in the EU and other markets, given that about 79% of Turkey's car production is exported abroad and about 73% of new cars sold in Turkey are imported from abroad (OSD, 2014). As a result, spillover effects from vehicle regulations abroad have an influence on the vehicle market, and also on CO_2 emission levels, in Turkey. Likely more important, though, is the fact that fuel and vehicle taxation levels in Turkey tend to be among the highest in the world, thereby driving the new car market toward models with smaller engine size, lower engine power, and—indirectly—also lower CO_2 emission levels (Mock, 2016). With this in mind, the current annual CO_2 reduction in Turkey appears rather low, for example, when compared with markets such as the Netherlands that are more similar to Turkey in terms of vehicle fleet structure and taxation levels.

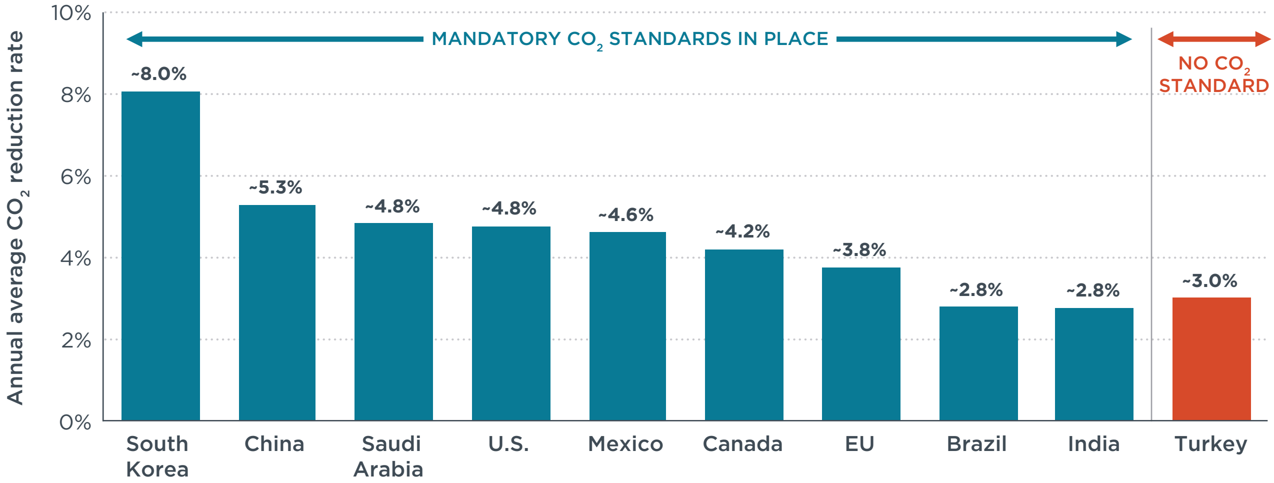


Figure 5. Comparison of estimated average annual new passenger car CO_2 emission reduction rates. *Data sources: ICCT, 2015a; ICCT, 2016; Kodjak, 2015.*

For the future, it is expected that if Turkey were to introduce mandatory CO_2 emission standards, the annual CO_2 emission reduction rate could be increased significantly. Simply applying the existing EU CO_2 regulation to the Turkish market, however, would not result in significant additional CO_2 reductions as the EU's 95 g/km CO_2 target for passenger cars for 2021 would translate into an approximately 3.4% annual CO_2 reduction for Turkey—not much higher than the current business-as-usual rate without any CO_2 regulation. The same is true for the light commercial vehicle market.

Two scenarios for the implementation of new vehicle CO_2 standards for Turkey are assessed in more detail in the following. Scenario 1 assumes an annual CO_2 reduction rate of 4.0%, similar to the reduction requirements in the U.S., Canada, Saudi Arabia, and the EU. At this rate of reduction, the average new vehicle CO_2 emission level in Turkey would drop to 94 g/km by 2020 for cars and to 123 g/km for light commercial vehicles.

Table 2. New vehicle fleet average CO_2 emission levels in Turkey assuming reduction rates of 4.0% and 6.0%.

Annual CO_2 reduction:	New vehicle average CO_2 emission level			
	Passenger cars		Light commercial vehicles	
	Scenario 1 4.0%	Scenario 2 6.0%	Scenario 1 4.0%	Scenario 2 6.0%
2014	121	121	157	157
2015	116	113	151	148
2016	111	107	145	139
2017	107	100	139	130
2018	102	94	133	123
2019	98	89	128	115
2020	94	83	123	108
2021	91	78	118	102
2022	87	74	113	96
2023	84	69	109	90
2024	80	65	104	85
2025	77	61	100	79

In Scenario 2, an annual reduction rate of 6.0% is assumed, which falls between the current requirements in South Korea and China. Under this scenario, the new vehicle fleet average would decrease to 83 g/km by 2020 for cars and 108 g/km for light commercial vehicles. The corresponding CO_2 targets for other years can be found in Table 2.

2.2 INTRODUCING A CO_2 STANDARD FOR NEW VEHICLES IN TURKEY

For a quantitative assessment of the implementation of a new vehicle CO_2 standard in Turkey, 2023 is purposefully selected as the target year to coincide with the 100th anniversary of the Republic of Turkey. Reducing fuel consumption and CO_2 emissions of motorized vehicles is mentioned as one objective in the "Energy Efficiency Strategy Paper 2012-2023," which falls under the umbrella of the "Turkey 2023 Vision." (EIE, 2012; Foreign Affairs, 2013). With 2023 as the target year, the two scenarios described above translate into a new car fleet CO_2 target value of 84 g/km when assuming a 4.0% per year CO_2 reduction rate and 69 g/km when assuming a 6.0% per year reduction rate.

Figure 6 illustrates the current situation of the new passenger car market in Turkey by including all vehicle model variants of which more than 100 vehicles were registered in 2014. Nine selected vehicle model variants were specifically highlighted. These models include some of the top-selling models within their segment, all of them being diesel powered except the Toyota Yaris, which was chosen as an example of a hybrid vehicle that is available on the Turkish market.

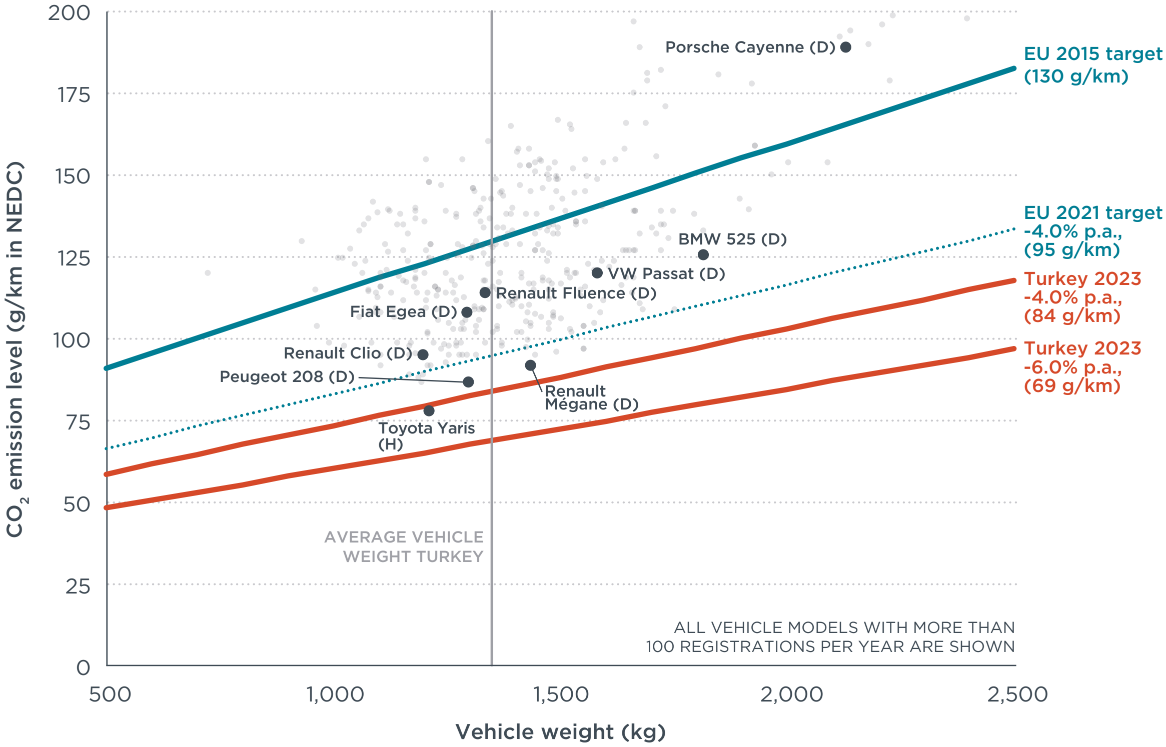


Figure 6. New passenger car registrations in Turkey in 2014, differentiated by vehicle weight and CO_2 emission levels. Some selected vehicle models are highlighted.[3] D indicates diesel power; H indicates hybrid vehicle. *Data source: ICCT, 2015a*.

The 2015 and 2021 CO_2 emission targets that apply to new passenger cars in the EU are also shown. It can be seen that the majority of vehicle models registered in Turkey already over-comply with the EU 2015 target line.[4] Furthermore, some models already comply with the CO_2 emission target that will apply in the EU in 2021. Specific examples include the Toyota Yaris hybrid, as well as variants of the Peugeot 208 and Renault Mégane.

Looking at the hypothetical target lines for a 2023 new car CO_2 standard in Turkey, it can be seen how these go one step beyond the current EU 2021 regulation, with an underlying annual reduction rate of 4.0% or 6.0% compared to a 3.8% reduction rate in the EU. At the same time it is noteworthy that already in 2014—nearly 10 years before the standard would apply—some vehicle models, such as the Toyota Yaris hybrid, already complied or nearly complied with the corresponding CO_2 emission targets. This observation is in line with the expectation that either 2023 CO_2 standard proposed for Turkey could largely be met by further improving conventional combustion engine vehicles and also making use of the mild- and full-hybrid electric vehicle technology. The introduction of a significant market share of fully electrified vehicles is not expected to be required for meeting the assumed CO_2 emission levels.

Figure 7 again illustrates the new car market situation in Turkey in 2014 but uses vehicle size, expressed in terms of vehicle footprint, instead of vehicle weight as the underlying parameter. This is in line with the CO_2 target system in markets like the U.S. A key benefit of a footprint-based CO_2 target system is that it continues to encourage vehicle lightweighting and thereby is more technology neutral than a weight-based CO_2 target

3 The 2014 vehicle database was partially updated to reflect the technical specifications of some vehicle models that were introduced more recently, such as the Fiat Linea.

4 The current vehicle CO_2 emission standards in the EU for 2015 and 2021 use vehicle weight as the underlying utility parameter. This means that the heavier a vehicle, the higher the CO_2 emission level allowed.

system. As a result, a footprint-based system increases the flexibility for manufacturers and thereby reduces the cost for regulatory compliance (Mock, 2011).

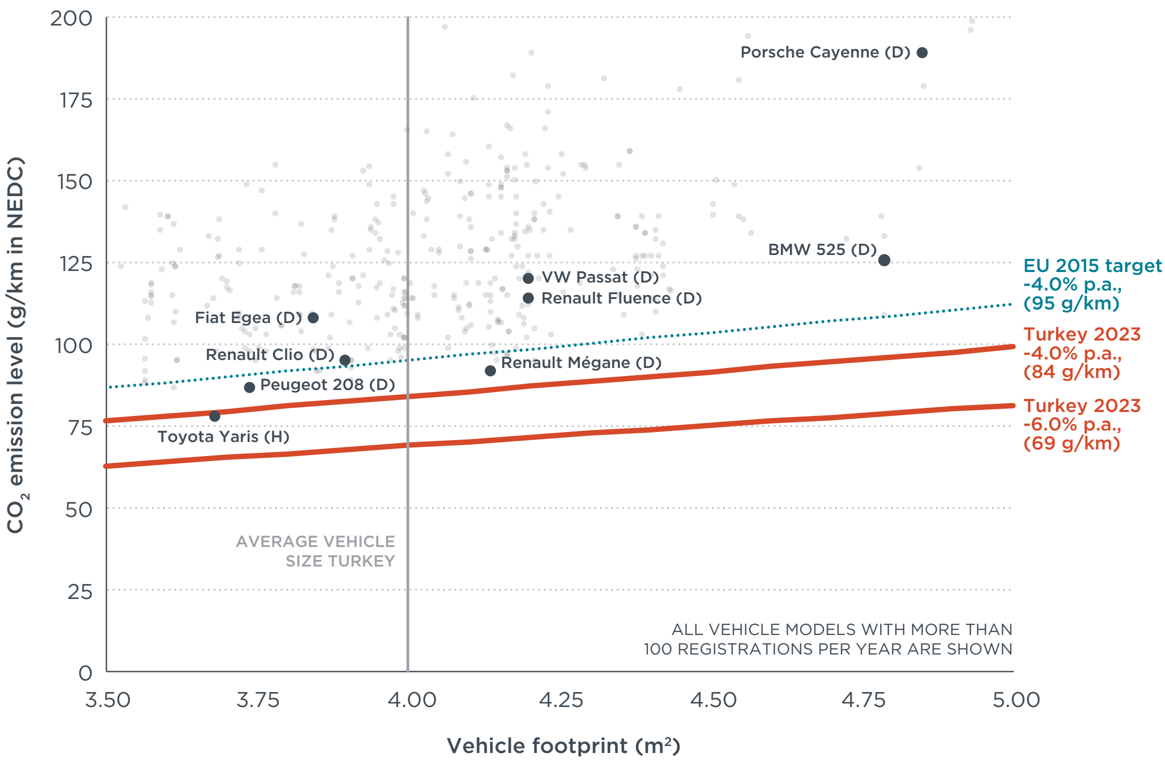


Figure 7. New passenger car registrations in Turkey in 2014 differentiated by vehicle size (footprint) and CO_2 emission levels. Some selected vehicle models are highlighted. *Data source: (ICCT, 2015a).*

It can be seen that if the EU had set a footprint-based CO_2 target for 2021, most of the new car models in Turkey would have already over-complied with this target in 2014. Similar to the graphical illustration for the weight-based target scheme, it can be seen how a footprint-based CO_2 standard for Turkey for 2023 would go beyond the current EU regulation. At the same time some vehicle models, such as the Toyota Yaris hybrid, would already today be in line or close to being in line with such a 2023 standard.

In a next step, the additional costs associated with the required technological improvements to meet a 2023 CO_2 standard in Turkey are estimated. The basis of this assessment is a detailed analysis of the technology CO_2 reduction potential and manufacturing cost increase for a variety of vehicle technologies and technology packages carried out by the engineering consulting providers Ricardo and FEV on behalf of ICCT in 2011-2013, as well as an updated assessment carried out in 2015-2016.[5] Figure 8 shows the simplified overall technology cost curve, derived as a high-level result from the detailed technology assessments.

It can be seen that with a decreasing CO_2 emission level the estimated additional manufacturing cost increases disproportionately. For an average new car fleet CO_2 target of 84 g/km by 2023, which is equivalent to a 4% annual reduction rate, the additional direct manufacturing cost is estimated to be around 2,400 Turkish Lira (TL) (720 euros). For a target of 69 g/km, based on a 6.0% annual reduction rate, the additional cost is around 3,800 TL (1,150 euros).

5 For the 2011-2013 work a summary document (Mock, 2013) and a library of detailed project reports (http://www.theicct.org/cost-curves-resources) are available online. The detailed documentation of the 2015-2016 work is forthcoming.

It should be mentioned that the estimated cost levels are likely to be overly conservative as previous studies indicate that technology cost levels tend to be overestimated, due in part to unexpected advancements in the development and production of CO_2 reduction technologies over time (Mock, 2015a). Furthermore, for this technology cost curve assessment it is assumed that all technologies are manufactured in Germany, implying higher labor and overhead rates than if manufacturing the same technologies in Eastern European countries or Turkey (Meszler et al., 2014).

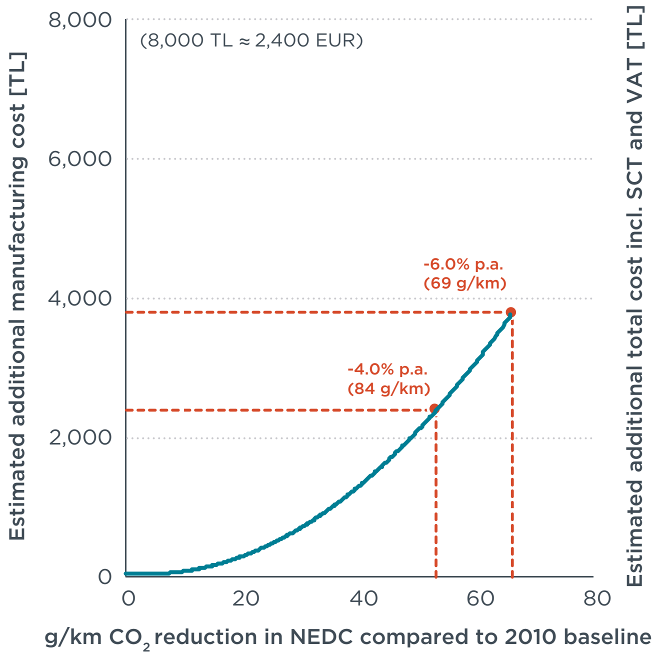


Figure 8. Summary curve of the CO_2 reduction potential and additional manufacturing cost for passenger car technologies.

