Fuel Economy and CO_2 Emissions of Light-Duty Vehicles in Bahrain

Centre for Environment and Development for the Arab Region and Europe (CEDARE)

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List of Acronyms

ACRONYM	DESCRIPTION
BHD	Bahraini Dinar
BAPCO	Bahrain Petroleum Company
CEDARE	Center for Environment and Development for the Arab Region and Europe
CIO	Central Informatics Organization
CO_2	Carbon Dioxide
EEA	European Environment Agency
GDP	Gross Domestic Product
GFEI	Global Fuel Economy Initiative
IEA	International Energy Association
IRF	International Road Federation
LDV	Light Duty Vehicle
MOF	Ministry of Finance
NEDC	New European Driving Cycle
OECD	Organization for Economic Cooperation and Development
RITA	Research and Innovative Technology Administration
UNEP	United Nations Environment Programme
WB	World Bank

1 INTRODUCTION

As part of the Global Fuel Economy Initiative (GFEI) and the strategic partnership between the Center for Environment and Development for the Arab Region and Europe (CEDARE) and the United Nations Environment Programme (UNEP) under the program titled *Improving Fuel Quality and Fuel Economy in Middle East & West Asia (MEWA)*, the present study aims to assess and fuel economy and carbon emissions of light duty vehicles in Bahrain and to discuss relevant regulations. This case study contributes to the global effort to reduce fuel-dependence, improve vehicle fleet technologies, and mitigate the environmental and economic impact of inefficient vehicles in pursuit of a more sustainable transport sector.

The scope of this report is limited to new Light Duty Vehicles (LDVs). Future studies may also address on-road vehicles (i.e. the entire stock) and the rest of vehicle classifications.

1.1 OBJECTIVES

The overall aim of this study is to present the case study of Bahrain in terms of the state of the vehicle fuel economy and carbon emission trends of new LDVs in the past years. It is presented in the context of the Global Fuel Economy Initiative (GFEI) target to reduce the global average of *new* LDVs from 8 L/100 km today to 4 L/100 km (50%) by 2030, and to further achieve this 50% reduction for the entire LDV stock by 2050; the *50-by-50* target.

The specific objectives of this study are as follows:

1. Report on the average fuel economy for *new* light duty vehicles in Bahrain and its trend over time.
2. Present follow-up recommendations for policy-makers and regulators.

2 BACKGROUND

The transport sector is responsible for 27 % of the world energy consumption (IEA, 2012a). This proportion has increased from 23% in 1973 (IEA, 2011) and contributes to 22 % of total CO_2 emissions (IEA, 2012b).

Many countries worldwide have fuel economy or CO_2 emissions standards in place to improve vehicle efficiency. A number of initiatives around the world are also introduced to help countries with regard to fuel economy standards, data availability and calculation methodologies. The Global Fuel Economy Initiative (GFEI) – for example - comes as an effort of five organizations[1] 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 awareness raising (GFEI, 2013a).

In Bahrain, as in most other countries, road transport sector is one of the highest energy consuming sectors. It consumes around 22 % of its total energy (IEA, 2012a) and is responsible for a significant share of the CO_2 emissions. According to Bahrain's Second Communication to the United Nations Framework Convention on Climate Change (UNFCCC), the CO_2 emissions from transport sector has been increasing over the period 2000 - 2010 by 5.5 % in average (PMEW, 2012). This is due to the rapid increase in the number of the passenger vehicles (7.3 % per year on average) (General Directorate of Traffic, 2012) which resulted in an accelerated rise in fuel consumption (5.7 % per year on average) (CIO, 2012) in addition to the increase in the carbon emissions. Fuel consumption and CO_2 emissions of passenger vehicles in Bahrain are projected to double in the year 2030 compared to 2010 (Alsabbagh et al., 2013).

Sustainability and energy efficiency issues receive considerable attention from policymakers in Bahrain. These issues are stated in the National Environment Strategy, the Economic Vision 2030, and the Second Communication Report to the UNFCCC. However, no specific targets or action plans have been developed yet. There is no car manufacturing industry in the country, and Bahrain still has not introduced any CO_2 emissions or fuel economy standards yet.

Fuel economy and CO_2 emissions are recognized as missing indicators for vehicles in Bahrain (Alsabbagh et al., 2013). Hence, this paper aims to achieve three main objectives: firstly, it supplies information on two important indicators, namely average fuel economy and CO_2 emissions of new Light Duty Vehicles (LDVs) in Bahrain in 2005, 2008, 2010 and 2012. Secondly, it analyzes the fuel economy trends of new LDVs. Thirdly, this study conducts comparisons between fuel economy of new LDVs in Bahrain and that of other countries.

This report consists of five sections. This section of the report sheds light on transport sector in Bahrain, while the methodology is explained briefly in the subsequent section. The study results

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

and discussion are presented in section 4 and finally, section 5 states the main conclusions along with some recommendations.

2.1 Transport Sector in Bahrain

Since 2000, the total vehicle number in Bahrain has grown dramatically to reach 501,481 vehicles in 2012 with an average annual growth rate of 7.3 % (General Directorate of Traffic, 2012). This is a result of the rapidly increasing population (average annual growth rate of 7.1 %) (CIO, 2011; CIO, 2012) and Gross Domestic Product (GDP) (average annual growth rate of 6%) (MOF, 2011) between 2000 and 2010. Figure 1 provides a significant, positive and very strong correlation[2] between the passenger vehicle number, the population size (R^2=0.99) and the real GDP (R^2=0.94) in Bahrain during the period between 2000 and 2010.

