

Fuel Economy and CO₂ Emissions of Light-Duty Vehicles in Tunisia

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1 INTRODUCTION

The transport sector is responsible for about a quarter of the world energy consumption and a similar attribution to global CO₂ emissions. A growing international concern over climate change induced by the burning of fossil fuels has been accelerating. Also the security and sustainability of oil supplies are subjects of growing global concerns. In response to those challenges many countries all over the world are working on curbing oil consumption and finding alternative resources. In turn, many countries worldwide have introduced fuel economy or CO₂ emissions standards for improving vehicles energy efficiency. A number of initiatives around the world have been introduced to help countries with regard to fuel economy standards. The Global Fuel Economy Initiative (GFEI) comes as an effort of five organizations¹ to promote improvements in vehicle fuel economy. This initiative aims to achieve 50% improvements by 2050 in all vehicles globally compared to that in the year 2005. The initiative's main activities include: data development and analysis, policy support, and raising awareness (GFEI, 2013).

1.1 OBJECTIVES

In line with the United Nations Environmental Program (UNEP) work on promoting sustainability and the GFEI's efforts in prompting the introduction of more energy efficient vehicles, this report aims to analyze the status and trends of fuel economy standards in Tunisia. This report presents an analysis of the Tunisian case study and eventually comes out with a discussion on how to improve the fuel economy performance of the Tunisian LDVs fleet with the associated recommendations.

¹FIA Foundation, International Energy Agency (IEA), International Transport Forum (ITF), United Nations Environment Programme (UNEP), and the International Council on Clean Transportation (ICCT).

2 METHODOLOGY

The report is about the trend patterns in fuel economy and CO₂ emissions. It views the status of emissions and fuel consumption through the lens of changing weighted averages for new Light Duty Vehicles (LDVs) for the years 2005, 2008, 2010 and 2012. Thus the report provides a sense of changing state of emissions and Fuel consumption in Tunisia

Accordingly, figures for sales of new Light Duty vehicles have been obtained along with the official figures for CO₂ emissions and fuel consumption for almost all the models. Figures for total LDVs on the road for the study years have also been obtained to put the trends in perspective and to feed into the report's discussion on improving fuel economy and the associated recommendations.

Figures for new LDVs sales in 2008, 2010 and 2012 have been obtained from manufacturers and were collected by an automotive markets consultant, Matthias Gasnier. For reliability, the figures were cross-checked with sample figures for new LDVs sales from IHS consulting as well as total figures of different model sales in Tunisia obtained from the International Organization of Motor Vehicle Manufacturers (OICA). Data are classified by Vehicle's make, model, fuel type, and engine size.

The 2005 figures were estimated based on certain characteristics of the Tunisian market, which is significantly unique. The Tunisian market is influenced for the most part by import quotas dictated each year by the government. There is no local car manufacturing industry in Tunisia, so 100% of cars sold in the country are imported, meaning the import quotas dictate for the most part the Tunisian new car market. This makes the Tunisian car market more predictable than other markets. Accordingly, 2005 figures were obtained taking into consideration a few long-term trends in the Tunisian new car market.

Manufacturers' specifications manual and compilations of the French Environment and Energy Management Agency (ADEME) have been used to arrive at the manufacturers' labeled figures for fuel economy and CO₂ emissions. Then GFEI methodology (GFEI, 2014) has been used in calculating the weighted average annual fuel economy, and the weighted average rate of CO₂ emissions.

The definition of the GFEI for LDVs has been used in deciding on the vehicles to be included in the report study provided in Table **1** (GFEI, 2014).