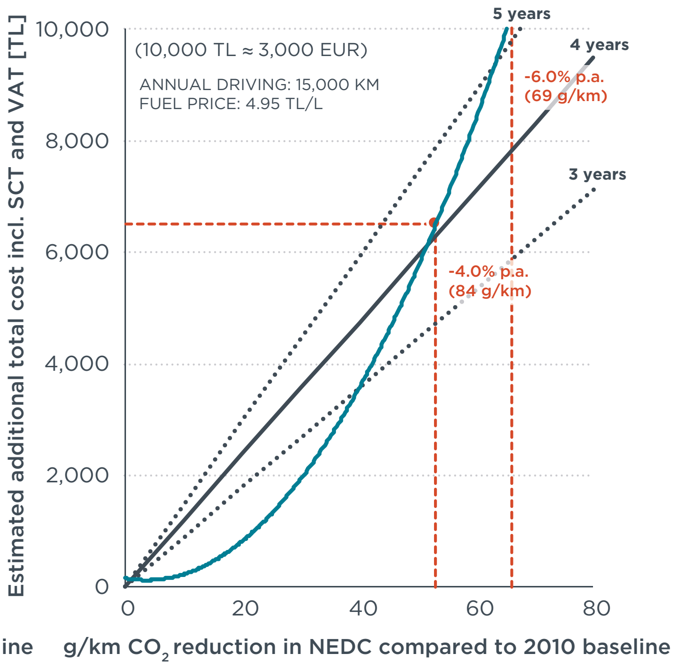


Figure 9. Summary curve of the CO_2 reduction potential and additional total cost, including indirect cost and taxes, for passenger car technologies as well as payback periods.

Figure 9 shows the same technology cost curve when it includes all indirect costs for applying the technologies into the vehicle as well as a 45% special consumption tax (SCT) and 19% value added tax (VAT). Comparing the estimated necessary investments in improved technologies to the expected savings in fuel costs, it is found that for a 84 g/km CO_2 standard in 2023 the payback period for the first owner of the vehicle would be about four years.[6] For a 69 g/km CO_2 standard, the required technology level would be higher, as would be the associated cost. Nevertheless, the expected payback period would still be around five years. This means that after five years of driving, the total fuel costs saved would be larger than the initial investment in advanced technologies. Over the lifetime of the vehicle, for the second or third owner, the cumulative fuel cost savings would greatly offset any initial technology investment.

Using the ICCT Global Transportation Roadmap Model (ICCT, 2015b) to assess the effect of introducing a mandatory CO_2 emission standard for new cars in Turkey on estimated

6 This is assuming an average annual mileage of 15,000 km as a best-guess estimate. Statistically robust data on the average annual mileage of new cars in Turkey was not found to be available. 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. Based on personal communication (April 6, 2016) with a representative of the Turkish government, the average annual driving distance for new car owners in Turkey is around 10,000 km for gasoline, 12,000 km for diesel, and 20,000 km for liquefied petroleum gas (LPG) vehicles. A preliminary assessment of secondhand cars' data for Turkey within the scope of this study indicates that the average annual mileage for gasoline cars of three to five years of age is around 13,000 km and for diesel cars around 23,000 km. Furthermore, an average fuel price level of 4.95 TL (1.50 euros) per liter is assumed. This is slightly higher than current levels in Turkey and a best-guess estimate for the further development of fuel price levels in the ~2020 timeframe. Furthermore, estimates make use of a simplified payback calculation approach, defined as the incremental additional vehicle cost divided by the undiscounted annual fuel savings.

fuel consumption yields predictable results. In a business-as-usual scenario, without a CO_2 standard and assuming a 1.0% annual new vehicle average emission reduction, the daily fuel consumption for light-duty vehicles is expected to rise from about 83,000 barrels of oil equivalent per day in 2010 to 116,000 barrels per day by 2030 (Mock, 2016). This is illustrated in Figure 10. Introducing a CO_2 standard equivalent to 84 g/km for the average new vehicle by 2023 would reduce the 2030 level to 98,000 barrels per day, a 15% decrease compared to the business-as-usual scenario. With a 69 g/km standard in place, the daily fuel consumption level would drop to about 87,000 barrels of oil equivalent by 2030—25% lower than in the business-as-usual scenario.

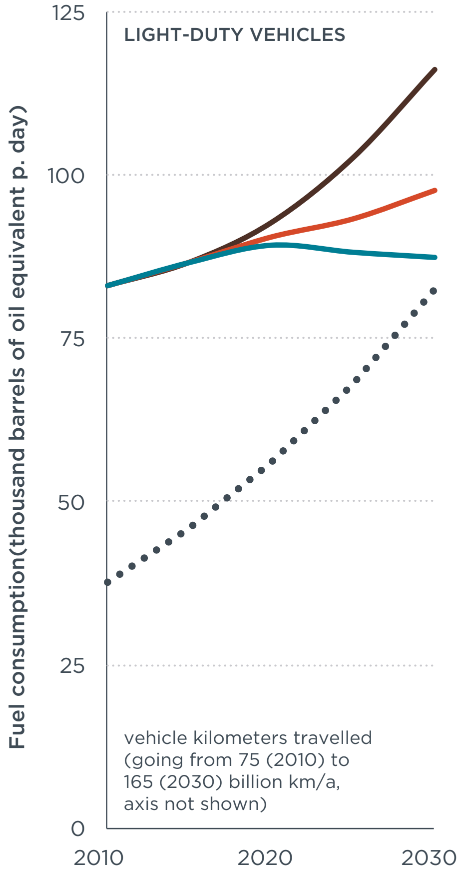


Figure 10. Estimated fuel demand from light-duty vehicles in Turkey (2010-2030).

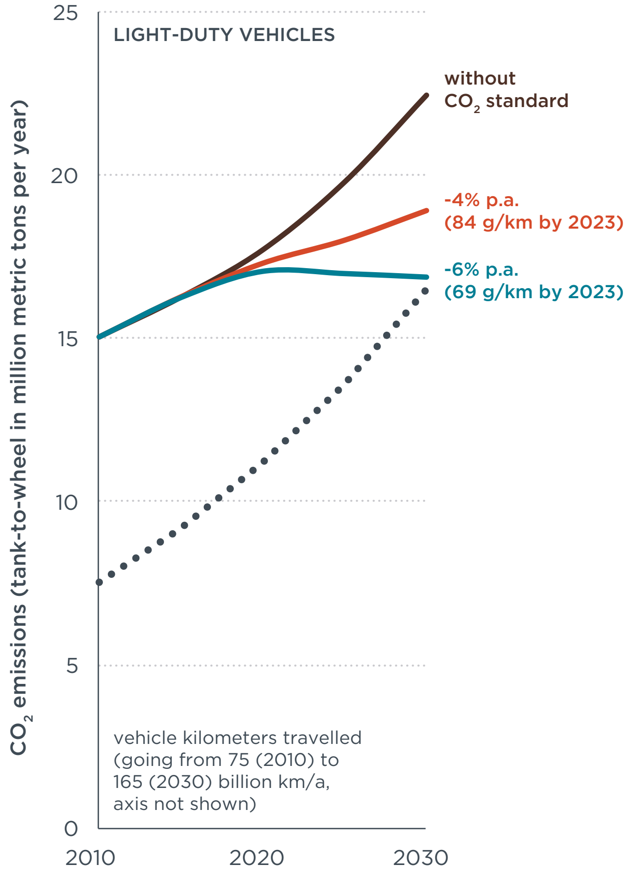


Figure 11. Estimated CO_2 emissions from light-duty vehicles in Turkey (2010-2030).

For CO_2 emissions, the expected impacts are similar, with an increase from 15 million metric tons per year in 2010 to 22 million metric tons per year by 2030 in a business-as-usual scenario, as shown in Figure 11. Introducing an 84 g/km CO_2 standard by 2023 would reduce the annual emission level to 19 million metric tons, down 15% relative to the business-as-usual scenario, while a 69 g/km standard would bring emissions down 25% to 17 million metric tons per year.

Figures 12 and 13 summarize the key impacts of introducing a mandatory new car CO_2 standard in Turkey. In a scenario with a 2023 target equivalent to 4% per year CO_2 reduction, the expected increase in total manufacturing costs of the vehicle is approximately 4,500 TL (1,360 euros). This represents about 7% of the average new car price in Turkey. It should be noted that given the experience with previous CO_2 standards it is unlikely that the full cost increase would be passed on to the end customer, thereby resulting in vehicle price increases less than 7%. In comparison, fuel cost savings are estimated to be around 1,570 TL (470 euros) per year. This is about 44% less than current fuel costs for an average car driver in Turkey. Fuel consumption, and thereby oil consumption, would decrease by around 19,000 barrels of oil equivalent per day in 2030. The level of CO_2 emissions per year would decrease by around 3 million metric tons, a 15% decrease compared to a business-as-usual scenario.

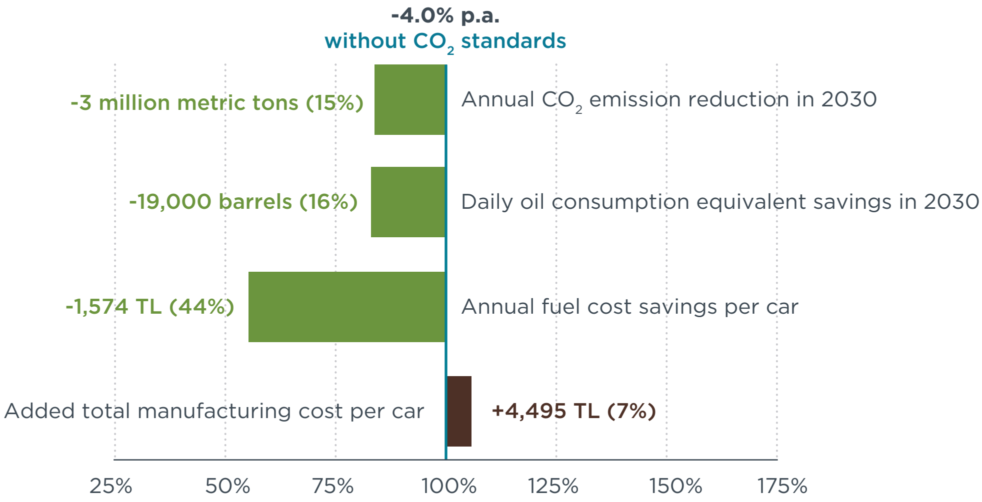


Figure 12. Key impacts of introducing a 2023 CO_2 standard equivalent to an annual CO_2 reduction of 4.0% for new passenger cars in Turkey.

In a scenario with a 2023 CO_2 standard in line with a 6% reduction per year, the expected additional manufacturing costs would increase to about 10% of the average new car price in Turkey while the expected fuel cost savings of 55% at the vehicle level and 25% reductions in oil consumption and CO_2 emissions at the fleet level of 25% would be even more evident than in the previous scenario.

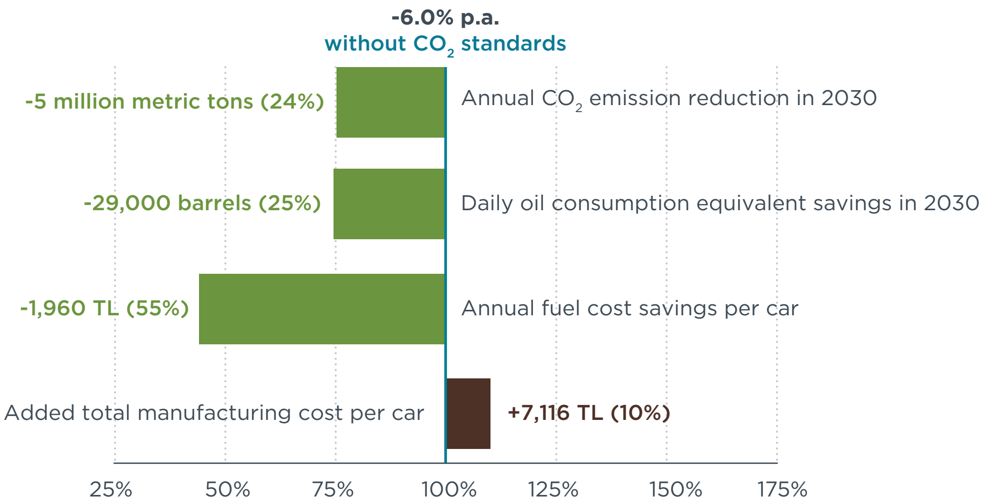


Figure 13. Key impacts of introducing a 2023 CO_2 standard equivalent to an annual CO_2 reduction of 6.0% for new passenger cars in Turkey.

It should be noted that the benefits of a new car CO_2 standard can be significantly enhanced when combining the standard with other policy elements, such as vehicle CO_2 labeling and CO_2-based vehicle taxation (see Sections 3 and 4 for details).

Furthermore, it should be noted that while the analysis here was carried out for passenger cars only, vehicle CO_2 standards also can be introduced for light and heavy commercial vehicles. In fact, given that light commercial vehicles account for about 15% of all new vehicle registrations in Turkey, it is important that these vehicles are not disregarded. Even more so, heavy-duty vehicles are responsible for more than half of CO_2 emissions from the transport sector in Turkey, with a strong expected increase in future years. This is why the introduction of a mandatory CO_2 standard for new heavy-duty vehicles is a key pillar of transport policy in Turkey. However, an assessment of a heavy-duty vehicle CO_2 standard is outside the scope of this analysis.[7]

7 More information on the topic of CO_2 emissions from heavy-duty vehicles and how mandatory CO_2 standards for new trucks and buses can help to reduce emission levels can be found, for example, in Muncrief and Sharpe (2015).

3 VEHICLE CO_2 LABELING

Vehicle CO_2 labeling helps customers and informs their purchase behavior by providing data on the CO_2 emission level of a vehicle in a more accessible and easier to understand format than would otherwise be the case. Furthermore, a standardized format allows for an easier comparison between different vehicles and ideally results in a situation where the customer chooses a vehicle with a lower CO_2 emission level.

3.1 THE CURRENT SITUATION IN TURKEY

Many countries worldwide have introduced vehicle labels showing CO_2 emissions, equivalent fuel consumption or fuel efficiency, as a mandatory policy measure. In the U.S. and also in the United Kingdom (UK), vehicle labels were introduced as early as 1978. In the EU, vehicle CO_2 labels have been required since 2001. In Turkey, a regulation similar to the one in the EU was published in December 2003, mandating CO_2 labeling for new passenger cars from January 2009 onward (Mevzuat Bilgi Sistemi, 2003).

Figure 14 shows the vehicle CO_2 label that is currently in place in Turkey. In addition to basic technical information about the vehicle (make and model, fuel type, engine displacement, transmission type), the label includes data on the vehicle's fuel consumption, in liters per 100 kilometers, when driven in inner-urban and extra-urban areas, as well as a weighted average of the different driving conditions. This information is provided according to the New European Driving Cycle (NEDC) test procedure. The average CO_2 emission value of the vehicle is given in the form of an absolute number as well as a color rating. Every vehicle with a CO_2 emission level of 100 g/km or below receives a dark green "A" rating; vehicles with CO_2 emissions between 101 and 125 g/km get a light green "B" rating, and so on. The vehicle CO_2 label in Turkey thereby applies a so-called "absolute" CO_2 rating scheme, not normalizing for parameters such as vehicle weight, and allows customers to directly compare CO_2 emission levels among all offered vehicles.

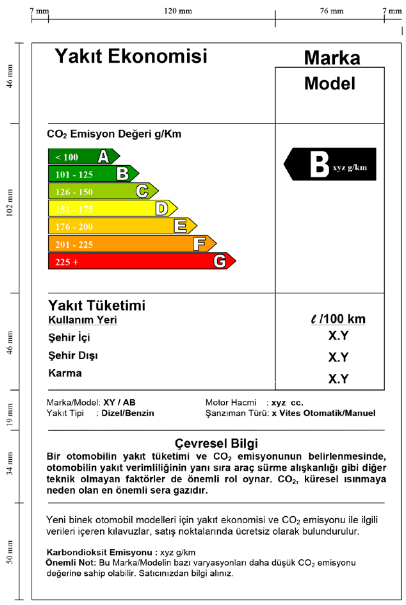


Figure 14. New car CO_2 label currently applied in Turkey. *Source: Mevzuat Bilgi Sistemi, 2003.*

The CO_2 label for new cars in Turkey must be clearly visible within the vicinity of the vehicle on sale. During a number of visits to new car showrooms of different brands in Istanbul in October 2015 and April 2016, all vehicles on sale had CO_2 labels attached to them or placed close to the vehicle (for an example, see Figure 15). Similarly, when visiting a number of new car showrooms in Berlin in September 2015, all vehicles for sale had CO_2 labels placed on or near them (for an example, see Figure 16). While these random observations on a number of new car showrooms do not provide a representative overview, they indicate that the CO_2 labeling requirements are applied in practice at least to some extent in Turkey as well as in the EU. In both markets the respective regulations authorize appointed inspectors to regularly carry out spot checks to supervise the enforcement of the CO_2 labeling regulation. A more representative overview of enforcement practices for the vehicle CO_2 label in the EU can be found in a 2011 report for the European Commission (AEA, 2011).

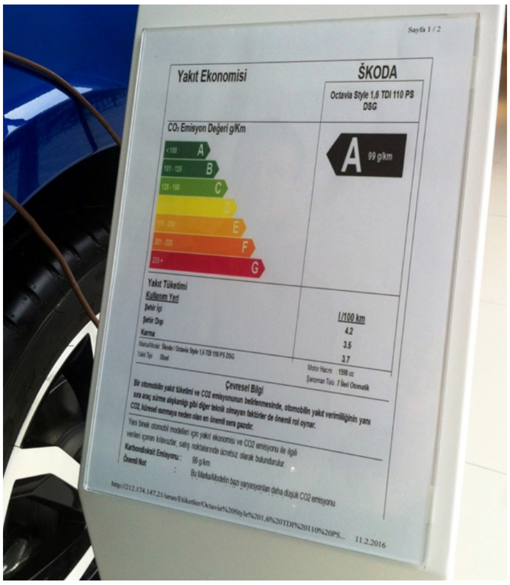


Figure 15. Vehicle CO_2 label in a showroom in Istanbul, Turkey. *Photograph taken by author*.