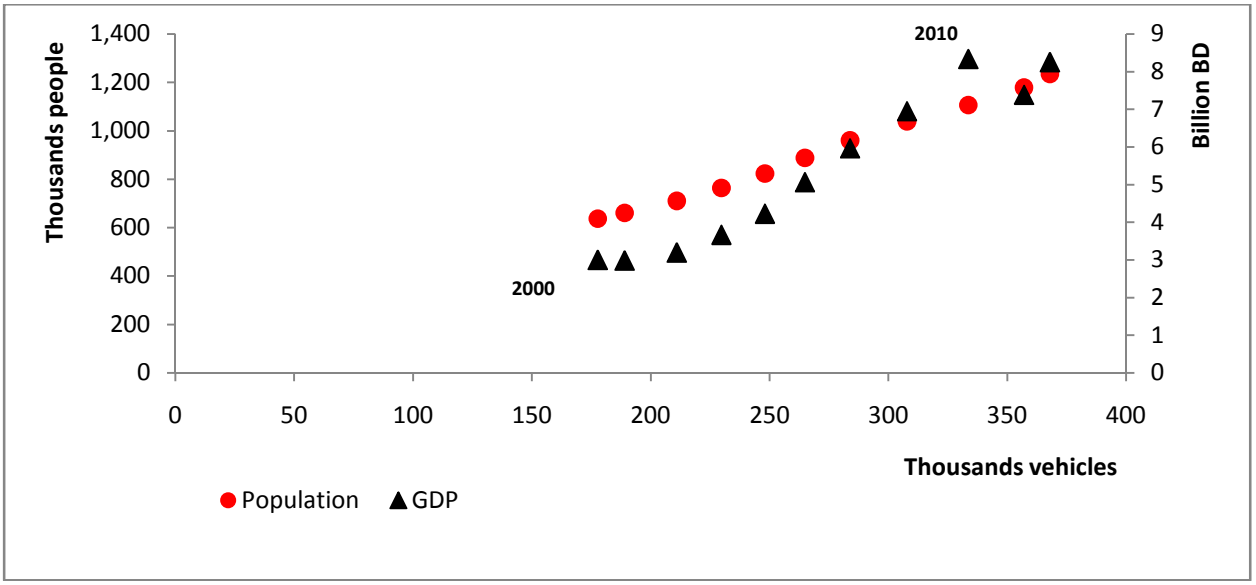

Figure 1: Passenger vehicle number vs. population size and real GDP in Bahrain between 2000 and 2010
Source: CIO, 2011; CIO, 2012; MOF, 2011

Despite the upward trend in vehicle ownership (366 vehicles per 1000 population in 2010), this is relatively low when comparing this statistic to that in countries worldwide (e.g. Australia 688, UK 523, USA 802 vehicles per 1000 population). However, this trend in Bahrain is higher than that of some neighboring countries (e.g. Saudi Arabia 192, and Oman 215 vehicles per 1000 population) (IRF, 2011).

Vehicles in Bahrain rely heavily on gasoline. In 2010, more than 93% of the total vehicles have gasoline engines whilst the remaining percentage uses diesel. Therefore, gasoline usage has experienced an increase in local consumption with an average annual growth rate of 5.7%

[2]The correlation is significant at the 0.01 level (2-tailed)

during the last decade (Figure 2). This increase was a result of the dramatic increase in the number of passenger vehicles, as shown in Figure 3 (CIO, 2012).

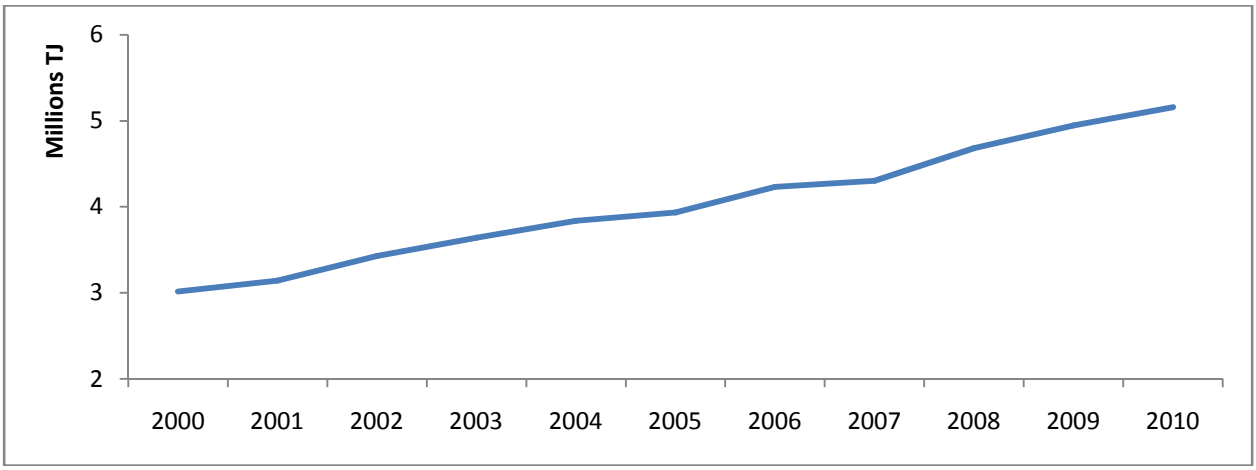

Figure 2: Gasoline consumption in Bahrain between 2000 and 2010 (TJ)
Source: BAPCO, 2010