Vehicle Segment	Examples
A: Mini / Micro / Small town car	Citroën C1
Smallest cars, with a length between 2.50m to 3.60m.	Fiat Panda
	Smart Fortwo
B: Small compact	Mitsubishi Colt
Slightly more powerful than the Minis; still primarily for	Opel Corsa
urban use; length between 3.60m and 4.05m	Suzuki Swift
C: Compact	Mazda 3
Length between 4.05m – 4.50m	Subaru Impreza
	Volvo S40
D: Family cars	BMW 3 series
Designed for longer distance; fits 5-6 people; length is	Chrysler Sebring
4.50m to 4.80m	Lexus IS
Light vans	Chevrolet Uplander
Size is similar to D, but interior volume is maximized to	Ford Galaxy
accommodate larger families	Volkswagen Sharan
Big / Full size cars	Cadillac DTS
Have generous leg room; can comfortably transport 5 - 6	Jaguar XJ
people; generally have	Mercedes-Benz E Class
V8 engines and are 5m or longer in length	
SUV / All terrain	Dodge Durango
The original cars were utility cross-country vehicles with	Jeep Grand Cherokee
integral transmissions like the Jeep	Nissan Patrol
	Toyota Land Cruiser

Table 1: The GFEI definition of LDVs

2.1 DRIVING CYCLES

Implementation of fuel economy standards requires the enforcing agency to test the fuel economy figures presented by model manufacturers. The applicable driving cycle should mimic typical driving patterns, behavior stops, accelerations, speed ranges with duration for each of urban and highway driving. For comparison across vehicles, a combined or overall fuel consumption or economy cycle is used, combining urban and highway cycles with different loading. In the United States the used driving cycle is called Corporate Average Fuel Economy (CAFE). In Europe, the used driving cycle is called New European Driving Cycle (NEDC).

For the driving cycles to be fully representative, they need extensive detailed data about characteristics of driving in locations where they are applied. Also, the vehicles used for designing the cycle must match the running models. Other factors such as roads elevation, air and wind need to be accounted for. Some claim that manufacturers design vehicles to match the driving cycle at the destination market's cycle, if there is one.

2.2 LIMITATIONS

Tunisia has no local driving cycle. Since the Tunisia market is in broad terms more streamlined with the European one, the study team obtained data for fuel economy based on the New European Driving Cycle (NEDC) in units of liter/100 km.

Because for some models the emissions figures were not available, the report eliminated those models from its analysis. Those models have made up less than 1 % of all models covered in the study years. Another limitation is the new LDVs sold through unauthorized dealers and parallel markets which are not to exceeding 10% of total new LDVs sales. Therefore the studied new LDVS in the report comprise estimated 89% of total new LDVs in Tunisia for the study years at least.

3 BACKGROUND

Tunisia is a North African and Arab country with a population of 10.9 million in 2013. It is classified as a *low-middle-income* economy according to the World Bank classifications based on GNI per capita (WB, 2014). Morocco had a modest average GDP growth rate of 2.2% over the past three years, 2011-2013 (World databank, 2014). This may be attributed to the significant economic crisis occurring during the year of the 2011 revolution of Tunisia when the growth rate dropped sharply, although currently recovering. Sales in LDVs accordingly showed a decline in the year of the revolution. Figure **1** illustrates the trends and shows a similar decline in Egypt, subject to similar circumstances in 2011.

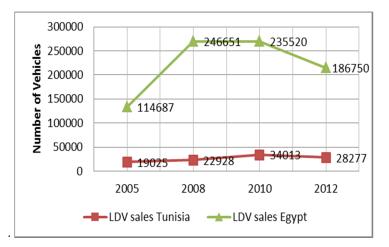


Figure 1: Sales of new LDVs in Tunisia and Egypt (Matthias Gasnier, 2014)

For Tunisia, total number of vehicles on the road has been relatively stable from 2005 till 2012, showing only a relatively slight increase from 974 thousand cars in 2005 to 1.35 million cars in 2012 (OICA, 2014). The vast majority of LDVs are gasoline fueled, being 88% of total LDV sales in 2012.

3.1 FUEL ECONOMY STANDARDS

Fuel economy is a measure of the maximum distance that can be covered by a vehicle per unit of fuel. The metric of fuel economy is miles per gallon (MPG) as used in the United States or alternatively also expressed as kilometers per liter such as used in Europe, which is used in this study in accordance with the GFEI preference.