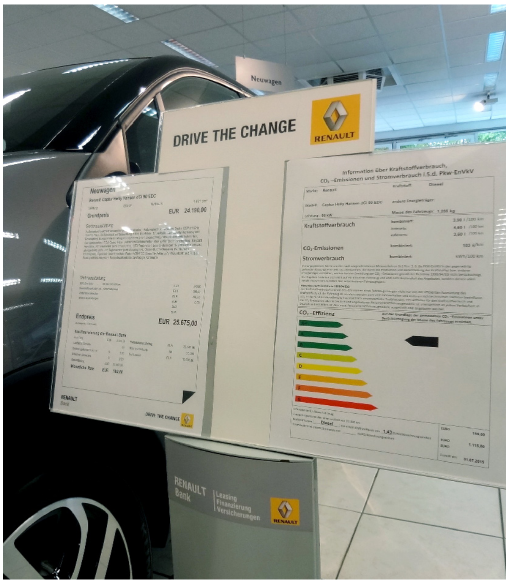
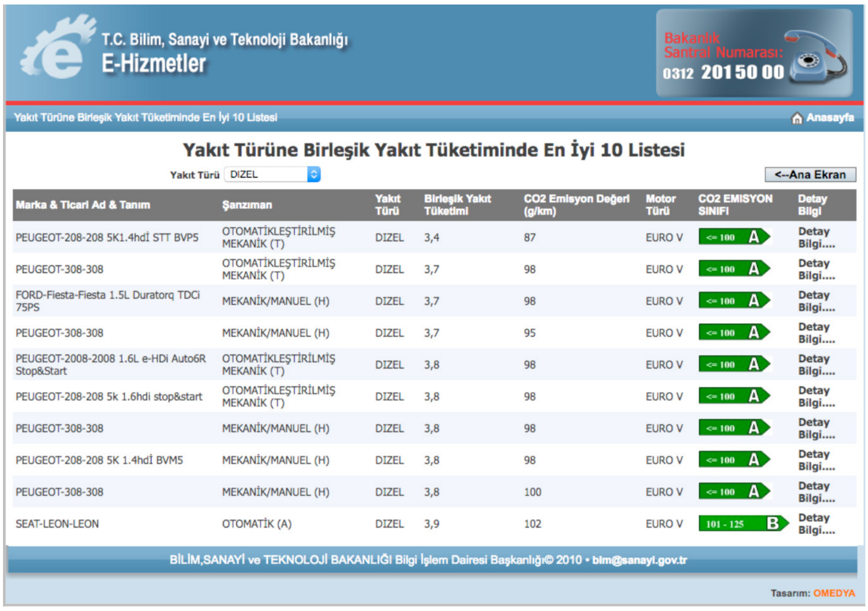


Figure 16. Vehicle CO_2 label in a showroom in Berlin, Germany. *Photograph taken by author*.

In addition to the CO_2 label itself at the point of purchase, the regulations in both Turkey and the EU foresee additional ways of informing customers about the CO_2 emission levels of vehicles on offer. One way is providing data on vehicle CO_2 emissions online in the form of a website. In Turkey, the respective website is hosted by the Ministry for Science, Industry and Technology (Bilim, Sanayi ve Teknoloji Bakanlığı). As Figure 17 shows, the website offers users the ability to filter for certain vehicles. However, when accessing the website in February 2015 and in April 2016, this filtering function did not work. A function to download a list of available vehicle models with their respective CO_2 emission levels also did not work. The only function working properly was a list of the top 10 vehicle models with the lowest CO_2 emission levels by fuel type (Figure 18).

Figure 17. Welcome screen of a website hosted by the Turkish Ministry for Science, Industry and Technology to inform consumers about the CO_2 emission levels of new passenger car models. *Source:* https://bim.sanayi.gov.tr/temp/ARAC_HALK_YENI.



Marka & Ticari Ad & Tanım	Şanzıman	Yakıt Türü	Birleşik Yakıt Tüketimi	CO2 Emisyon Değeri (g/km)	Motor Türü	CO2 EMISYON SINIFI	Detay Bilgi
PEUGEOT-208-208 5K1.4hdİ STT BVP5	OTOMATİKLEŞTİRİLMİŞ MEKANİK (T)	DİZEL	3,4	87	EURO V	<= 100 A	Detay Bilgi....
PEUGEOT-308-308	OTOMATİKLEŞTİRİLMİŞ MEKANİK (T)	DİZEL	3,7	98	EURO V	<= 100 A	Detay Bilgi....
FORD-Fiesta-Fiesta 1.5L Duratorq TDCi 75PS	MEKANİK/MANUEL (H)	DİZEL	3,7	98	EURO V	<= 100 A	Detay Bilgi....
PEUGEOT-308-308	MEKANİK/MANUEL (H)	DİZEL	3,7	95	EURO V	<= 100 A	Detay Bilgi....
PEUGEOT-2008-2008 1.6L e-HDi Auto6R Stop&Start	OTOMATİKLEŞTİRİLMİŞ MEKANİK (T)	DİZEL	3,8	98	EURO V	<= 100 A	Detay Bilgi....
PEUGEOT-208-208 5k 1.6hdi stop&start	OTOMATİKLEŞTİRİLMİŞ MEKANİK (T)	DİZEL	3,8	98	EURO V	<= 100 A	Detay Bilgi....
PEUGEOT-308-308	MEKANİK/MANUEL (H)	DİZEL	3,8	98	EURO V	<= 100 A	Detay Bilgi....
PEUGEOT-208-208 5K 1.4hdİ BVM5	MEKANİK/MANUEL (H)	DİZEL	3,8	98	EURO V	<= 100 A	Detay Bilgi....
PEUGEOT-308-308	MEKANİK/MANUEL (H)	DİZEL	3,8	100	EURO V	<= 100 A	Detay Bilgi....
SEAT-LEON-LEON	OTOMATİK (A)	DİZEL	3,9	102	EURO V	101 - 125 B	Detay Bilgi....

Figure 18. List of top 10 passenger car models with the lowest CO_2 emission levels by fuel type (diesel fuel in this case). *Source:* https://bim.sanayi.gov.tr/temp/ARAC_HALK_YENI.

When selecting one of the vehicle models, additional data on engine and transmission characteristics could be displayed, as well as the emissions data according to the NEDC test procedure, not only for CO_2 but also for other pollutants (Figure 19).

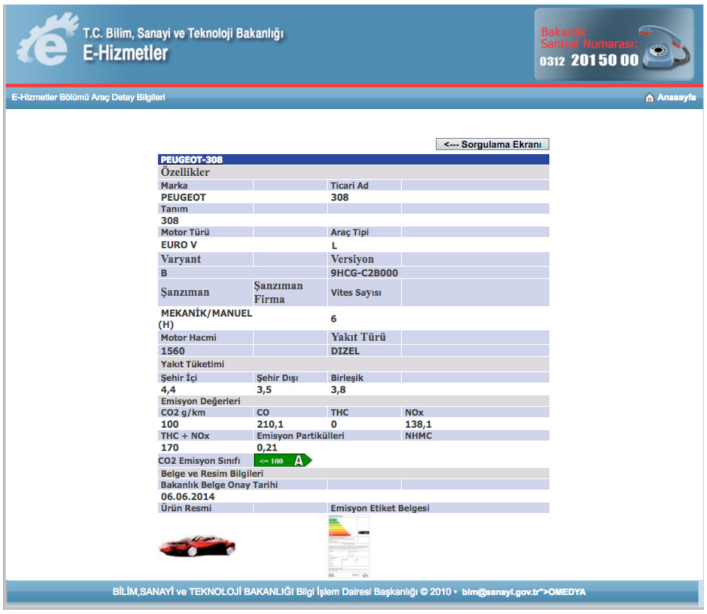


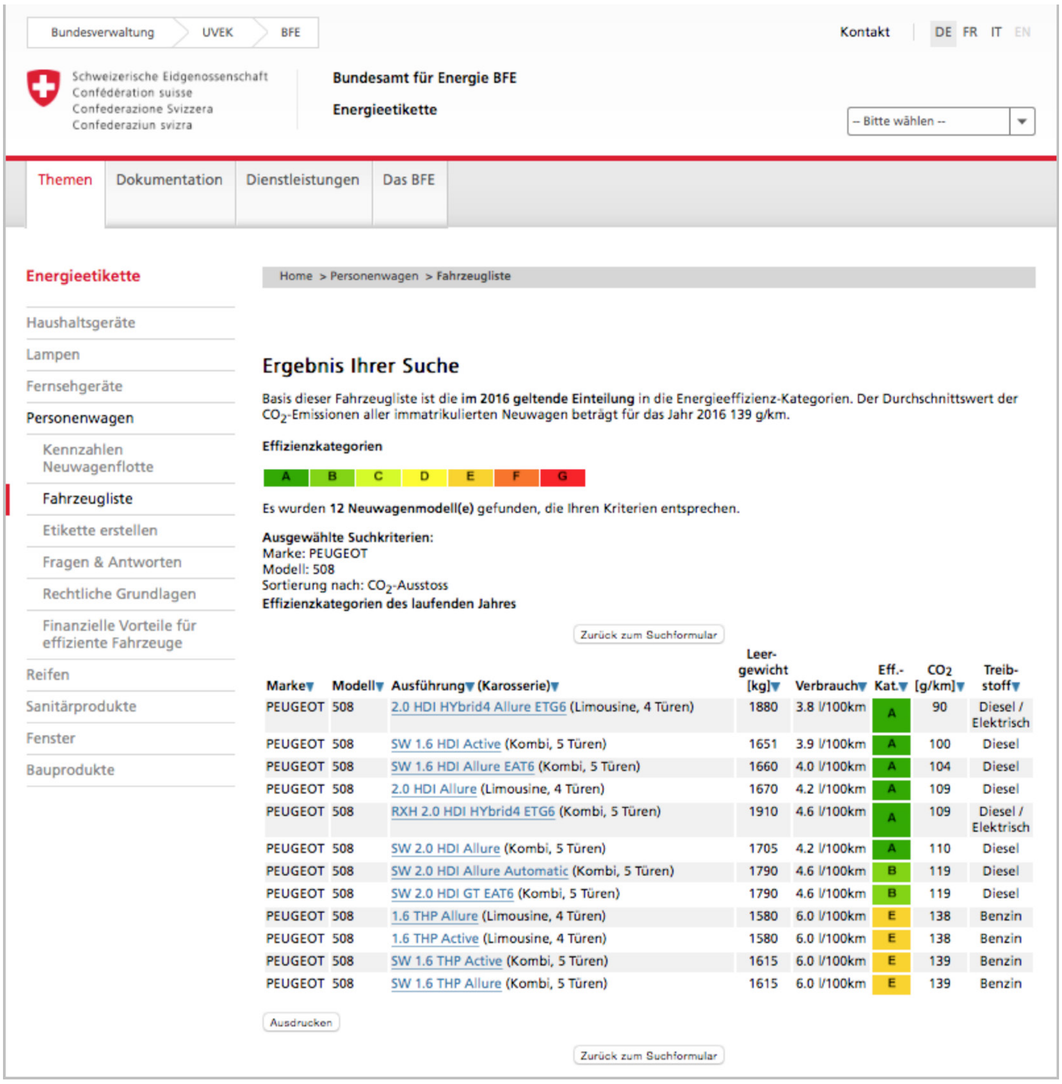
Figure 19. Example of the information provided for a specific selected vehicle model to an interested customer in Turkey. *Source:* https://bim.sanayi.gov.tr/temp/ARAC_HALK_YENI.

Given the technical problems with accessing the website itself as well as the design layout, which was perceived as difficult to interpret by an average customer, it is questionable if the current version of the website in Turkey is indeed successful in providing useful information to potential customers and thereby allowing them to make better informed purchase decisions.

3.2 BEST-PRACTICE EXAMPLES FROM WORLD MARKETS

The vehicle CO_2 label and the information complementing it are not harmonized among countries. Even within the EU, at this point the CO_2 labeling directive provides only a general framework, leaving the EU member states a significant level of freedom in terms of how to design the layout of the label, the customer website, and so on.

As a best-practice example of a website for consumer information, Figure 20 shows the corresponding website in Switzerland, hosted by that country's National Energy Agency (Bundesamt für Energie). Here, the user has the possibility to filter for certain vehicles using a number of available filter criteria. On the results page, all vehicles that fit within the filter criteria are then shown in an easy-to-compare way, including their color code ratings. For more information the customer can click on a specific vehicle to learn about the full set of data available. All information is provided in a way that is clearly structured and easy for the average consumer to understand.



Bundesverwaltung | UVEK | BFE

Kontakt | DE FR IT EN

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Energie BFE
Energieetikette

-- Bitte wählen --

Themen | Dokumentation | Dienstleistungen | Das BFE

Energieetikette

- Haushaltsgeräte
- Lampen
- Fernsehgeräte
- Personenwagen
  - Kennzahlen Neuwagenflotte
  - Fahrzeugliste
  - Etikette erstellen
  - Fragen & Antworten
  - Rechtliche Grundlagen
  - Finanzielle Vorteile für effiziente Fahrzeuge
- Reifen
- Sanitärprodukte
- Fenster
- Bauprodukte

Home > Personenwagen > Fahrzeugliste

Ergebnis Ihrer Suche

Basis dieser Fahrzeugliste ist die **im 2016 geltende Einteilung** in die Energieeffizienz-Kategorien. Der Durchschnittswert der CO_2-Emissionen aller immatrikulierten Neuwagen beträgt für das Jahr 2016 139 g/km.

Effizienzkategorien

A B C D E F G

Es wurden **12 Neuwagenmodell(e)** gefunden, die Ihren Kriterien entsprechen.

Ausgewählte Suchkriterien:
Marke: PEUGEOT
Modell: 508
Sortierung nach: CO_2-Ausstoss
Effizienzkategorien des laufenden Jahres

Zurück zum Suchformular

Marke	Modell	Ausführung (Karosserie)	Leergewicht [kg]	Verbrauch	Eff.-Kat.	CO2 [g/km]	Treibstoff
PEUGEOT	508	2.0 HDI HYbrid4 Allure ETG6 (Limousine, 4 Türen)	1880	3.8 l/100km	A	90	Diesel / Elektrisch
PEUGEOT	508	SW 1.6 HDI Active (Kombi, 5 Türen)	1651	3.9 l/100km	A	100	Diesel
PEUGEOT	508	SW 1.6 HDI Allure EAT6 (Kombi, 5 Türen)	1660	4.0 l/100km	A	104	Diesel
PEUGEOT	508	2.0 HDI Allure (Limousine, 4 Türen)	1670	4.2 l/100km	A	109	Diesel
PEUGEOT	508	RXH 2.0 HDI HYbrid4 ETG6 (Kombi, 5 Türen)	1910	4.6 l/100km	A	109	Diesel / Elektrisch
PEUGEOT	508	SW 2.0 HDI Allure (Kombi, 5 Türen)	1705	4.2 l/100km	A	110	Diesel
PEUGEOT	508	SW 2.0 HDI Allure Automatic (Kombi, 5 Türen)	1790	4.6 l/100km	B	119	Diesel
PEUGEOT	508	SW 2.0 HDI GT EAT6 (Kombi, 5 Türen)	1790	4.6 l/100km	B	119	Diesel
PEUGEOT	508	1.6 THP Allure (Limousine, 4 Türen)	1580	6.0 l/100km	E	138	Benzin
PEUGEOT	508	1.6 THP Active (Limousine, 4 Türen)	1580	6.0 l/100km	E	138	Benzin
PEUGEOT	508	SW 1.6 THP Active (Kombi, 5 Türen)	1615	6.0 l/100km	E	139	Benzin
PEUGEOT	508	SW 1.6 THP Allure (Kombi, 5 Türen)	1615	6.0 l/100km	E	139	Benzin

Ausdrucken

Zurück zum Suchformular

Figure 20. Best-practice example of a consumer information website on new car CO_2 emission levels, hosted by the Swiss National Energy Agency. *Source:* http://www.bfe.admin.ch/energieetikette/00962/00964/index.html?lang=de

With respect to the CO_2 label itself, the label being used in the UK is often referred to as a best-practice example. In comparison to labels in Turkey, a main difference is the fact that the UK label provides information on the estimated yearly running costs, expressed as the fuel costs over a vehicle mileage of 12,000 miles (Figure 21). In addition, the level of applicable vehicle registration and annual vehicle tax also is provided on the label. All of this financial information is prominently placed toward the center of the label, close to the color-coded ranking. Previous studies have found that consumers value this kind of quantitative information on running costs and taxation levels and that it can have a measureable impact on customer purchase behavior (LowCVP, 2010).

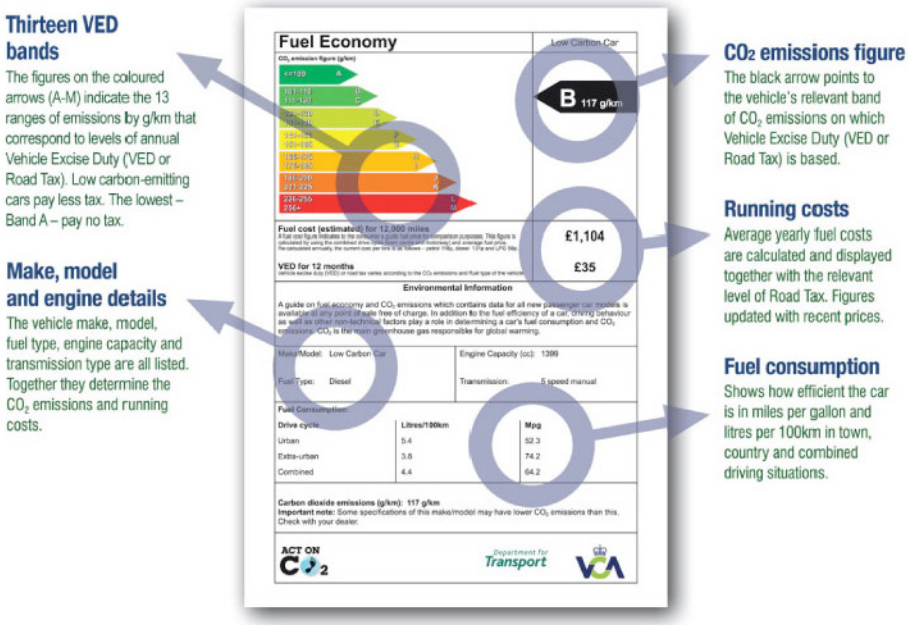


Figure 21. New car CO_2 label in the UK, including explanation of key features.
Source: http://www.unep.org/transport/gfei/autotool/approaches/information/labeling.asp.

Similarly, the vehicle fuel economy label in the U.S. and the corresponding website of the U.S. Department of Energy prominently feature information on the running cost of a vehicle (Figure 22 and Figure 23). The information is compared to statistics on the average new vehicle (e.g., "*You save $[...] in fuel costs over 5 years compared to the average new vehicle*"). In addition to information on the official laboratory test fuel efficiency of a vehicle, the U.S. website features unofficial estimates on the real-world behavior of the vehicle.