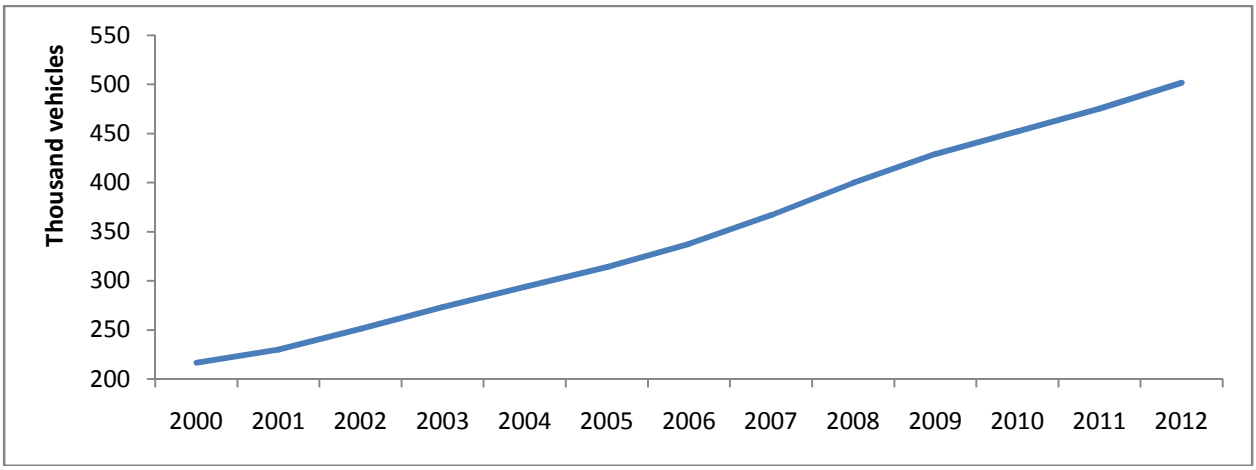

Figure 3: Total number of registered vehicles in Bahrain between 2000 and 2012
Source: General Directorate of Traffic, 2012

The nearly complete reliance on gasoline has resulted in an average annual increase of 5.5 % in CO_2 emissions between 2000 and 2010 (Figure 4) (PMEW, 2012; own calculations). Despite the relatively low share of the carbon emissions from transport sector at 6.8% of the country's total emissions in 2000 (PMEW, 2012), this rate has been gradually increasing since 1994. Therefore, this emissions rate is one of a high priority to be controlled and managed.

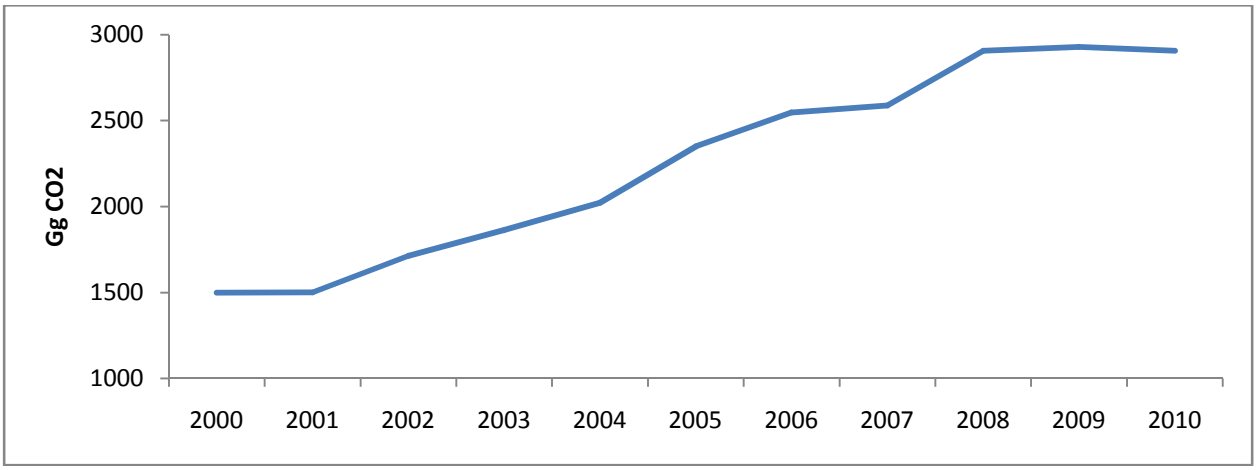

Figure 4: Carbon emissions from transport sector in Bahrain between 2000 and 2010
Source: PMEW, 2012; own calculations.

2.2 Policies and Regulations

The new Traffic law (Law no. 23 of 2013) has been issued in July 2014 and took effect in February 2015 replacing the previous law of 1979. The new Traffic law authorizes the Minister of Interior to define the maximum age of used imported vehicles which was not covered previously. However, the maximum age for on-road registered vehicles is not defined as the law only requires passing the annual vehicle test successfully.

There is also the unified requirements guideline for new cars issued by the Standardization Organization for the GCC countries (GSO 2015). The requirements include technical and safety specifications of new vehicles. It also sets a number of standards on specific air pollutants including Carbon Monoxide, Hydrocarbons and Nitrogen Oxides; however, these standards do not include Carbon Dioxide.

Furthermore, another relevant regulation is Decree no. 8 (2002) on the standards for controlling air pollution from cars, but it is for monitoring cars in operation. Air pollutants mentioned in this decree include Carbon Monoxide and Hydrocarbons only.

2.3 Fuel Prices

The 95-*octane Mumtaz* petrol is sold in Bahrain at BHD 0.10 per liter (USD 0.27 / liter) while the price of 91-octane *Jayyid* petrol is BHD 0.08 per liter (USD 0.02 / liter). The price of petrol in Bahrain is the second lowest[3] in the GCC countries after Saudi Arabia (USD 0.16 / liter) (GIZ

[3] Kuwait has announced that the fuel price will increase between 66 and 88% in the first quarter of 2015. However, Kuwait plans to provide indirect subsidies to the nationals through around USD 102 monthly vouchers (http://www.alwasatnews.com/4468/news/read/941045/1.html).

2014). The price of diesel in Bahrain is BHD 0.12 per liter (USD 0.32 / liter) (El-Maghny 2015). However, less than 1% of LDVs use diesel.