Climate change, and the associated urge to curtail the growth of greenhouse gas emissions by cutting down the consumption of fossil fuels, have combined with the uncertainties associated with volatile oil prices and the energy security challenges to bring the topic of reducing fuel consumption by vehicles to the fore of global environmental and energy agendas. The European Union has set its fuel economy standards where manufacturers have to meet average fuel economy levels for their entire fleets (GFEI, 2014). The assigned value to each manufacturer is calculated on the basis of the mass of a vehicle giving manufacturers a level of flexibility to increase and decrease the fuel economy of their different models. It also allows higher values for heavier vehicles through what is termed a limit curve (Automobile Fuel Economy standards, 2010). Penalties are applied using a sliding scale. The fuel economy limits continue to increase in response to regulation (Automobile Fuel Economy standards, 2010).

In a European context, the standards are realistic meeting lesser resistance from concerned civil society portions due to the predominance of small cars, efficient and widely spread public transportation and the proliferation of the more efficient diesel vehicles. Japan followed in the footsteps of the EU with its own stringent weight-based standards (IPCC, 2007). The USA has been adopting fuel economy standards since the seventies that have been slightly loosening over time for light trucks and constant for passenger cars since 1990 (GFEI, 2014). Light Duty Vehicles were regulated using different standards for passenger cars and light trucks. In the US, the same average fuel efficiency was required from each manufacturer regardless of vehicle attributes. It was calculated by the following formula

 $\frac{\sum_{i} Production_{i}}{\sum_{i} \frac{Production_{i}}{TARGET_{i}}} = CAFE_{required}$

(Source: Centre for Climate and Energy solutions, 2014)

The downside of this approach is that the playfield is not level for large vehicle segments since compliance is easier for smaller ones. The standards were assessed by experts to have led to fuel savings of billions of barrels of oil over the years (Government Accountability Office, 2008).

With the support of the Obama administration, the US Environmental Protection Agency jointly with the National highway Traffic Safety administration has set fuel economy standards for 2017-2025 vehicles. Vehicles are classified on size basis for two broad categories: passenger cars and light trucks. Vehicle size (footprint) that is determined in a standardized way enters a formula that accounts as well for a manufacturer's production or sales level. The standards are designed to accomplish a US fleet average fuel economy, by 2016, of at least 35.5 MPG (GFEI, 2014).

4 REGULATIONS AND POLICY ENVIRONMENT

The Tunisian government since 1995 has heavily regulated the Tunisian automotive market. The largest part of the market is small cheap cars. The Tunisian market is unique in the sense that the vast majority, with the exception of a niche of luxury cars, is completely determined by the government on an annual basis. The quotas are determined by several factors. These are the country's trade deficit, domestic demand and arrangements made between foreign automotive manufacturers and local car components manufacturers (US foreign commercial service, 2012). Those quota cars are termed in Tunisia "Shaabiyaa", meaning the popular cars in Arabic. For those vehicles, most of the selected ones are small engine variants of popular models posing lesser technological sophistication than the ones in their countries of origin. Vehicles franchise holders are naturally pushing for increasing the quotas.

4.1 CUSTOMS AND TAXATION

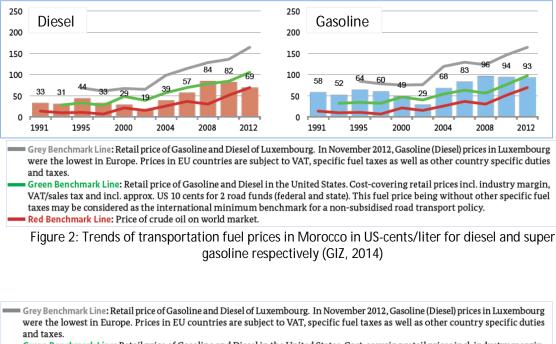
The tariff barriers in Tunisia are among the highest in the world and could reach up to 200%. Moreover, imported Shaabiyaa cars are liable to a 12% VAT and a 3% customs formality fee (Meritas, 2013).

European manufacturers have the larger share of the Tunisian market with mainly French manufacturers in addition to Volkswagen. American, Japanese and Korean manufacturers have also penetrated into the market (US commercial service, 2012).