In the example of the Toyota Prius below, the official fuel economy rating is 50 miles per gallon (MPG), equivalent to about 4.7 l/100 km or 110 g/km of CO_2. In comparison, based on the reporting of 12 consumers who drive this specific Toyota Prius vehicle version, the real-world fuel economy is 44.7 MPG (5.3 l/100 km, 123 g/km CO_2). The data underlying these real-world driving estimates are derived from input of more than 40,000 drivers who regularly report about their everyday experience on the "My MPG" website,[8] thereby allowing other consumers to take into account these real-world figures for their own vehicle purchases.

8 https://www.fueleconomy.gov/mpg/MPG.do

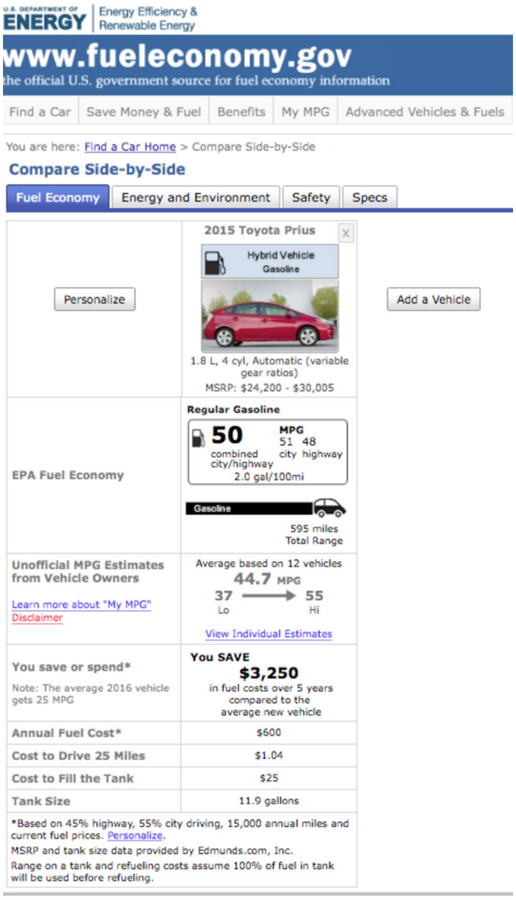


Figure 22. Consumer website on new vehicle fuel economy levels, hosted by the U.S. Department of Energy. *Source:* http://www.fueleconomy.gov/feg/findacar.shtml.

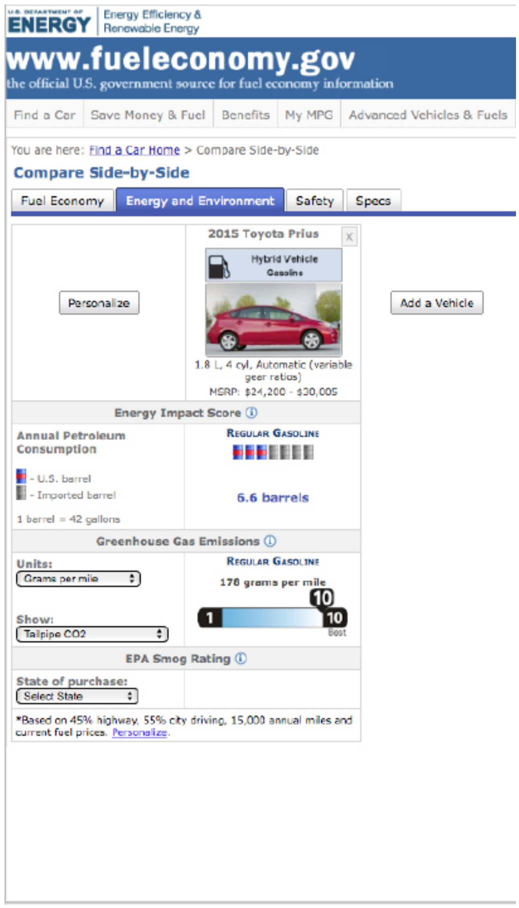


Figure 23. Consumer website on new vehicle energy consumption and air pollutant emission levels, hosted by the U.S. Department of Energy. *Source:* http://www.fueleconomy.gov/feg/findacar.shtml.

The most recent overview of vehicle CO_2 labeling schemes across a number of countries can be found in a November 2015 report for the Asia-Pacific Economic Cooperation (APEC) (Yang et al., 2015). In addition, the Global Fuel Economy Initiative (GFEI) maintains a website summarizing vehicle CO_2 policy measures, including CO_2 labeling schemes.[9]

Table 3 shows a comparative assessment of vehicle CO_2 labeling schemes in selected vehicle markets, taken from the 2015 APEC report. For this report, Turkey was added to the original table to allow for a direct comparison with other markets worldwide. An explanation of the rating system applied can be found in Table 19 of the APEC report (Yang et al., 2015).

9 http://www.unep.org/transport/gfei/autotool/approaches/information/labeling.asp

Table 3. Comparative evaluation of vehicle CO_2 labeling schemes in selected markets. *Based on Yang et al., 2015.*[10]

	1-1. Legislative/regulatory support	1-2. Other fuel efficiency related policies	2-1. Mandatory VFEL requirement	2-2. Broad coverage of the VFEL program	2-3. Understanding the market	2-4. Accurate information that reflects vehicle real-world performance	3-1. Understandable fuel efficiency/CO_2 emissions information	3-2. Indication of running cost or financial penalties/rewards	3-3. Comparable information for AFVs	3-4. Specialized information for advanced technologies	4-1. User-friendly website providing VFEL information	4-2. Mandatory fuel efficiency information in other media	4-3. Direct communication channels with consumers	5-1. Audits of vehicle fuel efficiency/CO_2 emissions test	5-2. Encourage and ensure label requirement compliance	6-1. Periodic VFEL effectiveness assessment
Turkey																
Turkey	Green	Red	Green	Yellow	Red	Red	Green	Red	Yellow	Red	Red	Yellow	Red	Red	Red	Red
Other selected vehicle markets																
Australia	Yellow	Red	Green	Yellow	Yellow	Yellow	Yellow	Red	Yellow	Green	Green	Red	Yellow	Yellow	Red	Red
Austria	Yellow	Green	Green	Yellow	Yellow	Yellow	Green	Green	Green	Red	Yellow	Green	Red	Red	Yellow	Red
Brazil	Yellow	Yellow	Green	Yellow	Yellow	Red	Green	Red	Yellow	Yellow	Green	Green	Green	Green	Yellow	Yellow
Canada	Yellow	Red	Red	Yellow	Yellow	Red	Yellow	Green	Green	Green	Yellow	Red	Green	Yellow	Yellow	Red
Chile	Yellow	Red	Green	Yellow	Yellow	Red	Yellow	Red	Red	Red	Green	Yellow	Yellow	Yellow	Yellow	Red
China	Yellow	Yellow	Green	Yellow	Green	Red	Yellow	Red	Red	Red	Yellow	Red	Red	Yellow	Red	Yellow
Germany	Green	Yellow	Green	Yellow	Red	Yellow	Green	Green	Green	Red	Green	Green	Red	Red	Green	Red
Japan	Yellow	Green	Green	Yellow	Yellow	Red	Yellow	Red	Red	Red	Red	Yellow	Red	Red	Red	Red
South Korea	Green	Yellow	Green	Yellow	Green	Green	Green	Red	Red	Green	Yellow	Green	Red	Green	Yellow	Red
Netherlands	Yellow	Green	Green	Yellow	Yellow	Yellow	Green	Red	Yellow	Red	Yellow	Red	Red	Red	Yellow	Yellow
New Zealand	Green	Red	Yellow	Green	Green	Yellow	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Green	Green
United Kingdom	Yellow	Green	Yellow	Green	Green	Yellow	Green	Green	Green	Green	Yellow	Green	Green	Red	Yellow	Green
United States	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Green

Note Green: Follows best practice, or follows most best practices. Yellow: Meets some best practices, some room for improvement. Red: Follows few or none of the best practices, with room for improvement

When comparing the current vehicle CO_2 labeling scheme in Turkey to corresponding schemes in other markets in Table 3, it is notable that the labeling scheme is not linked to other fuel efficiency related policies, identified here as best practice 1-2. In particular, there is no mandatory CO_2 regulation for new cars in place in Turkey for which the CO_2 label could help to leverage any effects on customer purchase behavior. Similarly, there is no CO_2-based vehicle taxation scheme in place in Turkey for which the CO_2 label could help to raise consumer awareness.

Ideally, all three elements—CO_2 vehicle standards, CO_2 vehicle labeling, and CO_2-based vehicle taxation—together would help to create a market "push" and "pull" situation wherein low-CO_2 vehicles would be produced and offered by vehicle manufacturers ("push") and those vehicles would be demanded and purchased by consumers ("pull"), thereby leveraging the CO_2 reduction effects of each of these individual policy measures. An additional element missing from the CO_2 labeling scheme in Turkey, compared to other markets, is the indication of running costs or other financial parameters to the customer, identified as best practice 3-2. This information would help consumers better understand the financial implications of their purchase decisions and how low-CO_2 emission vehicles help reduce their spending on fuel over the lifetime of the vehicle. Improving the vehicle CO_2 information website to be more user-friendly, best practice 4-1; providing an indication of real-world fuel consumption and CO_2 emission data to consumers, best practice 2-4; and providing special consideration of the efficiency of advanced technologies, such as electric vehicles, best practice 3-4, are other important elements where the CO_2 labeling scheme in Turkey could be strengthened.

10 VFEL = Vehicle Fuel Efficiency Labeling; AFVs = Alternative Fuel Vehicles

4 CO_2-BASED VEHICLE TAXATION

Most countries have implemented taxes on vehicle purchase and/or vehicle ownership. Using a vehicle's CO_2 emissions as the basis for its taxation level results in a situation where the customer pays less tax if the vehicle emits less CO_2. As a result, there is an incentive for customers to choose vehicles with lower CO_2 emissions, thereby helping to reduce the average CO_2 emission level of the new vehicle fleet and also supporting vehicle manufacturers in their attempt to sell vehicles with lower CO_2 emissions.

4.1 THE CURRENT SITUATION IN TURKEY

New passenger cars in Turkey are subject to the general VAT (Katma Değer Vergisi—KDV—in Turkish), which is 18% and applies to all goods. In addition, a special sales tax is levied, the Motorlu Taşıt Araçlarına İlişkin Özel Tüketim Vergisi (ÖTV), also called Special Consumption Tax (SCT). In addition to cars, ÖTV is levied upon some other goods categories, such as petroleum products, tobacco, alcohol, and luxury products.

The amount of ÖTV to be collected depends on the vehicle's engine displacement and ranges from 45% to 145% of the net sales price, without taxes, as shown in Table 4. VAT is then added to the sum of the net price and ÖTV, resulting in the gross sales price of the vehicle. In addition to these taxes, which are applied once at vehicle purchase, all passenger cars in Turkey are subject to an annual ownership tax, the *Motorlu Taşıtlar Vergisi* (MTV). This annual tax is again linked to the engine displacement of the vehicle, and it decreases with the age of the vehicle.

Table 4. Overview of passenger car vehicle taxes in Turkey in 2015. *Data source: ACEA, 2015.*

Engine displacement (l)	Special sales tax ("OTV"), one-time	Value-added tax ("KDV"), one-time	Ownership tax ("MTV"), annual (in TL), based on age of vehicle				
			year 1-3	year 4-6	year 7-11	year 12-15	more than 16
≤ 1.3	45% of net sales price	18% of net sales price + special sales tax	591	412	231	175	63
> 1.3 and ≤1.6			945	709	412	291	112
> 1.6 and ≤1.8	90% of net sales price		1,667	1,304	786	469	182
> 1.8 and ≤2.0			2,626	2,024	1,189	709	280
> 2.0 and ≤2.5	145% of net sales price		3,939	2,860	1,787	1,068	423
> 2.5 and ≤3.0			5,491	4,777	2,985	1,607	591
> 3.0 and ≤3.5			8,362	7,524	4,553	2,263	831
> 3.5 and ≤4.0			13,147	11,352	6,686	2,985	1,189
> 4.0			21,516	16,135	9,556	4,296	1,667

The ÖTV in particular strongly influences customer purchase behavior. One indication is the fact that 95% of all new cars in Turkey have an engine displacement of 1.6l or less. By comparison, in the EU only about 70% of all new cars have 1.6l or smaller engines. In fact, 40% of cars in Turkey are right at the tax threshold of 1.6l, indicating the importance of this step in the tax rate.

Figure 24 illustrates the current situation, using the example of a new car with a net sales price of 66,000 TL (20,000 euros). The tax difference between a vehicle with a 1.6l engine and one with a 1.7l engine then is 29,700 TL (9,000 euros) if considering only ÖTV and 31,866 TL (9,700 euros) if also taking into account MTV for the first three years of ownership. This significant difference in taxation levels provides a strong incentive for consumers to pick a vehicle with an engine displacement of 1.6l or less. A similar tax threshold can be found at the 2.0l engine size. Again using the example of a 66,000 TL vehicle, the tax difference between a 2.0l and a 2.1l engine size amounts to 40,239 TL (12,200 euros). As a result, another clustering of new car sales around the 2.0l tax threshold is observed, accounting for nearly 5% of vehicle sales. Vehicles above the 2.0l engine size are very rarely found in the Turkish new car fleet.

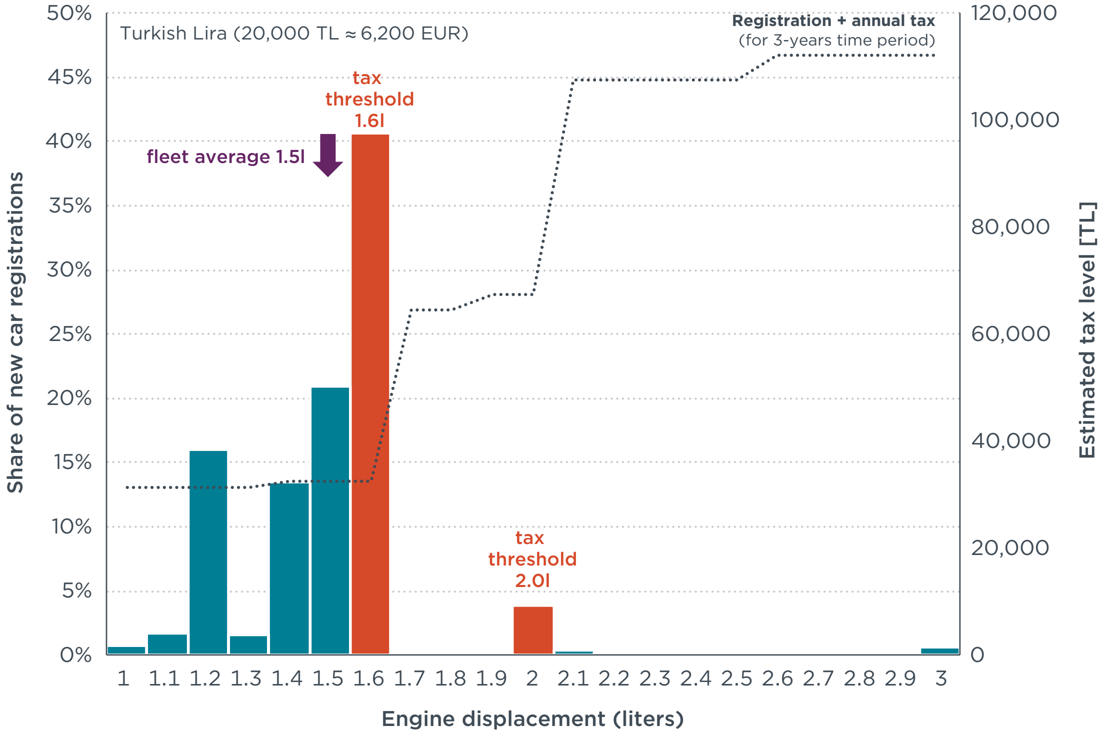


Figure 24. Taxation levels for a 66,000 TL (20,000 euros) new car in Turkey and distribution of new car sales by engine displacement. *Data source: ICCT, 2015a; ACEA, 2015.*

In order to assess the effect of the current vehicle taxation scheme in Turkey on consumer prices, five vehicle models were selected and compared to the same vehicle models in Germany, France, and the Netherlands. Each of the selected vehicle models is the most popular model within its respective vehicle size segment.

The first three models—the VW Polo, Golf, and Passat—fall below the 2.0l threshold and, therefore, in Turkey are subject to 45% ÖTV. It can be seen in Figure 25 how the impact of ÖTV increases with vehicle value, which is highest for the Passat. In Germany, there is no vehicle sales tax equivalent to the ÖTV in Turkey. In France, a vehicle sales tax is in place but applies only to vehicles above 130 g/km of CO_2. As all of the vehicle models examined are below this CO_2 threshold, they are not subject to a sales tax in France. In the Netherlands, vehicle sales tax is linked to the vehicle's CO_2 emissions. CO_2 emission, and thus sales tax, is lowest for the VW Polo but increases significantly with the other vehicle models examined. An annual vehicle ownership tax does not exist in France and ownership tax rates are very low in Turkey, Germany, and the Netherlands when compared to the sales price of the vehicle. VAT rates are similar in all four markets.

The fourth vehicle, again a VW Passat, falls above the 2.0l engine displacement tax threshold in Turkey and, therefore, is subject to 90% ÖTV. The impact of the ÖTV is even stronger in the case of the fifth vehicle, a 3.0l engine Mercedes-Benz E350. In comparison, these two vehicles in France are neither subject to a sales tax nor a high annual tax, only to a minimal annual ownership tax. In the Netherlands, the sales tax increases notably for the 2.0l VW Passat and the E350. It is, however, still only about half of the tax level in Turkey for the Passat and about one-fifth for the E350.

Overall, it can be seen that gross vehicle prices, which include taxes, for the vehicles below 1.6l engine size are relatively similar for Turkey, Germany, and France, with the prices in the Netherlands being notably higher than in the other three markets. For the 2.0l Passat and the 3.0l E350, however, consumer prices in Turkey are significantly higher than in Germany and France. Even though tax levels for these two vehicles are comparably high in the Netherlands, vehicle prices are still lower than in Turkey. It is remarkable that for all five vehicles examined net vehicle prices are lower in Turkey than in Germany, France, and also the Netherlands. This is possibly an effort of vehicle manufacturers to compensate for the relatively high vehicle taxation rates in Turkey by offering the vehicles with a lower profit margin in Turkey than in other markets.