There is no clear reason for which why the share of gasoline cars in Bahrain is higher but this could be due to the wide variety of gasoline passenger cars in the market. It is worthy to note in this context that Saudi Arabia was considering a project that aimed at increasing the number of diesel cars on the road. However, this project was postponed until cleaner diesel is produced at the kingdom (Al-Jazirah 2015).

Subsidies to the prices of oil and gas products amounted to BHD 800.9 and 841.3 million in 2011 and 2012 respectively (USD 2,123.9 – 2,231 million) (Ministry of Finance – Bahrain 2013).

In 2012, Bahrain produced 30.5 million barrels of diesel, 7.5% of which was consumed locally whereas the remaining was exported (CIO 2012a, 2012b). However, it should be noted that a significant amount of the locally-consumed diesel is used for fishing boats. There is no statistic on the exact amount of diesel consumed by vehicles in Bahrain.

3 METHODS

Methodology suggested by the Global Fuel Economy Initiative (no date) to construct a baseline that tracks trends in the fuel economy and CO_2 emissions of new light-duty vehicles (LDVs) is used to carry out this study. LDVs include mini, small, compact, family and big cars in addition to light vans and sport utility vehicles (SUVs) (Annex 1).

The new LDVs data are compiled from the General Directorate of Traffic – Ministry of Interior for the years 2005, 2008, 2010 and 2012. A sample of the data set is presented in Annex 2. The data set includes the following vehicle characteristics:

- Vehicle make and model
- Model production year
- Year of first registration
- Fuel type
- Engine size (in cubic meters – cc)
- Curb weight (in kilograms – kg)
- Number of cylinders
- Body type
- Registration plate type / use of the vehicle

A number of tasks involved with data processing and management were undertaken. Details on the sources contacted and data cleaning are available in Annex 1. It is worth noting in this context that more than 50 % of accurate emission factors and fuel economy was achieved.
Details are available in Annex 1.

4 Results and Discussion

The fuel economy of new LDVs in Bahrain has improved in 2012 by 1 liter per 100 km compared to the year 2005. However, the detailed figures indicate a slight decrease in the fuel economy numbers in 2008 and 2010 matching a similar trend in non – OECD countries[4] (GFEI, 2013b).

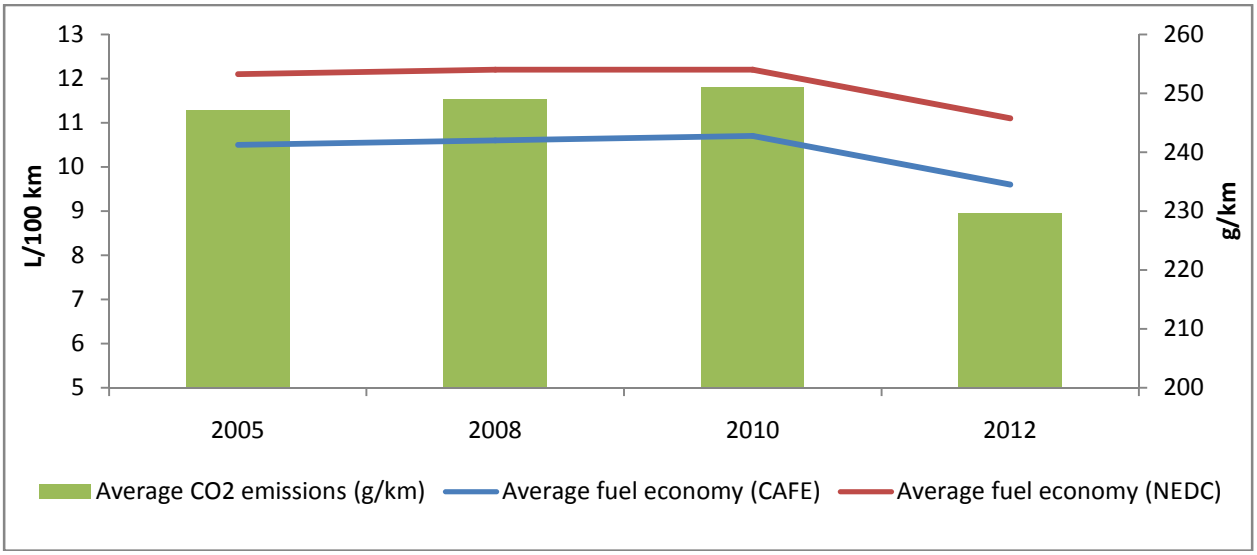

Figure 5: Average fuel economy (L/100km) and CO2 emissions (g/km) for new LDVs in Bahrain

When compared to the fuel economy trend of new vehicles in the USA[5], the gap widens over time in favor of the USA as shown in Figure 6. The US fuel economy standards are set at 7.2 l/100 km for passenger vehicles manufactured in the year 2012, and at 9.3 l/100km for light trucks manufactured in the same year (RITA, 2013). These standards ensure improvements in the vehicle fuel economy unlike the case of Bahrain. The fuel economy figures for Bahrain are also higher than that of the Organization for Economic Co-operation and Development (OECD) countries, and non-OECD countries (Figure 7).