Luxury and 4-by-4 cars are sold through authorized dealers though they are subject to very high consumption tax rates of 67% and 88% for gasoline and diesel luxury cars, respectively (US commercial service, 2012). They are not subject to the quota system, yet the prohibitive rates confine luxury cars to a very small share of the market. Tax breaks are granted to cars owned by Tunisians abroad relocating to Tunisia, with the provision that they remain circulating within first-degree relatives. This portion is expected to be minor and was not included in the scope of this report due to the lack of data.

4.2 FUEL PRICES

Transportation fuel prices have been in steady increase in Tunisia and are presently subject to low subsidies, but are significantly more expensive than fuel prices in the rest of the Arab region such as in the neighboring Algeria and Libya. For example, the prices are more than double the prices in Egypt in the same year (GIZ, 2014).



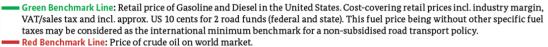


Figure **2** shows the gradual increase in fuel prices in Tunisia illustrated in the bar chart, showing diesel (on the left) and super gasoline (on the right), indicating high prices comparable to the US retail price yet lower than the high fuel prices and taxes in the EU.

5 RESULTS AND DISCUSSION

Figure **3**Figure **3** shows fuel economy (I/100km) trends for new LDVs in Tunisia for the years 2005, 2008, 2010 and 2012 for diesel and gasoline vehicles together since gasoline fueled LDVs are in all years close to 90% of all sales. A more detailed breakdown of fuel economy figures for the new LDVs is provided in Table **2**.

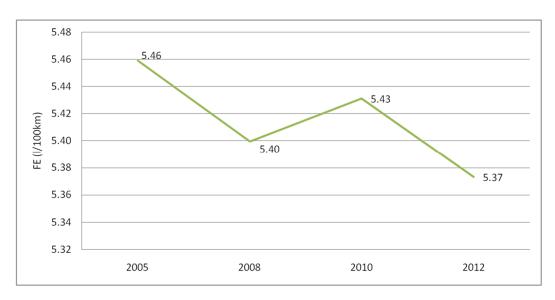


Figure 3: Average Fuel Economy of new LDVs (I/100km, NEDC driving cycle) in Tunisia since 2005

The FE trends show slight fluctuations but a general long-term improvement reaching 5.37 I/100km in 2012, and emission rates show similar long-term improvement.

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Year	2005	2008	2010	2012
FE of Gasoline fueled LDVs (I/100km)	5.44	5.43	5.46	5.37
FE of diesel fueled LDVs (I/100km)	5.66	5.09	5.17	5.37
Weighted avg. FE of all new LDVs (I/100km)	5.46	5.40	5.43	5.37
Wt. avg. CO_2 emission rate, all new LDVs (g CO_2 /km)	135	136	136	134

Table 2: Average Fuel Economy and emission rates of new gasoline and diesel fueled	
LDVs (based on NEDC driving cycle)	

It was notable that although sales have slightly decreased between 2010 and 2012, the number of models increased to further diversify the choices; 77 models in the market in 2012. Table **3** shows the top 10 LDV models in 2012 in terms of sales. Together, the top 10 (off 77 models) represent 67% of all sales in the same year and most of them are of relatively small engine sizes, 1200 cc.

Model	Fuel Type	Engine size (Liter)	Total sales	Fuel Economy (I/100km)
Renault Symbol	Gasoline	1.2	4774	5.8
VW Polo	Gasoline	1	3273	3.99
Kia Rio	Gasoline	1.2	2636	4.13
Ford Fiesta	Gasoline	1.2	2326	5.8
Fiat Punto	Gasoline	1.2	1906	5.7
Peugeot 206	Gasoline	1.4	1869	6
VW Golf	Gasoline	1.2	1213	4.61
Chevrolet Aveo	Gasoline	1.2	1183	3.92
Citroen C3	Gasoline	1.6	1161	6.1
Seat Ibiza	Gasoline	1.2	1122	5.5

Table 3: Top 10 LDV models in 2012 in terms of sales

Non-OECD fuel economy averages for LDVs in I/100km for 2005, 2008 and 2011 were 7.5, 7.6, 7.5, while OECD averages were 8.1, 7.6 and 7 respectively. Tunisia is therefore in a relatively good position.