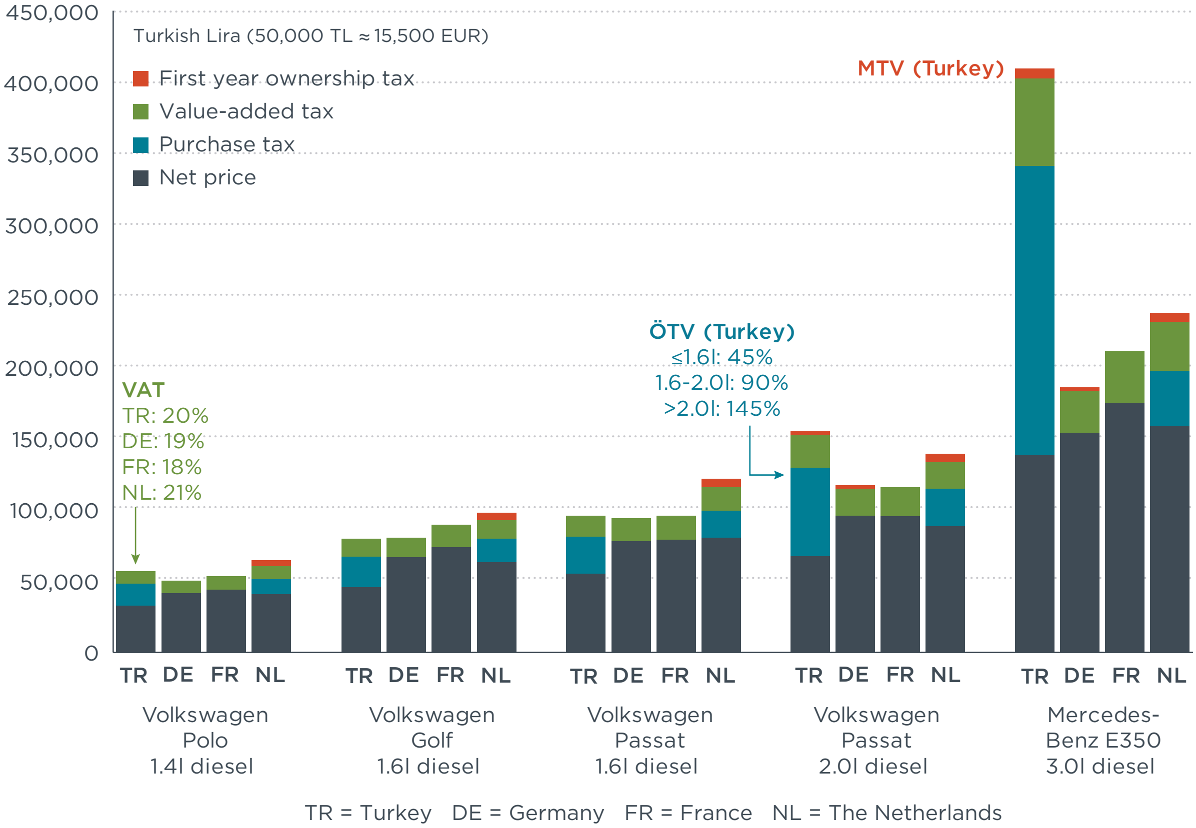


Figure 25. Sales prices and taxation levels for selected vehicle models in Turkey, German, France and Netherlands.[11] *Data from vehicle manufacturers' sales brochures and ACEA 2015.*

From a government perspective, vehicle taxes account for a significant share of tax revenues in Turkey. In 2014, vehicle ÖTV revenue amounted to 12.9 billion TL (3.6 billion euros) (Republic of Turkey Presidency of Revenue Administration, 2016). Even though MTV rates are much lower on a per-vehicle basis, MTV revenue amounted to a similar level, at 7.8 billion TL (2.3 billion euros) in 2014. This is because MTV is imposed every year throughout the lifetime of a vehicle and covers the entire vehicle fleet on the road (about 9.9 million cars), not only new vehicle sales (about 0.6 million cars). The overall tax revenue of the central government in Turkey was 401.7 billion TL (121.7 billion euros) in 2014. Hence, ÖTV and MTV together accounted for about 5.2% of total tax revenue. By comparison, vehicle tax revenue in Germany in 2014 amounted to 8.5 billion euros, representing about 1.5% of the government's total tax revenue (585.9 billion euros), excluding tax revenue at the municipality level (Bundesministerium der Finanzen, 2016).

4.2 POTENTIAL ALTERNATIVE APPROACHES

As has been shown, vehicle taxation levels in Turkey are relatively high and, as a result, have a strong effect on consumer purchase behavior. However, taxes for passenger cars

11 Wherever possible, vehicle prices were adjusted for differences in optional equipment.

in Turkey currently are linked only to the engine displacement and price of a vehicle. They therefore provide an incentive to choose a vehicle with lower engine displacement and lower net price.

There is a correlation between a vehicle's engine displacement, its fuel consumption, and its CO_2 emission level (He & Bandivadekar, 2011). However, this correlation is not particularly strong, and it is also no longer necessarily valid for modern vehicles. For example, a hybrid-electric vehicle generally has significantly lower fuel consumption and CO_2 emission levels than a conventional combustion engine vehicle, despite the fact that its engine displacement might be the same or very similar to that of a conventional gasoline or diesel vehicle. Another example is the worldwide explosion in turbocharged engines. A 1.6l turbocharged engine can easily match the performance of a 2.5l naturally aspirated engine, but its fuel consumption and CO_2 emissions are far higher than 1.6l naturally aspirated engines. Hence, it can be concluded that the current passenger car taxation scheme in Turkey provides a strong steering effect for the vehicle market overall yet, at the same time, a weak effect in terms of increasing the demand for new passenger cars with lower fuel consumption and CO_2 emissions.

In recent years, many countries have changed their vehicle taxation schemes to be based directly on the CO_2 emissions or fuel consumption of new vehicles (ACEA, 2016). For example, France introduced a CO_2-based feebate system in 2008 (Kågeson, 2011). In a feebate system, vehicles above a certain CO_2 threshold, the so-called pivot point, have to pay a fee, or malus, while those vehicles with lower CO_2 emissions receive a rebate, or bonus (He & Bandivadekar, 2011). In the case of the French feebate system, instead of a straight tax-rate line there are many little steps with specific thresholds that determine the bonus or malus level. As a result, while the French feebate system was found to have a significant steering effect, thereby leveraging the CO_2 reductions of the EU-wide vehicle CO_2 standards (INSEE, 2012), it also led to an unintended clustering of new vehicle registrations around the discrete tax thresholds (Mock, 2015b). One additional shortcoming of the French system, particularly in its early years, was that the tax thresholds were not adapted regularly enough to the changing market. As a result of its own success, the bonus payments soon outweighed the malus revenue and, therefore, created an overall financial loss for the French government. The tax thresholds were readjusted in later years and today allow for a tax revenue neutral system. Figure 26 shows the 2015 tax thresholds for the vehicle tax feebate system in France.

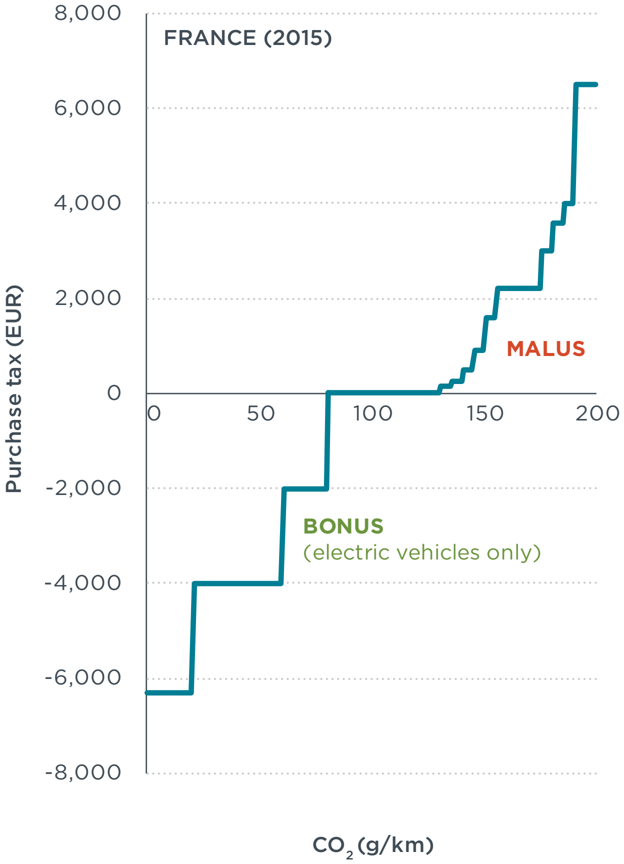


Figure 26. Passenger car sales tax structure in France. *Data source: ACEA, 2015.*

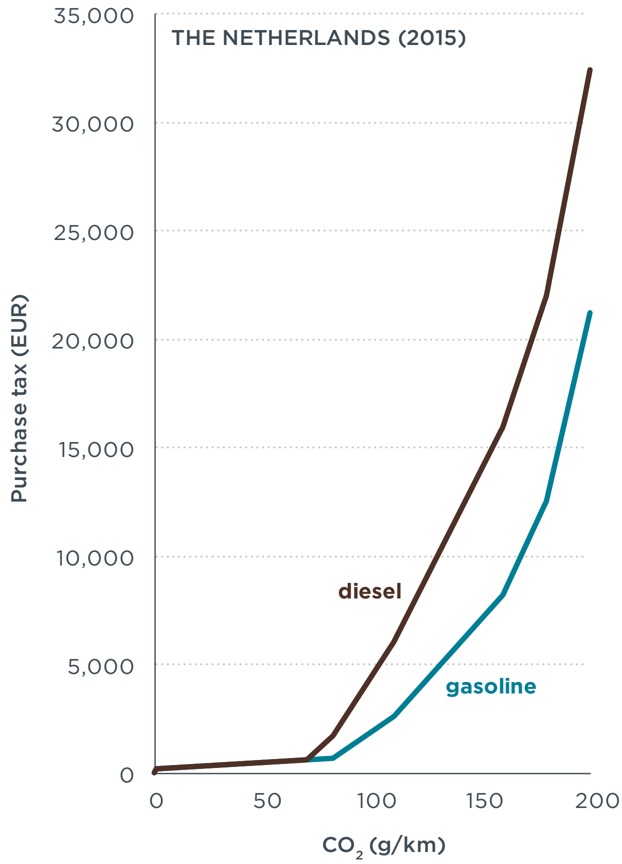


Figure 27. Passenger car sales tax structure in the Netherlands. *Data source: ACEA, 2015.*

By contrast, the vehicle taxation scheme in the Netherlands largely avoids clustering of new registrations around discrete tax thresholds by mostly applying a linear tax rate. As illustrated in Figure 27, the tax rate, which is assessed in euros per g/km of CO_2, is the same throughout a large CO_2 range. The Dutch system does not offer any bonus payments for vehicles below a certain CO_2 threshold but instead solely imposes a malus for all vehicles, varying drastically depending on the respective CO_2 emissions of a vehicle. The taxation rate for diesel cars is higher than for gasoline cars, primarily to account for the negative side effects of diesel engines with respect to air quality. The Netherlands switched to a CO_2-based taxation scheme in 2007. Since then, the CO_2 emission level of newly registered passenger cars in the Netherlands has fallen significantly more quickly than in other EU countries (Kok, 2013).

Generally, a one-time vehicle tax at the point of purchase has a much stronger influence on customer purchase behavior than an annual tax at a similar level. This is due to the fact that consumers tend to discount future costs as well as future savings; therefore, any payment upfront is more likely to have an impact on the choice of a vehicle (Greene et al., 2008). Furthermore, it is self-evident that the higher the tax level the stronger its impact on purchase behavior is. In this sense, the Turkish vehicle taxation scheme with its comparably high one-time tax on new car purchases will make a heavy impact.

Figure 28 illustrates schematically the design of a best-practice vehicle taxation scheme. The taxation basis should be the CO_2 emission level of a vehicle and a linear tax function should be applied without any discrete tax thresholds. This means that the tax rate, in TL per g/km of CO_2, is the same for every vehicle, thereby ensuring technology neutrality and avoiding any clustering of vehicles around discrete tax thresholds. Vehicles below a set pivot point would receive a bonus payment, while vehicles above the pivot point have to pay a malus. The revenue collected from the malus payments would be used to balance out the bonus payments for low-emission vehicles, thereby ensuring budget neutrality from a government perspective.[12] Additional tax revenue could be collected, if desired by the government, by placing the pivot point in such a way that the sum of revenue collected from malus payments is larger than the sum of bonus payments to low-emission vehicles. It should be noted that these guidelines for designing a CO_2-based vehicle taxation scheme are also shared by vehicle manufacturers (ACEA, 2016). For a simplified system, it would also be possible to not include the payment of a bonus for low-CO_2 emission vehicles and instead only impose a malus payment for all vehicles above a certain threshold.

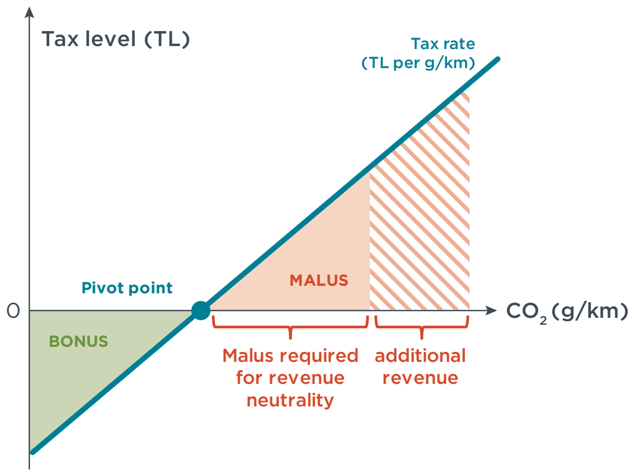


Figure 28. Schematic illustration of best-practice design for a feebate-like vehicle taxation scheme.

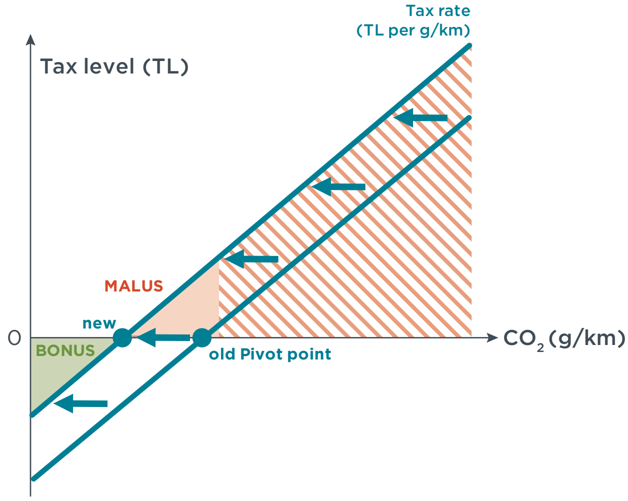


Figure 29. Schematic illustration of adapting a feebate taxation scheme to changes in vehicle market structure.

Finally, it should be emphasized that it is important to regularly adapt a feebate-like taxation scheme to ongoing changes in the vehicle market structure. A successful feebate system will have an impact on customer purchase behavior and also on the manufacturers' vehicle development and marketing strategies, thereby leading to a situation in which the CO_2 emission level of new passenger cars will decrease over time. As a result, the sum of bonus payments will increase and the amount of revenue from malus payments will decrease, thereby threatening government budget neutrality. It is therefore important to regularly adapt the pivot point to ensure that the overall revenue collected remains about the same over time and that the feebate system continues to have an impact on new vehicle purchase behavior. This mechanism for adapting the pivot point of the taxation scheme is illustrated in Figure 29. Ideally, the pivot point of a feebate-like taxation scheme is directly connected to the market average CO_2 emission level. For example, defining the pivot point as always being 3% lower than the market average in the previous year automatically recalibrates the taxation system on a regular basis.

4.3 ASSESSING A REDESIGN OF TURKEY'S VEHICLE TAXATION SCHEME

In order to assess the impacts of modifying the current vehicle taxation scheme in Turkey, a calculation model was developed including details on more than 1,000 vehicle model versions available on the Turkish market in 2014. The parameters covered include fuel type, engine displacement, CO_2 emission level, sales price, and number of registrations in 2014.[13]

12 A feebate simulation tool, designed to assist policy makers in developing a bonus/malus like vehicle CO_2 taxation scheme can be found online: http://www.theicct.org/feebate-simulation-tool

13 The underlying data source is described in more detail in the European Vehicle Market Statistics Pocketbook 2015/16 (ICCT, 2015a). The 2014 vehicles' database was partially updated to reflect the technical specifications of some vehicle models that were introduced more recently, such as the Fiat Linea.

Information on engine displacement was known for all vehicle model versions and, therefore, determined into which ÖTV sales tax category a vehicle falls. For 2014 these categories were 40%, 80%, and 135%. Individual vehicle sales price data were then used to estimate the actual level of ÖTV that applied for each vehicle. Sales price data were available for only 82% of vehicle models. Using the calculated sum of tax revenues for those vehicles for which sales price data were available, the model was calibrated in such a way that the total tax revenue equaled the government ÖTV revenue in 2014, which is to say 12.9 billion TL (3.6 billion euros) (Republic of Turkey Presidency of Revenue Administration, 2016).

In a next step, the 2016 tax rates of 45%, 90%, and 145% were substituted for the 2014 tax rates for each of the respective engine displacement categories. Rerunning the model with these tax rates produced an estimate of total ÖTV revenue for 2016, which was around 14.4 billion TL (4.0 billion euros).

Figures 30 and 31 illustrate this status quo situation of the passenger car taxation scheme in Turkey in 2016. It can be seen that the entire ÖTV revenue originates from taxing vehicles depending on their engine displacement and net sales price with three discrete engine displacement steps. The number of new registrations for a particular vehicle model version is indicated by the size of the bubbles, with selected vehicle examples being highlighted separately. The selected vehicles include some of the top-selling vehicle models within their segments, all of them being diesel-powered except the Toyota Yaris, which was chosen as an example of a hybrid vehicle that is available on the Turkish market. Similar to Figure 24, a clustering of vehicles can be seen at or below the 1.6l engine size. The figure also shows a clustering at the 2.0l engine size, as for the example of the BMW 525. The Porsche Cayenne serves as an example of vehicles that are well above the 2.0l engine size tax threshold.