[4] With regard to 2008 models
[5] For passenger vehicles only

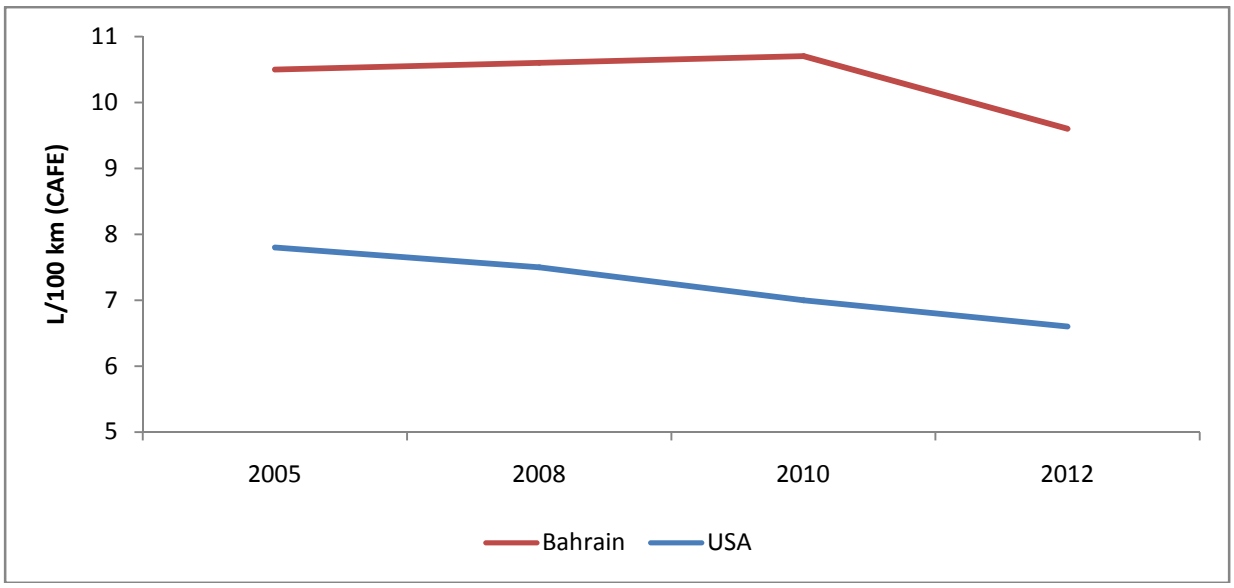

Figure 6: A comparison between the average fuel economy of new LDVs registered in Bahrain and USA in 2005, 2008, 2010 and 2012 (L/100 km, CAFE)
Source: RITA, 2013

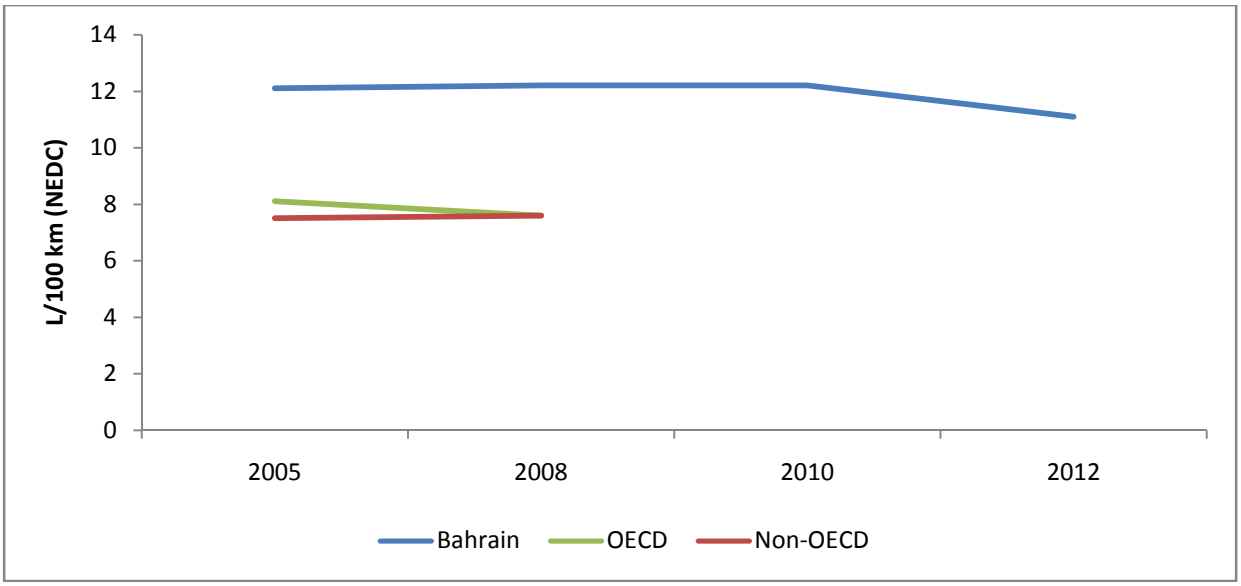

Figure 7: : A comparison between the average fuel economy of new LDVs registered in Bahrain, OECD, and non-OECD countries in 2005, 2008, 2010 and 2012 (L/100 km, NEDC)
Source: GFEI, 2013b

The study also reveals that the average CO_2 emission for new LDVs in Bahrain has decreased by 7% in 2012 compared to 2005 (Figure 5). However, a slight increase in the emissions has again occurred in 2005 and 2008.

Figure 8 shows that apparent variations exist between the EU figures and Bahrain's calculated numbers. The calculated numbers for Bahrain are considerably higher than that of the EU (EEA,

2013). This could be a result of number of factors that affect the engine size and performance including dissimilar weather, consumption patterns, alternative modes of transportation, and CO_2 emissions standards.