Fuel consumption of diesel LDVs had been close to gasoline for the same study period despite the use of larger diesel LDVs with larger engine sizes. Diesel engines show better fuel consumption rates than gasoline ones unless vehicle features such as a much larger engine size or body weight offset the characteristic.

Year 2005

Renault symbol, Volkswagen Polo, Peugeot 206, Fiat Punto, Volkswagen Passat and Ford Fiesta accounted for 83.9% of total sales of new gasoline LDVs through authorized dealers. Their fuel consumption levels in I/100km were 5.9, 3.9, 6.4, 5.7, 4.9, and 5.8. All well below both the OECD and non-OECD average.

For diesel LDVs, Renault symbol, Peugeot Partner and Citroen Berlingo accounted for most of sales with the Berlingo and Symbol being of the pick-up/mini-van segment.

Year 2008

Renault symbol, Volkswagen Polo, Peugeot 206, Fiat Punto, Volkswagen Passat and Ford Fiesta accounted for 80% of total sales of new gasoline LDVs through authorized dealers. Fuel consumption for those years has not changed, yet their sales increased and their share of total LDV sales slightly decreased.

For diesel LDVs, sales of Citroen Berlingo and Peugeot partner remained almost the same. However, Renault symbol sales increased in addition to increased sales of Citroen C4 which has a fuel consumption of 4.5 I/100km.

Year 2010

Renault symbol, Volkswagen Polo, Kia Rio, Ford Fiesta, Peugeot 206, Volkswagen Golf, Fiat Punto, Volkswagen Passat, Kia Picanto accounted for 75% of total sales for new gasoline LDVs through authorized dealers. Most of them had fuel consumption levels slightly lower than those for the previous years. The weighted fuel economy average therefore had remained almost the same with a slight increase from 5.43 liter/100 km to 5.46 liter/100 km.

Year 2012

Renault Symbol, VW Polo, Kia Rio, Ford Fiesta, Fiat Punto, Peugeot 206, VW Golf, Chevrolet Aveo, Citroen C3 and Seat Ibiza accounted for 76% of total sales for new gasoline LDVs through authorized dealers. 2012 experienced a wider variety of more efficient LDVs accompanied by a slight decrease in the market share of the aforementioned models that had retained the largest portion by far of the Tunisian market throughout the recent.

Renault Symbol, Peugeot Partner, Citroen C4 and Citroen Berlingo made up most of diesel LDVs sales in Tunisia for the year 2012. Fuel consumption increased marginally by a decimal point due a wider variety of models in 2012.

6 CONCLUSIONS

Tunisia managed to maintain relatively a good fuel economy average. The quota regulation of the gasoline *Shaabiyaa* vehicles seems to be the influential factor when comparing with other countries in the Arab region, and seem to be an effective policy.

The selected models show an overwhelming preference for cheap European vehicles thus capitalizing on the increasingly tightening fuel economy standards of European manufacturers. Furthermore, in many cases the variant design is tweaked to suit markets with significant taxation and tariff barriers. This is carried out through offering a variant for a certain model with a scaled down engine size. On the downside, the gasoline model variants selected for the Tunisian market have less sophisticated technological capabilities than their European counterparts.

In absolute terms, the motor gasoline consumption in Tunisia has been on the rise since 2006 as shown by Figure **4**.