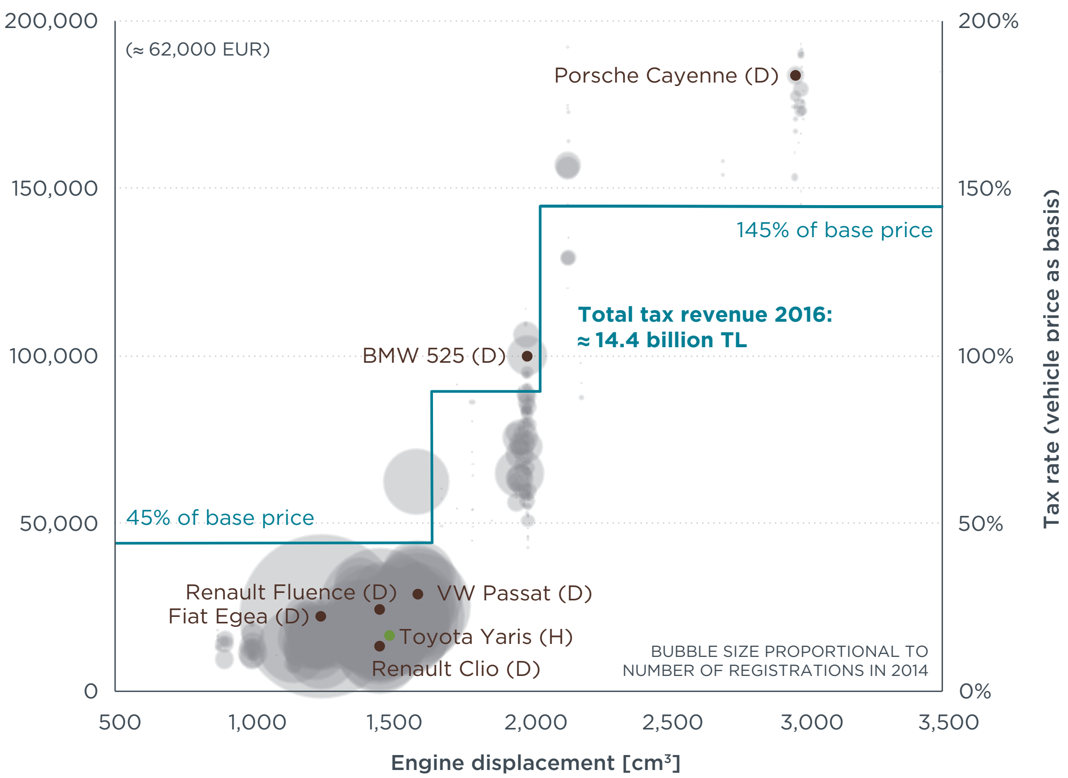


Figure 30. Level of vehicle sales tax (ÖTV) in Turkey in 2016—in the current vehicle taxation scheme –according to vehicle model version level, dependent on engine displacement.

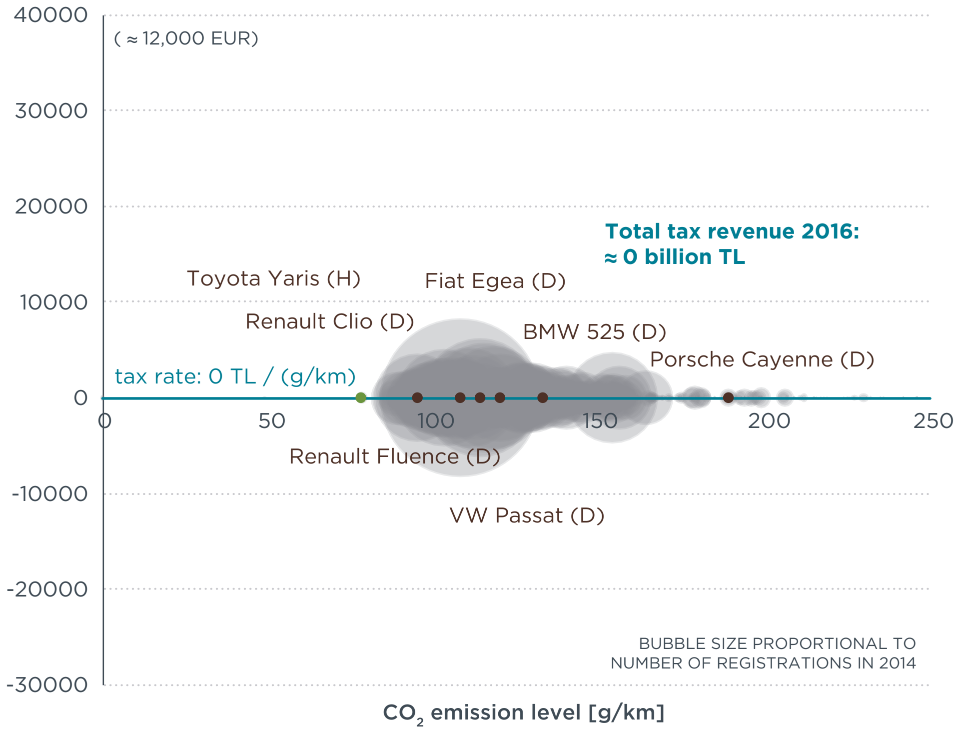


Figure 31. Level of vehicle sales tax (ÖTV) in Turkey in 2016—in the current vehicle taxation scheme –according to vehicle model version level, dependent on CO_2 emission level.

In a next step, a scenario for an alternative vehicle taxation approach for the Turkish market was assessed. Replacing the current engine displacement and net price dependent taxation scheme entirely by a system that would be based solely on the CO_2 emission level of a vehicle was found to be impractical at this point in time. The reason is that the resulting tax rate would have to be extremely steep—approximately 960 TL or 270 euros per g/km of CO_2—in order to raise the same level of revenue as in the current Turkish tax scheme. As a result, the difference in taxation levels between vehicle model variants would be very high, and unintended market distortions would be expected.

Instead, at least for the near term, it is suggested that the current structure remains, with ÖTV being dependent on engine displacement and net sales price. However, the tax rates should be lowered to allow for the introduction of a second taxation element that then would be based on the CO_2 emissions of a vehicle. Instead of the engine displacement dependent taxation levels being 45%, 90%, and 145%, as is currently the case, taxation levels should be lowered to 30%, 80%, and 140%. This would reduce tax revenues by about 4.1 billion TL (1.1 billion euros). This loss in tax revenues could be balanced out by the introduction of a feebate-like system with a tax rate of 258 TL (90 euros) per g/km of CO_2 for gasoline cars and 323 TL (113 euros) per g/km of CO_2 for diesel cars. These tax rates correspond closely to the penalty level imposed by the EU if a vehicle manufacturer does not meet the mandatory EU CO_2 targets and therefore are expected to provide a strong enough incentive for low-emission technology deployment (Smokers et al., 2011).

In the suggested modified vehicle taxation scheme, the taxation level of a vehicle would no longer be dependent only on engine displacement and net sales prices but would also depend on the vehicle's CO_2 emission level. By modifying the current system instead of replacing it with an entirely new system based solely on CO_2, a sudden change in market structure is avoided while a fairly strong steering effect still would be expected. This is due to the fact that vehicle taxation levels in Turkey are high enough so that even a partial switch to a CO_2-based feebate system would be sufficient to generate a notable steering effect. Government budget neutrality would also be ensured as any foregone revenue from the displacement/price part of the taxation scheme would be balanced out by the new CO_2 part. Finally, by lowering the current displacement-dependent taxation rates more for the smaller vehicle size categories than for larger vehicles, social equity is ensured as well.

It is important to mention that, although in the short term—mostly for political reasons—it is recommended to have the vehicle taxation system in Turkey remain at least partly based on engine displacement, for the mid/long term this is not seen as a sustainable and advisable practice. This is due to the fact that engine displacement is not a good proxy for any of the multiple externalities that need to be taxed. Apart from CO_2 emissions those externalities include, for example, air pollution, noise pollution, road wear, and congestion. To address these negative side effects of increased road transportation, a set of policy instruments, including but not limited to vehicle taxation, is needed, targeting each of the mentioned externalities directly rather than through taxing engine displacement as an outdated and unsuitable proxy.

The effect of the change in the taxation scheme described above is illustrated for individual vehicle models in Figures 32 and 33. Compared to the situation in the current taxation scheme, the engine displacement-based taxation levels would decrease for all vehicle models but more so for the vehicles with lower engine displacement and less for the vehicles with higher engine displacement, such as, for example, the Porsche Cayenne or BMW 525. At the same time, thanks to the newly introduced CO_2-based part of the taxation scheme, there would be a differentiation of vehicle models based on their emission levels. The Toyota Yaris hybrid model would benefit from a bonus of about 5,000 TL, while the Renault Clio 95 g/km version would be right at the pivot point of the tax system, thereby being subject to neither bonus nor malus. The other selected vehicle models would have to pay a malus depending on their CO_2 level. As a result of this newly introduced differentiation between vehicle models' CO_2 emission levels there would then be a fiscal incentive for consumers to choose a vehicle model with lower CO_2 emissions than other vehicles available on the market.

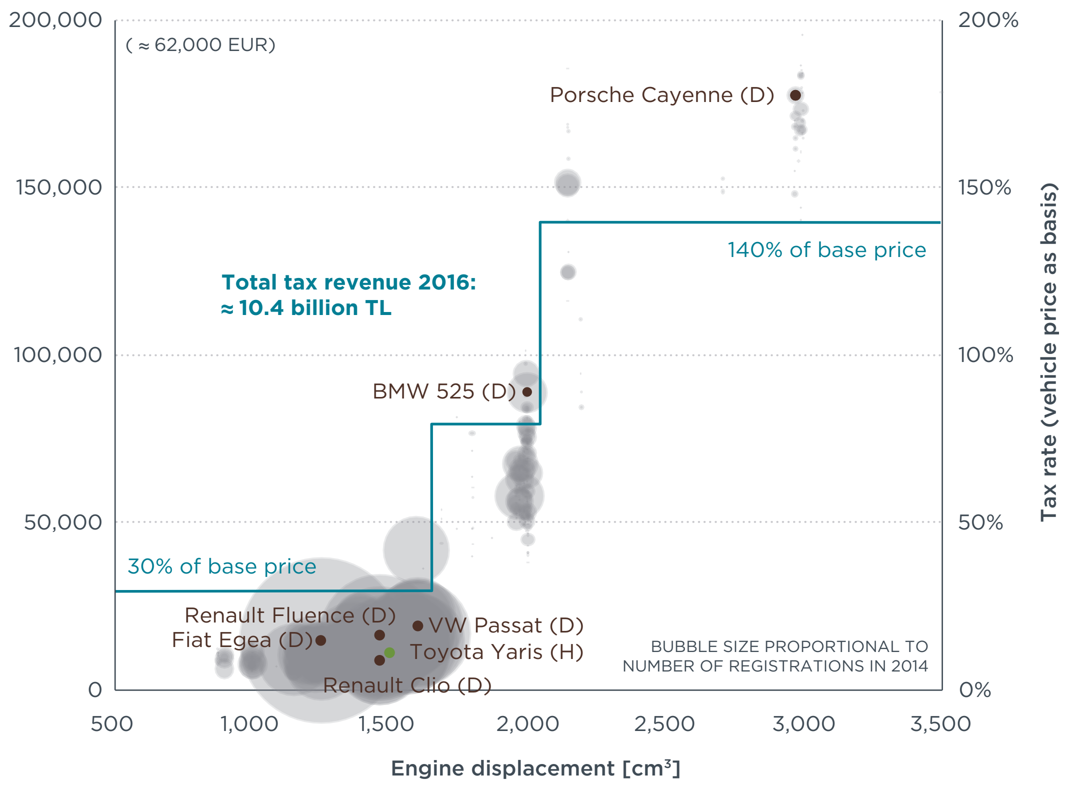


Figure 32. Level of vehicle sales tax (ÖTV) in Turkey in 2016—in an alternative taxation scheme—according to vehicle model version level, dependent on engine displacement.

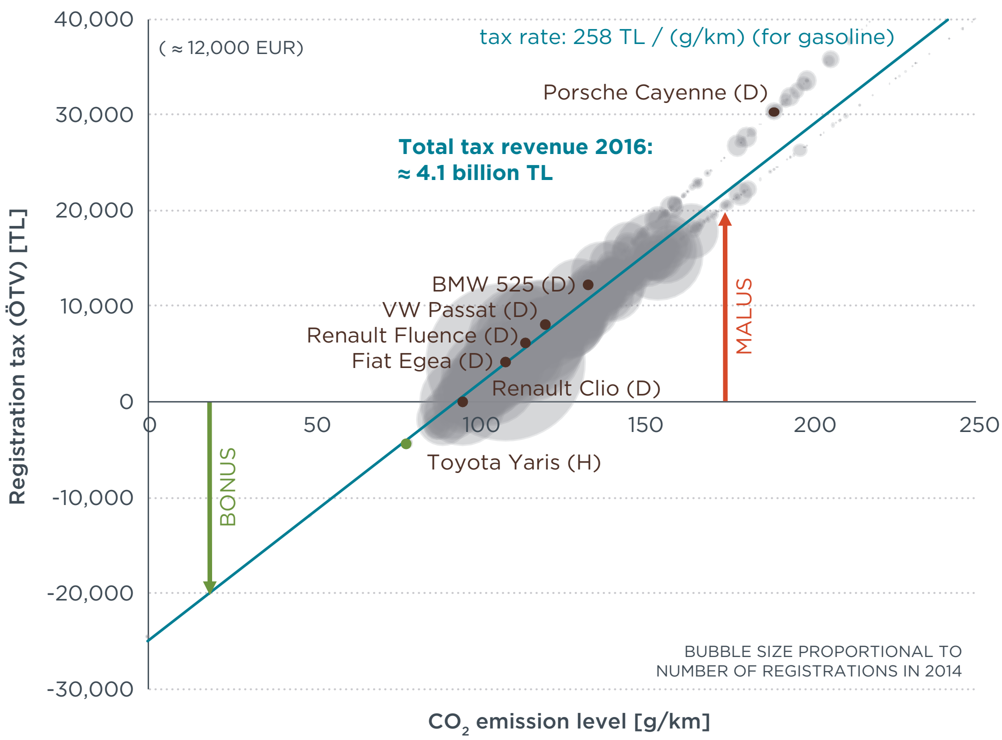


Figure 33. Level of vehicle sales tax (ÖTV) in Turkey in 2016—in an alternative taxation scheme – according to vehicle model version level, dependent on CO_2 emission level. Note that both pillars of the revised taxation system together would ensure tax revenue neutrality (14.5 billion TL).

Figure 34 summarizes the expected effects at the vehicle segment level. For vehicles in the small, lower medium, and medium segments, the suggested switch to a partly CO_2-based taxation scheme would result, on average, in lower tax payments than in the current scheme that is fully based on engine displacement. These segments together account for about 84% of all new passenger car sales in Turkey. In addition, the vehicle models produced locally in Turkey tend to be mostly from these segments. Some examples are the Renault Fluence, Fiat Linea, and Renault Clio. At the same time, the average taxation level for the upper medium and SUV segment models is expected to increase, affecting primarily vehicles imported into the Turkish market.

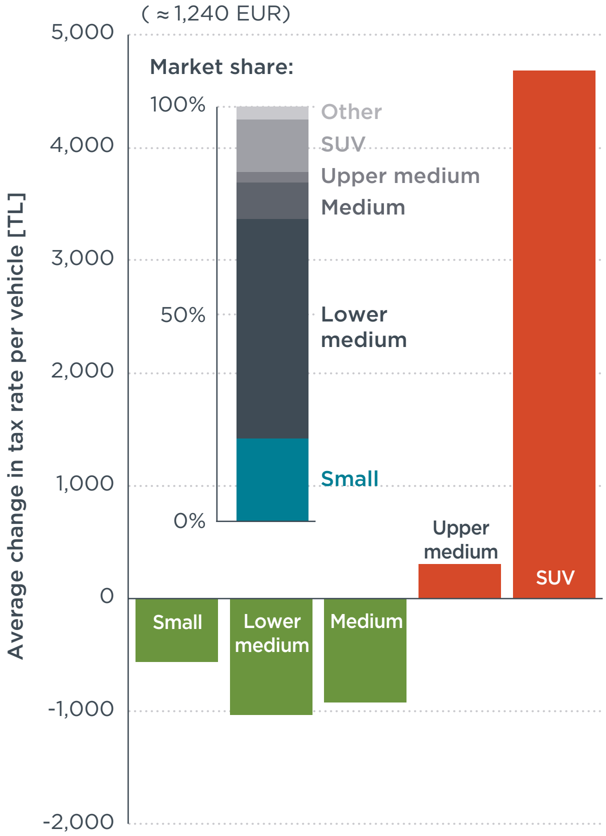


Figure 34. Expected aggregated effect of switching to a partly CO_2-based vehicle taxation scheme in Turkey, by vehicle segment.

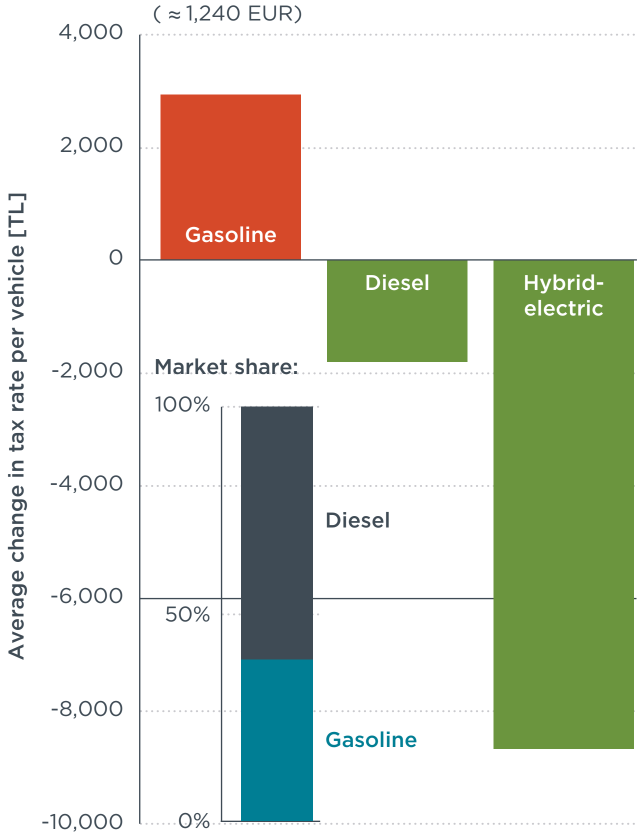


Figure 35. Expected aggregated effect of switching to a partly CO_2-based vehicle taxation scheme in Turkey, by fuel type.