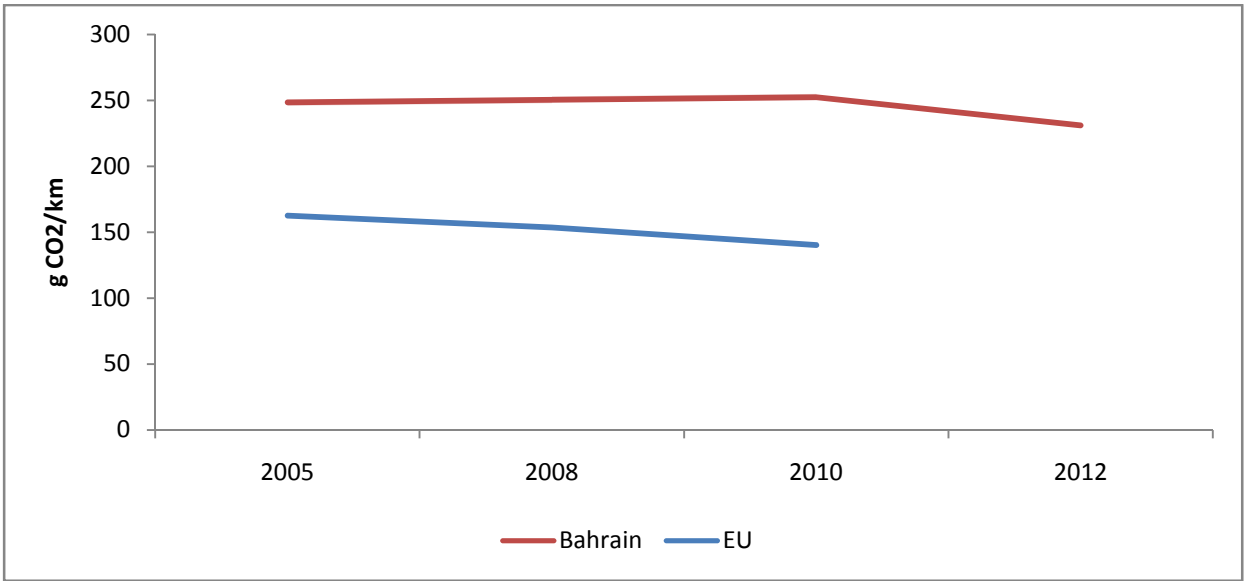

Figure 8: A comparison between the average CO2 emissions from new models of passenger vehicles in the EU and Bahrain in 2005, 2008, 2010 and 2012 (g CO2/km)
Source: EEA, 2013

The study results show that the number of new vehicles in Bahrain has grown by 19.8 % in 2012 compared to 2005 with LDVs making 82 % in average (Figure 9). New LDVs in Bahrain rely heavily on gasoline as it makes more than 99 % of the total number, while the remaining share uses diesel.

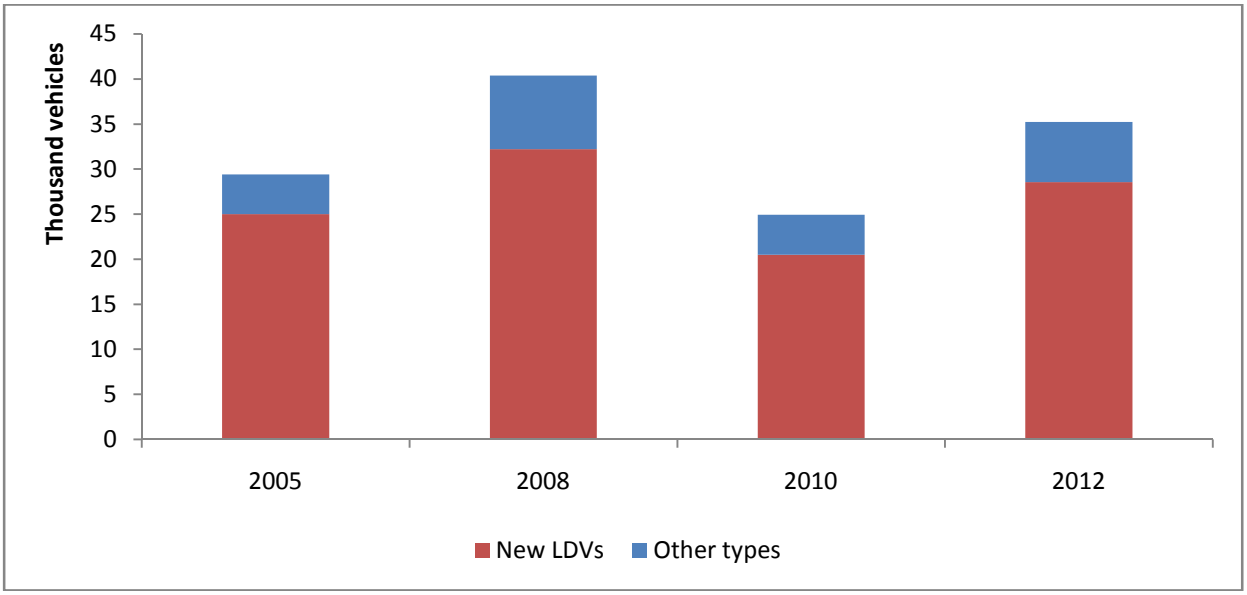

Figure 9: Total new LDVs and other types in Bahrain in 2005, 2008, 2010 and 2012

The average curb weight of new LDVs has increased over the study period reaching 1718 kg in 2012 compared to 1685 kg in 2005 (Figure 10). These figures indicate that the new LDVs in Bahrain are growing in weight as predicted by Alnaser (1995) and Eltony (1996) and evidenced by Alsabbagh et al. (2013).