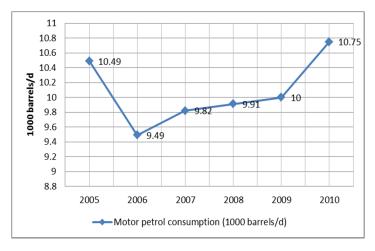


Figure 4: Trend of gasoline consumption in Tunisia (The globaleconomy.com, 2014)

The discussion in previous sections demonstrates that the current quota system is indeed not the best available design as far as gasoline consumption is concerned. The fact that Tunisia does not hold sizeable oil reserves and that its refining industry only supplies a part of its domestic demand highlights the importance of curbing fuel consumption, an issue that should be pushed to the fore of national agendas. It is worth mentioning that the noticeable drop in gasoline consumption in 2006 can be attributed to the 2006 8.9% increase in fuel prices reported by the OECD (2014). In Tunisia, fuel consumption in absolute terms is affected considerably by fuel prices due to the widespread public transportation in comparison to other Middle-Eastern countries. Above ground metro serves Tunis the capital and some other cities. Other cities enjoy wide coverage of both public and private bus networks that cater to the needs of different societal segments. Tunisia has no automotive manufacturing industry. Lacking an automotive industry can be turned into quite an advantage when it comes to fuel economy standards. One reason is the absence of political leverage wielded by the automotive industry in other countries, which puts limits on the design of fuel economy standards.

Recommendations for Fuel economy standards in Tunisia are as follows:

The establishment of a multi-stakeholder committee at the competent ministry: The committee must include representatives from domestic automotive components industry, the national statistics agency, and high caliber international fuel markets experts, trade and energy policy makers, technical automotive engineers, and automotive markets consultants. The committee should be assigned the task of preparing a roadmap for the preparation and introduction of fuel economy standards.

Monitoring and Evaluation: To ensure an annual assessment of both the vehicle stock and the new LDVs (and other categories of vehicles eventually) in order to have a better understanding of the improvement in the vehicle stock and to facilitate comparison with other countries. This will also help showcase the results of the existing policies in Tunisia and the quota system so that it may offer lessons learnt for other countries with similar conditions.

Drawing on international experience and expertise: The GFEI has accumulated a wealth of technical and planning experiences with respect to fuel economy standards, their implementation, and impacts. It is therefore the entity best equipped and resourced to support the abovementioned resident committee in materializing the roadmap into a comprehensive action plan for developing, implementing fuel economy standards serving towards the end of curbing Tunisian fuel consumption in absolute terms. It should play a consultative role starting from the inception phase of the resident committee. This starts by determining the data gaps and the required studies for arriving at accurate information about driving patterns and behaviors, commute distances at an encompassing national level.

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Model	Fuel Type	Engine size (liter)	Total sales	Fuel economy (I/100km)	Co2 emissions (g/Km)
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Fiat Punto	Gasoline	1.2	1906	5.7	136
Peugeot 206	Gasoline	1.4	1869	6	139
VW Golf	Gasoline	1.2	1213	4.61	129
Chevrolet Aveo	Gasoline	1.2	1183	3.92	111
Citroen C3	Gasoline	1.6	1161	6.1	145
Seat Ibiza	Gasoline	1.2	1122	5.5	125
Peugeot 207	Gasoline	1.4	834	6.3	145
Renault Symbol	Diesel	1.5	777	4.4	115
Peugeot Partner	Diesel	1.6	656	6.19	175
Citroen C4	Diesel	1.6	636	4.5	120
Citroen Berlingo	Diesel	1.9	389	5.7	181
Peugeot Bipper	Diesel	1.3	356	4.5	119
Citroen C4	Gasoline	1.6	328	6.4	153
Dacia Logan	Gasoline	1.4	320	6.8	157
Peugeot 508	Gasoline	1.6	308	7.1	164
Chevrolet cruze	Gasoline	1.6	301	6.5	153
Kia Picanto	Gasoline	1	266	5.9	139
Renault Fluence	Gasoline	1.6	261	6.5	149
Audi A4	Gasoline	1.8	256	5.8	139
Fiat Linea	Gasoline	1.4	218	6.3	156.1
BMW 1 Series	Gasoline	1.6	194	6.3	150
Mazda 3	Gasoline	1.6	193	6.4	147
Citroen Jumpy	Diesel	2	181	10.1	241

ANNEX-1: SAMPLE LDV DATA