Figure 35 summarizes the expected effect, differentiating by fuel/powertrain types. It can be seen that, on average, gasoline cars would be subject to a slightly higher tax level while diesel cars would benefit from a slightly lower tax rate. In this respect, to better reflect the negative side effects of diesel engines, it would be possible to introduce two different taxation rates for gasoline and diesel vehicles and thereby tax diesel engines proportionally higher. However, the main difference is found between hybrid-electric and fully electric (not shown here) vehicles. These vehicles, which tend to have significantly lower CO_2 emission levels, are penalized in the current taxation scheme given that their engine displacement is about the same or even larger than for conventional gasoline or diesel cars. In the suggested alternative taxation scheme, vehicles are rated based on their emission level, and as a result there would be a strong incentive for consumers to choose hybrid or even fully electric vehicles, thereby benefiting from a significantly reduced tax rate.

Figure 36 depicts the expected effects at the manufacturer level and Figure 37 for selected individual vehicle models. On the one hand, it was found that in particular Renault, Volkswagen, Fiat, Ford, and Peugeot-Citroën (PSA) would benefit from the switch to a CO_2-based vehicle taxation scheme. This is because their vehicle models offered in Turkey tend to have lower CO_2 emission levels than those of their competitors. This is, for example, the case for the Renault Fluence 114 g/km and the Renault Clio 95 g/km model versions, and also for the Fiat Egea 108 g/km model version. On the other hand, considering the current vehicle model portfolio in Turkey, customers of some other manufacturers would face, on average, higher tax payments, especially in the short term. For example, the top-selling Hyundai vehicle in Turkey, a gasoline version of the i20, is found to emit 114 g/km of CO_2, which is significantly higher than for other vehicle models of a similar size and with similar performance characteristics. As a result, the average tax rate for Hyundai models would initially be higher when switching to a CO_2-based vehicle taxation scheme. Over time, however, it is expected that there would be an incentive for this manufacturer to offer more efficient vehicle models to the Turkish market. Similarly, although General Motors and Toyota are expected to initially face higher taxation rates in a CO_2-based taxation scheme, both companies have highly efficient vehicle models, including hybrid vehicles, in their portfolios in other markets. It is expected that a CO_2-based vehicle taxation scheme would help these manufactures sell their most efficient vehicles also in Turkey.

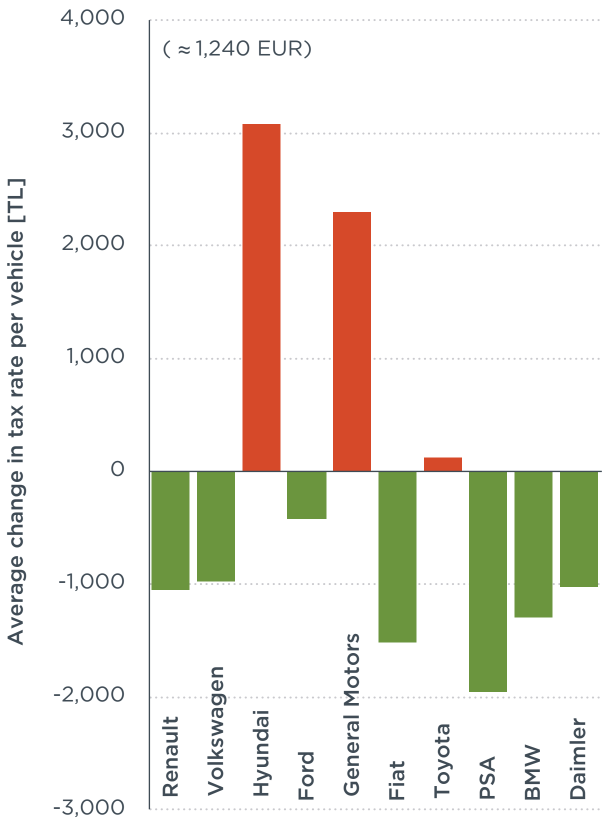


Figure 36. Expected aggregated effect of switching to a partly CO_2-based vehicle taxation scheme in Turkey, by manufacturer.

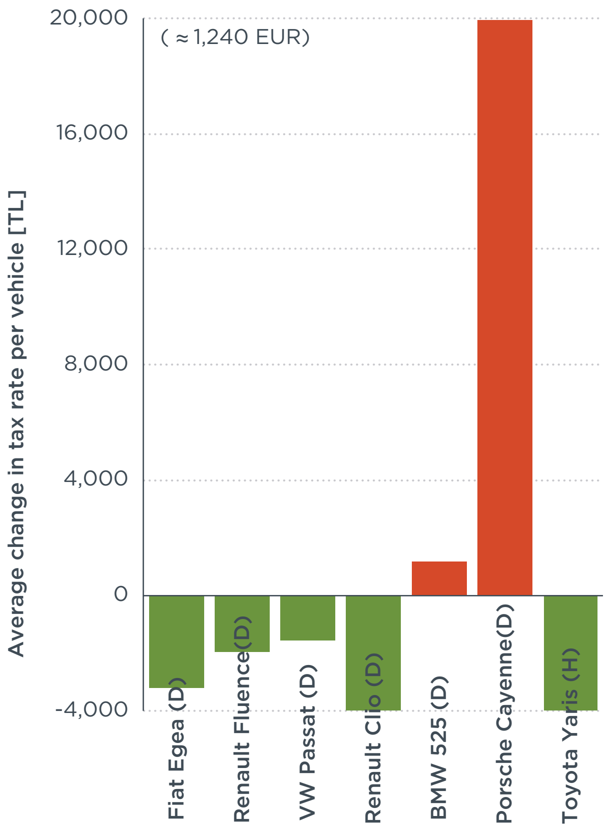


Figure 37. Expected aggregated effect of switching to a partly CO_2-based vehicle taxation scheme in Turkey, for selected vehicle models.

From a customer's point of view, a CO_2-based vehicle taxation scheme would make it more attractive to choose a vehicle with low CO_2 emissions at the point of purchase. This is due to the fact that any initial investment into CO_2 reducing technologies, such as hybrids, would pay off more quickly for the customer. Not only would the customer pay less for fuel due to the direct link between lower CO_2 and lower fuel consumption, but also the taxation level would be lower. This effect would be even stronger if not only the purchase tax (ÖTV) but also the annual ownership tax (MTV) was adapted to be based on CO_2. A discussion of a potential adaptation of the annual ownership tax is outside the scope of this paper but could work in a similar way as the purchase tax. In the current vehicle taxation system in Turkey, the annual ownership tax is based on engine displacement and decreases with the age of the vehicle, thereby creating an incentive to keep older—presumably less efficient—vehicles longer instead of replacing them more frequently with modern technology. Finally, it should be noted that with the introduction of CO_2-based vehicle taxation, the respective taxation rate could be shown on the vehicle CO_2 label, thereby again leveraging the effect in terms of consumer purchase decision for vehicles with lower CO_2 emissions.

5 ENHANCED VEHICLE EMISSION TESTING

The basis for any kind of vehicle emission regulation is reliable data, both for CO_2 and other air pollutants. New vehicle models typically are tested in the laboratory, following preset test cycles and framework testing conditions. Since Volkswagen was found to have communicated incorrect emission values, it is known that laboratory emission test results diverge more and more from the real-world emission data measured while driving on the road. The following section examines the current situation with respect to official versus real-world emissions in Turkey and other key vehicle markets. It then outlines a number of policy changes regarded as necessary in order to arrive at more reliable vehicle emission data in the future.

5.1 THE CURRENT SITUATION IN TURKEY, THE EU AND THE U.S.

For CO_2 emissions and fuel consumption, an analysis of data for more than 600,000 vehicles all over Europe found that the average discrepancy between official type-approval and real-world values for new cars increased from about 8% in 2001 to 40% by 2014 (Figure 38). This means that new cars first registered in 2014 emit about 40% more CO_2 and consume about 40% more fuel than they should, according to the results of the official type-approval testing. The underlying data for the analysis were gathered from leasing companies, car magazines, and consumer websites where car drivers can report back on their own everyday driving experiences.

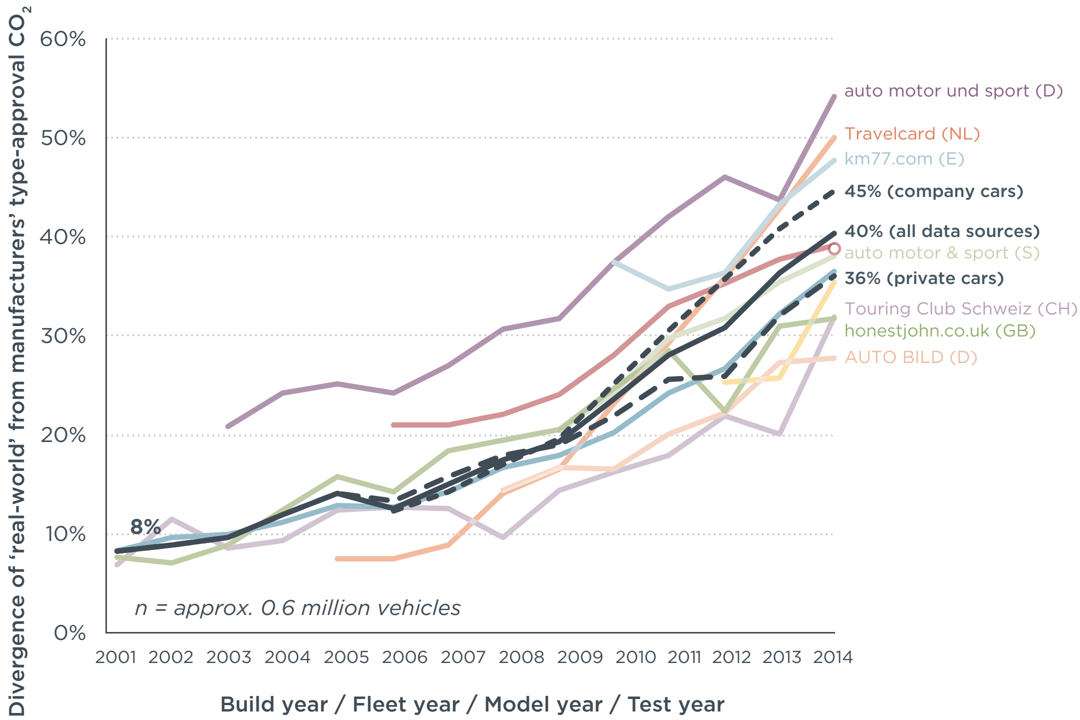


Figure 38. Divergence between real-world and manufacturers' type-approval CO_2 emissions for various real-world data sources in Europe, including average estimates for private cars, company cars, and all data sources. *Source: Tietge et al., 2015.*

In Turkey, similar websites exist where consumers can let other drivers know about their everyday fuel consumption experience. One example is the website "arabam kaç yakar."[14] The number of user entries at this point in time is low by comparison, however, with only about 600 entries in total. A preliminary analysis of the user input for these 600 vehicles suggests that the current average real-world discrepancy for CO_2 and fuel consumption in Turkey is at around 20%-25%. Hence, even if the level of data availability is restricted, it can be expected that consumers in Turkey are facing a similar development as in Europe, with an increasing gap between official and real-world CO_2 and fuel consumption figures.

The reason for the growing discrepancy is found in the NEDC test procedure. This test procedure was originally developed in the 1970s and at that time was not intended to accurately reflect the fuel consumption and CO_2 emissions of a vehicle (Mock et al., 2014). It includes a number of tolerances and flexibilities that can be exploited by vehicle manufacturers to achieve low CO_2 emissions and fuel consumption during laboratory testing without having the same positive impact on the actual on-road performance of the vehicle. A 2015 study for the UK Committee on Climate Change examines in detail the list of regulatory loopholes and how they have been exploited more and more over time (ElementEnergy and ICCT, 2015). With Turkey following the EU regulation and also having exactly the same NEDC test procedure in place, the same flexibilities and tolerances apply to vehicles registered in Turkey.

In regard to air pollutants, it is mostly nitrogen oxides (NO_x) and particulate emissions from diesel vehicles that are of greatest concern. With the introduction of the Euro 6 regulation, applicable in Turkey from 2017 onward, significantly lower particulate emissions are expected in future years. However, for NO_x emissions, a similar development is not in sight. The reason is that NO_x emissions, specifically for diesel cars but also for other vehicles that are type-approved under the Euro 6 regulation, dramatically exceed any emission limit when driven under normal driving conditions on the road.

Figure 39 illustrates the current situation in Europe. New gasoline cars are well below the Euro 6 NO_x emission limit of 60 mg/km, which is notably lower than the 80 mg/km required for diesel cars, even under real-world driving conditions. At the same time, the average on-road NO_x emission level of new diesel cars is about seven times higher than the Euro 6 emission limit (Franco et al., 2014). As a result, a new Euro 6 diesel car is—on average—even more polluting than a 40-ton new heavy-duty truck. Extreme cases of NO_x exceedance are the Volkswagen models that were found to be equipped with an illegal defeat device. These vehicles perform well under laboratory driving conditions but then switch to a different exhaust aftertreatment strategy when driving under normal conditions on the road, resulting in average NO_x emission levels close to 2,000 mg/km. While Volkswagen admitted that this performance of their vehicles is illegal according to U.S. and EU law, it is still under investigation as to what extent the excessively high NO_x emissions of vehicles of other manufacturers are in line with regulatory requirements.

14 http://arabamkacyakar.com

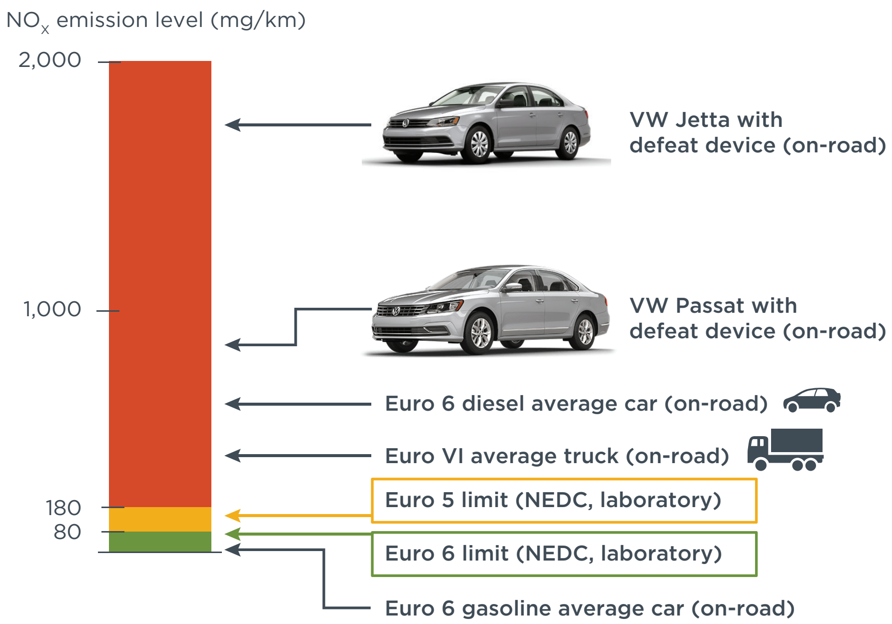


Figure 39. Illustration of real-world NO_x emission levels of diesel passenger cars in comparison to regulatory limits for laboratory tests for gasoline and diesel cars as well as diesel trucks.

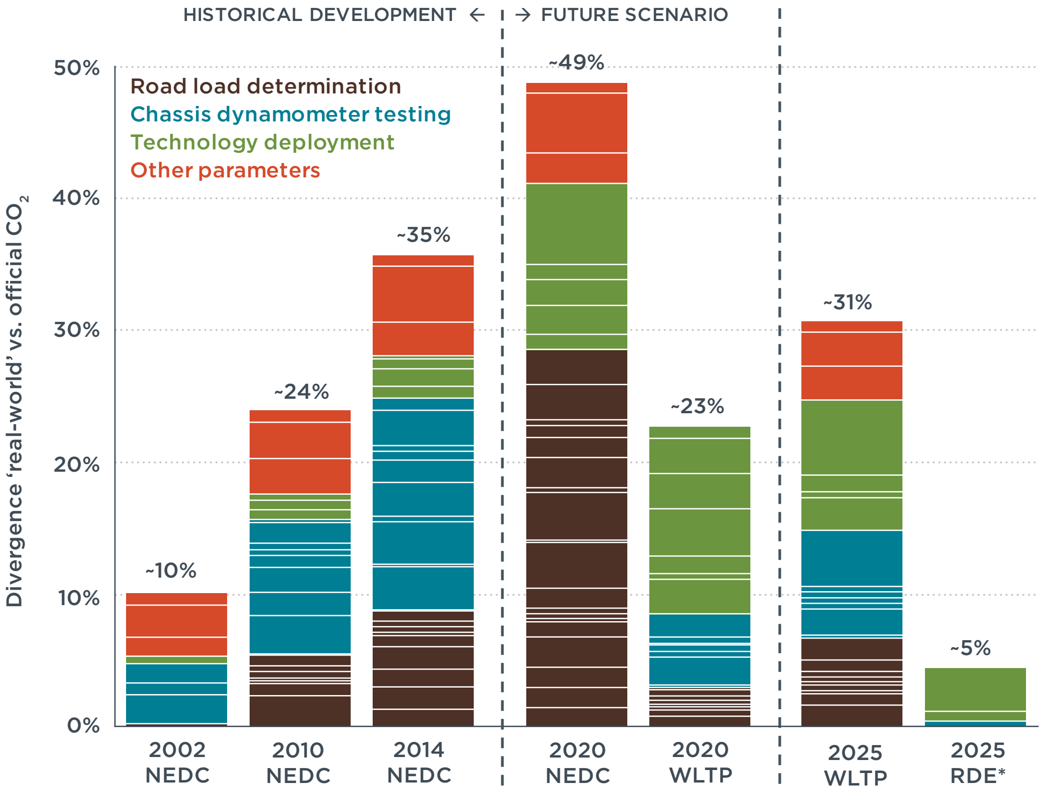
For Turkey, there are no specific data on the real-world performance of modern diesel cars publicly available at this time. However, it is to be assumed that Turkey is facing a problem similar to that in the EU. This is due to the fact that Turkey is following the EU vehicle emission testing regulations, and it is therefore unlikely that Volkswagen or any other vehicle manufacturer might be using a different exhaust aftertreatment strategy for Turkey than for the EU market (Mock, 2015c).