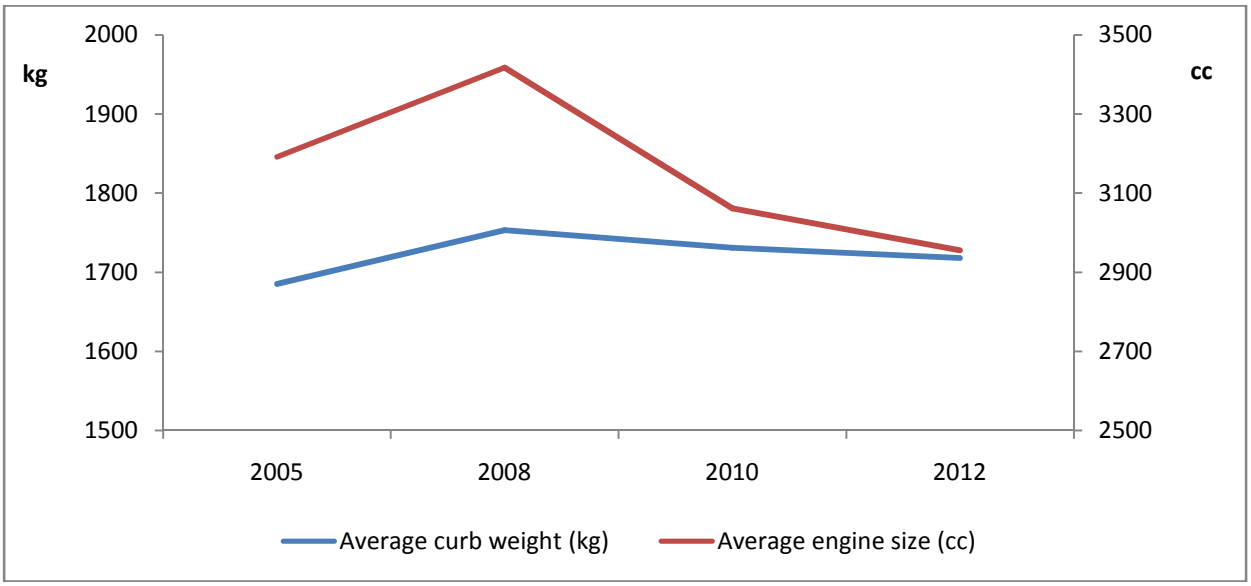

Figure 10: Average curb weight and engine size of new LDVs in Bahrain in 2005, 2008, 2010 and 2012

The majority of new LDVs in Bahrain are first registered at the vehicle year of manufacture (Figure 11). A considerable number of LDVs is registered a year before that, while only a small fraction is registered after the vehicle year of manufacture. One implication that can be drawn is that most LDVs in Bahrain are new imported vehicles.

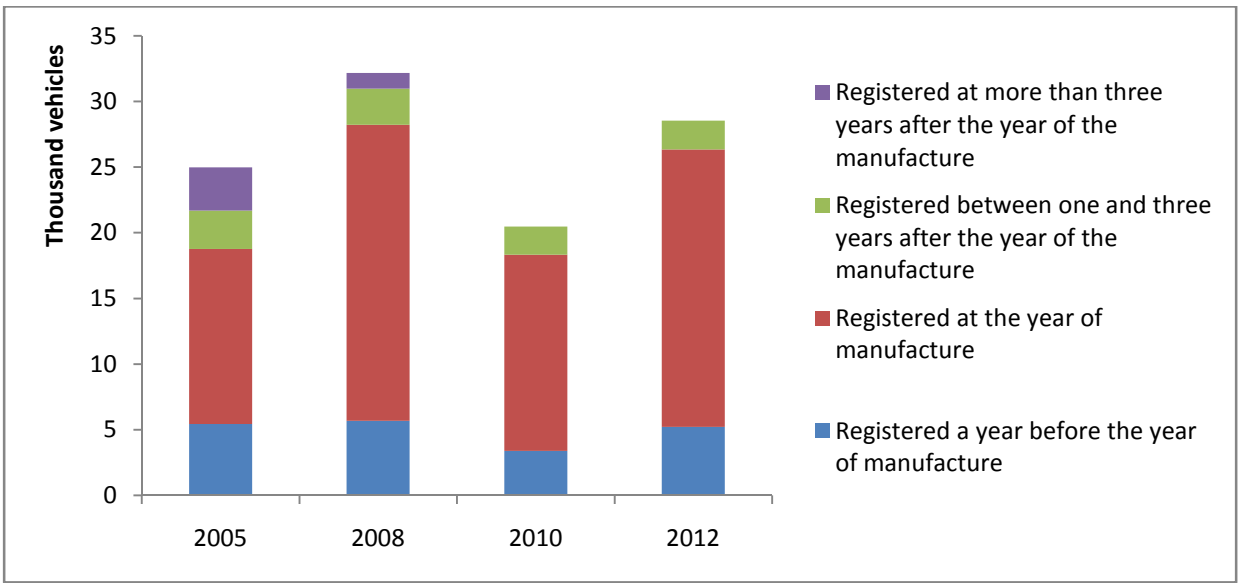

Figure 11: Number of new LDVs per year of first registration (year of manufacture is stated as one year ahead)

Bigger and heavier cars seem to be more preferred in Bahrain. The ownership of these cars may be justified or encouraged by various factors. SUV's for example are used mainly to travel abroad. However, other factors such as easy payment schemes or the subsidized price of gasoline may encourage the wide distribution of these cars.

A recently-published study shows that policymakers and experts highly support imposing fuel economy standards in Bahrain (Alsabbagh et al. 2015). In fact, they suggest including such standards in the unified requirements for new cars in the GCC countries.

Introducing fuel economy standards in Bahrain at 7.2 l/100 km based on the NEDC driving cycle by 2030 is projected to achieve 9% reductions in CO_2 emissions compared to business-as-usual scenarios at cost of USD 90 per ton CO_2e. Sitting a more stringent target of 4.5 l/100 km can achieve around 22% savings at a higher cost of about USD 112 per ton CO_2e (Alsabbagh et al. 2015).

The issue of vehicles fuel economy has been addressed by the Saudi Energy Efficiency Center in the Kingdom of Saudi Arabia. A fuel economy labeling program has been introduced at two stages in August 2014 and January 2015 to include all imported vehicles. The next step would be imposing fuel economy standards in January 2016 (SEEC 2014).

5 CONCLUSIONS

This study aims to provide a clear picture of the fuel economy and CO_2 emissions trends of LDVs in Bahrain. Having a clear understanding of these indicators is crucial to informing effective policies. Analysis shows an improvement in vehicle fuel economy in 2012 compared to the base year 2005. However, an increasing trend towards buying large vehicles can be observed. This implies that the increase in the vehicle weight has offset the potential of significant savings gained from the wide distribution of small and more efficient vehicles.