5.2 REQUIRED CHANGES FOR A ROBUST EMISSION TESTING SCHEME

In a previous study, a set of key measures to improve the reliability of vehicle emission test results in the future was described (Mock & German, 2015). In the following, three areas that are of particular importance for the Turkish market are examined in more detail.

In response to the outdated NEDC test procedure that was originally developed in the 1970s, a new vehicle emission test procedure was developed at the United Nations (UNECE) level. The so-called Worldwide Harmonized Light Vehicles Test Procedure (WLTP) includes a test cycle that more realistically represents the average driving pattern of customers and also includes a number of improvements for the test procedure itself, for example, by tightening allowed tolerances and flexibilities (Mock et al., 2014). The EU is planning to implement the WLTP by 2017, replacing the current NEDC. Similarly, Japan and South Korea have announced that they will replace their respective test procedures with the WLTP. For Turkey, which already follows the vehicle emission regulation of the EU, switching to the WLTP as soon as possible is seen as an important next step.

The expected impact of the WLTP was illustrated as part of a detailed analysis for the UK Committee on Climate Change and is reflected in Figure 40. In a business-as-usual scenario, keeping the NEDC in place until 2020, the average gap between official and real-world CO_2 emission figures is expected to increase to about 49% by 2020. The introduction of the WLTP would help decrease this gap to a level of about 23% instead. However, it was also found that the WLTP itself is likely to introduce new loopholes that might be exploited by vehicle manufacturers in future years. As a result, with manufacturers optimizing their new vehicle models toward the WLTP, the discrepancy level is likely to increase again to a level of about 31% by 2025.



RDE = comprehensive in-use conformity and on-road testing scheme*

Figure 40. Bottom-up estimate of the emissions gap between type-approval and real-world CO_2 emissions, differentiated into individual influencing parameters—historical development and 2020 scenarios without and with introduction of WLTP in the EU, as well as 2025 scenarios with WLTP only and RDE (comprehensive conformity + on-road testing scheme). *Source: ElementEnergy and ICCT, 2015.*

For this reason, the WLTP will need to be complemented by a not-to-exceed (NTE) limit. The Real-Driving Emissions (RDE) regulation in the EU recently introduced such a NTE for NO_x emissions (European Commission, 2016). As part of the RDE regulation, in May 2015 the EU decided to introduce mandatory on-road emission testing of new vehicle models in addition to the usual laboratory testing. The measured on-road NO_x emissions are allowed to be above the Euro 6 emission limits for laboratory measurements but only by a maximum factor of 2.1 in 2017 and 1.5 from 2020 onward (Franco, 2016a). Hence, the EU has introduced a NTE limit for NO_x emissions under on-road driving conditions. If the RDE regulation were to be extended to cover CO_2 emissions in the future as well, the gap between official and real-world CO_2 emissions could decrease to as low as 5% by 2025. As a result, introducing on-road emission testing for air pollutants and CO_2 emissions is seen as a key step to bring down emission levels of new vehicles sold in the EU as well as in Turkey.

As a third pillar, in addition to introducing the WLTP and RDE, the vehicle emission testing scheme itself will need to be revised in the future. Figure 41 compares the current situation in the EU and the U.S. In both regions, before a new vehicle model is approved for sale, it needs to go through coast-down[15] and laboratory testing. Both tests are regulated in a similar way in the EU and the U.S., with one main difference: In the U.S. the regulator regularly carries out confirmatory testing to check whether the values measured by the car manufacturers are reasonable. These kinds of independent

15 Coast-down tests, during which a vehicle is driven and then coasted (hence the name "coast-down tests") on a track, determine parameters required to set up a chassis dynamometer to simulate road-load forces like tire friction and aerodynamic drag during a type-approval test.

confirmatory checks are currently absent in the EU. Similarly, independent conformity testing of vehicles in use is currently not foreseen in the EU.

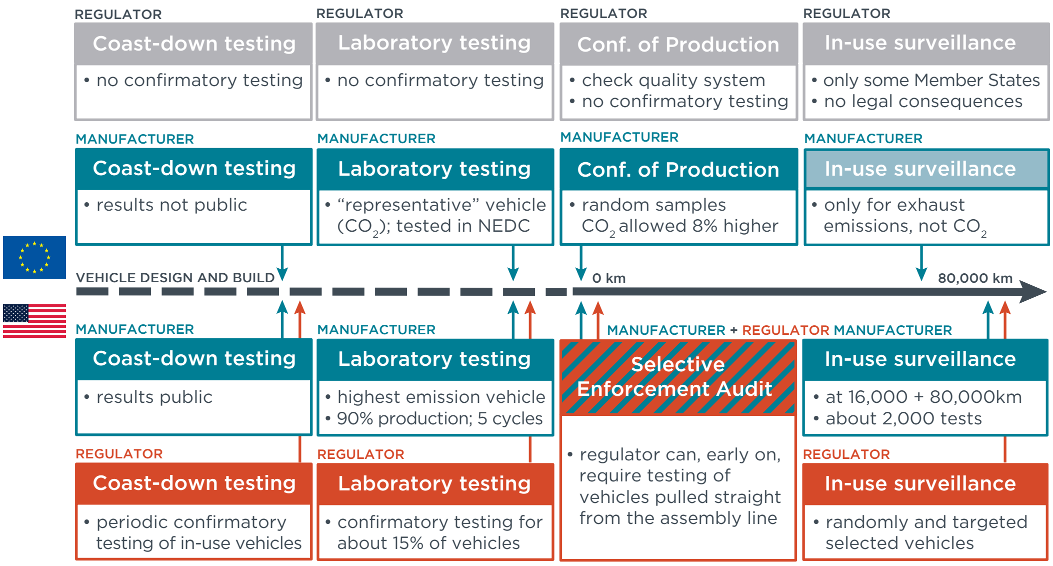


Figure 41. Overview of the EU and U.S. vehicle emission testing and enforcement schemes. *Source: Mock & German, 2015.*

These important faults in the current vehicle emission test procedure in the EU have been identified and acknowledged. The European Commission recently came forward with a regulatory proposal introducing elements that are intended to strengthen the vehicle emission testing scheme in the EU (Franco, 2016b). Again, given that Turkey is closely following the EU's vehicle emission regulation, these revisions will have to be mirrored also in the Turkish market in a next step.

In addition to the aforementioned strengthening of vehicle emission testing at the national level, it is possible to supplement with policy measures at the local level. In particular, city level authorities can decide to restrict access to inner-urban areas for vehicles that are in line with the recent emission requirements. For example, a number of European cities including London, Paris, Berlin, and many smaller cities, have implemented low emission zones that allow access to the city centers only by vehicles meeting recent emission standards. A charge is levied on those vehicles that only meet older emission standards (Franco, 2016b). More recently, the European Commission has evaluated the possibility of introducing a voluntary label that would take into account the real-world emissions of a vehicle based on RDE testing, which could also be used by cities to restrict access to inner-urban areas to those vehicles that cannot ensure low emission levels under everyday on-road driving conditions (Ntziachristos et al., 2016).[16] In the case of Istanbul, a concept for restricting vehicle access to the historical peninsula was described in detail earlier (EMBARQ Turkey, 2013). It is conceivable to further develop such a concept to cover a wider range of the city center and differentiate between vehicles depending on their emission levels. As a result, this would not only help to improve the air quality levels in Turkish cities but also provide another incentive for customers to choose vehicle models with low emissions.

16 The European Commission project report is forthcoming.

6 CONCLUSIONS AND OUTLOOK

Vehicle sales and vehicle emissions are steeply rising in Turkey. It is important not only from an environmental and health protection perspective but also from an economic and international competitiveness point of view that new vehicles coming into the market in Turkey in future years should be equipped with the best available technology and emit as little as possible. A set of distinct policy measures can help increase the efficiency and reduce the emission levels of the vehicle fleet in Turkey.

One policy measure found to be of particular importance is for Turkey to set mandatory CO_2 standards for new vehicles. All of the largest automotive markets worldwide have already introduced such standards, and many of them are currently preparing for the second or even third round of tightening the regulatory requirements. Turkey is already indirectly influenced by the standards of other countries and regions due to its strong dependence on vehicle imports and exports. However, at this point Turkey is not taking action itself to steer its vehicle market with the help of CO_2 standards.

Implementing the same annual CO_2 reduction rate requirement when setting mandatory standards for new passenger cars in Turkey would most likely not lead to any significant effect given the structure of the automotive market in Turkey. Instead, a higher annual reduction rate would be required. For the analysis within this report, two scenarios were assessed in more detail, allowing for annual CO_2 reduction rates of 4% and 6% and resulting in an average new car fleet CO_2 level of 84 g/km and 69 g/km, respectively, by 2023. It was found that already today, years before such standards would be in place, a number of vehicle models are close to these CO_2 target levels. Furthermore, it was found that the required investment in new vehicle technologies to meet future CO_2 targets is reasonably low from the manufacturers' side, at a maximum of 2,400-3,800 TL (720-1,150 euros) per vehicle. At the same time there is significant fuel cost savings from the consumers' side thanks to the higher efficiency of those vehicles equipped with modern technologies that allow for payback periods of as short as four to five years. The introduction of CO_2 standards is therefore seen as a win-win situation for all stakeholders, allowing for significant savings of fuel cost and oil imports, emission reductions, and at the same time, stipulation of technological innovation and international competitiveness.

One policy measure already implemented in Turkey is the provision of consumer information through vehicle CO_2 labeling. Since 2009 new cars offered for sale in Turkey must be accompanied by a label clearly indicating the CO_2 emission level of the vehicle in comparison to other models available on the market. As discussed in this report, comparing the current Turkish labeling scheme to those in other markets shows some areas where further improvement is possible. Examples include a revision of the current website to allow customers a better overview of available vehicle models and their CO_2 emission labels, as well as including information on vehicle taxation levels and on-road driving emission levels on the label. It should be emphasized that the vehicle CO_2 label by itself is not expected to have a significant effect on customer purchase behavior but that it can help leverage the effects of other policy measures, such as CO_2 standards and CO_2-based vehicle taxation, if those measures are introduced in parallel to a labeling scheme.

Taxes on the purchase and ownership of passenger cars in Turkey are high in comparison to other markets worldwide and have a strong effect on the sales structure of the vehicle market. In particular the Special Consumption Tax (ÖTV) has a strong influence as it can be as high as the net price of the vehicle itself or even higher. However, this tax is currently based solely on the engine displacement of a vehicle and its purchase price and has no or very little effect on the CO_2 emission level of new vehicles. Revising the current vehicle taxation scheme in Turkey to be partly based on vehicle CO_2 emissions is expected to make it easier for manufacturers to market their low-emission vehicle technologies, and it would provide a strong financial incentive for customers to choose cars that emit less than other models available on the market. A bonus/malus-like feebate system is regarded as the best-practice example in this respect, awarding those vehicles with low emission levels and imposing a higher tax on those vehicles with high emission levels. Even if, for administrative reasons, the introduction of a feebate system was regarded as not feasible, fully or partly replacing engine displacement by the CO_2 emission level of a vehicle would still strongly contribute to a reduction of the average emission level of the new car fleet in Turkey. Acknowledging that vehicle taxes account for a large portion of the revenue budget of public authorities in Turkey, it should be emphasized again that a switch to a CO_2-based vehicle taxation scheme can be implemented in a budget-neutral way, which is to say without lowering the government's revenue stream in any way.

All of the abovementioned policy measures rely on correct data on vehicle emission levels. Previous studies have found that there is an increasing gap between official and real-world emission levels of new passenger cars, so much so that CO_2 and fuel consumption were found to be about 40% greater in real-word scenarios in Europe in 2014. Turkey, closely following the EU's vehicle testing procedures and emission regulations, is expected to face a similar problem of increasing discrepancy between official and real-world data. As a result, it is recommended that Turkey not only introduce the new WLTP test procedure as soon as possible but also introduce mandatory on-road emission tests for new vehicle models, both for CO_2 and other air pollutants. Regular retesting of the emission levels of vehicles in use, carried out by the authorities or independent third parties, is also strongly advised. Together, these three measures for enhanced vehicle emission testing will help to reduce the discrepancy between official and real-world performance and will ensure a solid basis for any future policy measures.

A quantification of the expected effect of introducing mandatory CO_2 standards for new passenger cars in Turkey was provided in Figures 12 and 13. A similar quantitative estimate for the effect of introducing/revising the CO_2 labeling and vehicle taxation schemes in Turkey is more challenging to provide, as today there is little quantitative data available on the additional effect of those measures when introduced on top of mandatory standards. Based on an analysis of the Dutch vehicle market, it is estimated that the additional effect from CO_2-based vehicle taxation in Turkey would be at around 2% per year (Kok, 2015). A revision of the CO_2 labeling scheme, while useful in leveraging the effect of CO_2 standards and vehicle taxation, is expected to be negligible from a modeling point of view. For the effect of introducing enhanced vehicle emission testing, it is assumed that it would help to decrease the CO_2 discrepancy level in Turkey from about 20% today to a level of 5% by 2025 (Mock, 2016). With these assumptions, Figures 42 and 43 provide a rough estimate of the expected total impact.

The total CO_2 emissions of the light-duty vehicle fleet in Turkey would increase from about 16 million metric tons in 2015 to 22 million metric tons by 2030 if no further policy measures are taken. With only a mandatory CO_2 standard in place, the emission level would be lower, at 17-19 million metric tons by 2030. Complementing CO_2 standards by also introducing a CO_2-based vehicle taxation scheme and enhanced vehicle emission testing would help to further reduce the emission level to about 14-16 million metric tons by 2030, representing a potential reduction of as much as 36% compared to a business-as-usual scenario. Similarly, the amount of fuel consumption in the light-duty vehicle sector could be reduced by about the same extent.

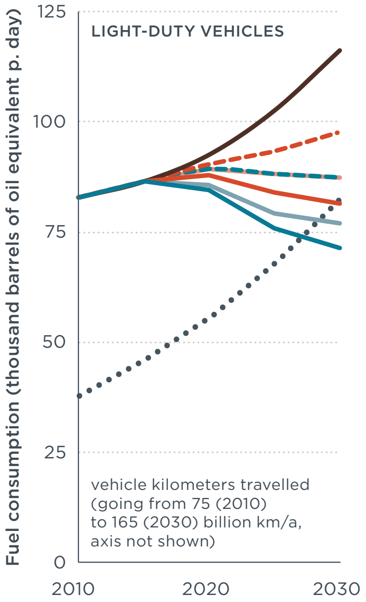


Figure 42. Estimated fuel demand from light-duty vehicles in Turkey (2010-2030).

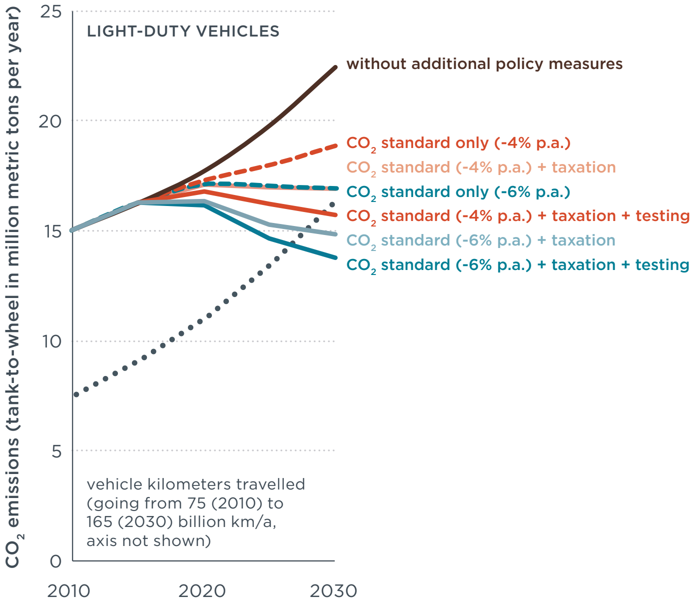


Figure 43. Estimated CO_2 emissions from light-duty vehicles in Turkey (2010-2030).

It should be emphasized that none of the discussed policy measures result in any additional cost from the government's perspective and in addition help to reduce the financial burden from the consumers' perspective. This is due to the fact that after a payback period of four to five years consumers would benefit from significantly lower fuel costs over the lifetime of the vehicles, thereby also benefitting subsequent car owners. In summary, the policy measures discussed would result in larger investments in vehicle technologies and less spending on fuel and oil imports, thereby providing benefits for all stakeholders in Turkey, including the vehicle and vehicle parts manufacturing industry.

The scope of policy options selected for the discussion within this report includes vehicle CO_2 standards, CO_2 labeling, CO_2-based taxation, and enhanced vehicle emission testing but is by no means to be seen as complete. Instead, it is meant to cover measures that are commonly applied in other automotive markets worldwide and that were identified as also potentially relevant for Turkey during discussions with stakeholders throughout the duration of this research project. Furthermore, it is important to acknowledge that the focus of this report is on policy measures to tackle the emissions of passenger cars. Light commercial vehicles make up about 15% of the new vehicles market in Turkey, which is why any policy measure to reduce emissions should be extended to those vehicles as well. Similarly, heavy-duty vehicles are important as they account for more than half of fuel consumption and emissions in Turkey and, therefore, should be subject to future research and policy discussions.

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