Although this could be a common problem that may possibly be found in other countries, it is of special importance to Bahrain. There are no restrictions in Bahrain on new vehicles with respect to fuel economy or CO_2 emissions. Furthermore, environmental labeling, emission reduction targets and action plans are yet to be developed for the country. Hence, this denotes abundant objectives for focusing policy framing and research to encourage the use of more efficient vehicles and the introduction of fuel economy standards. Additionally, cooperation between GCC countries in this matter would highly be recommended. The GCC countries may consider incorporating fuel economy standards into the current guideline on unified requirements for new cars especially that some GCC countries have already prepared their future plans.

5.1 CARBON TAXES

To foster the turnover of the fleet, distinguishing in the annual vehicle registration fees between vehicles based on their CO_2 emission is recommended. Taxation is seen as the most effective way to make people take responsibility for their choices and change their behavior and attitudes (Berrittella et al. 2008). Such system is widely applied in many countries including UK, Ireland and Spain while a similar approach based on the vehicle's fuel economy is applied in Denmark (ACEA 2014). The Traffic Law in Bahrain sets the vehicle weight as basis for the annual registration fees distinguishing between two categories only with regard to passenger vehicles (<2.5 tons and > 2.5 tons). Nonetheless, results from a recent survey to policymakers and experts in Bahrain show that 60% of participants support changing the current system (Alsabbagh et al. 2015). Although changing the basis of the annual vehicle registration fees system from vehicle weight to vehicle emissions may not achieve considerable savings in energy demand or CO_2 emissions, it can provide finance required for other projects such as public transport (Alsabbagh et al. 2015).

5.2 FUTURE STUDIES

In Bahrain, similar to most countries in the Arab region, there is a significant lack of data availability. Focus on providing reliable transport-related indicators is suggested for future work. These indicators include price elasticity of demand, energy intensity and vehicle mileage.

Special attention also needs to be paid to heavy duty vehicles. Exploring the technical specifications, fuel economy and energy intensity of heavy duty vehicles would support evidence-informed decision making in Bahrain. Furthermore, the market penetration of different types of hybrid cars is worth examining along with a proposed package of incentives.

In all studies, it is essential to pay great attention to public concerns about the implementation of fuel economy standards or any other policy. The public's acceptance and support of the final decision ensures the success of the policy and its implementation.

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ANNEX 1: METHODOLOGY

Obtain vehicle registration data:

- The data are compiled from the General Directorate of Traffic –Ministry of Interior.
- The collected data for Bahrain are extracted from the on-road registered vehicles in 2013 data set. The new LDVs data could not be obtained directly due to IT system change in the General Directorate of Traffic.
- The collected data contains the following information and specifications:
    - Year of manufacture
    - First registration date
    - Vehicle make code and name
    - Vehicle model code and name
    - Engine capacity (cc)
    - Weight (kg)
    - Fuel type
    - Vehicle type code and name
    - Plate type code and name
    - Number of axles
    - Number of cylinders
- The database does not indicate whether the vehicle is imported as a new or used vehicle. However, estimates can be obtained from the comparison between the year of manufacture and the first registration year. If the car is registered three years or more after the year of manufacture, it can be assumed that it was imported as a used vehicle.

Cleaning data:

- Vehicles not classified as LDVs are removed. Types of vehicles classified as LDVs are presented at Table 1 (GFEI, no date).

Table 1: Types of LDVs

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

Source: GFEI, no date

- Correct data entry errors.

Structure the data set:

- New LDVs data are extracted from the data set based on the year of manufacture (2005, 2008, 2010, 2012).
- Find fuel economy and CO_2 emission factors for Bahraini LDVs. Data sources and contacts are briefed in Table 2.

Table 2: Data sources and contacts

Country	Source	Comments
USA	DoE / EPA Fuel Economy ratings www.fueleconomy.gov/	This website is used to obtain fuel economy and CO_2 emissions data
China	www.gzly.miit.gov.cn:8090/datainfo/miit/babs2.jsp	Couldn't use and couldn't use Google Translate
UK	Car Fuel Data Booklet http://carfueldata.direct.gov.uk/search-new-or-used-cars.aspx	Different from Bahraini vehicle types
France	Consommationconventionnelles de carburant et émissions de gazcarbonique www2.ademe.fr/servlet/getDoc?cid=96&m=3&id=52820&p1=00&p2=12&ref=17597	Different from Bahraini vehicle types
Australia	Green Vehicle Guide Factsheets www.greenvehicleguide.gov.au	No assessment yet, sent an email to ask for database and they replied after submitting the report. Nevertheless, they mention data duplication which means more time is required for cleaning the data.
Japan	JIDOSHA NENPI ICHIRAN (in Japanese) www.mlit.go.jp/jidosha/jidosha_mn10_000001.html	Couldn't use and couldn't use Google Translate
Mexico	Indicadores de EficienciaEnergética y EmisionesVehiculares www.ecovehiculos.gob.mx/	Couldn't use and couldn't use Google Translate
South Africa	National Association of Automobile Manufacturers of South Africa http://www.naamsa.co.za/ecelabels/	Doesn't show the year of manufacture and when contacted, they sent emission factors for BMW only.
Swiss	Automobil Revue catalogue (not official this one, but good compilation of worldwide vehicle production www.katalog.automobilrevue.ch/	Different from Bahraini vehicle types
	Major car manufacturers	Data for 2013 models only were received
	The Next Green Car http://www.nextgreencar.com/ Car Emissions http://www.car-emissions.com/ CO_2 Emissions Calculator http://www.falconsolution.com/co2-emission/index.php?Year=0&Make=ACURA&Model=0&Distance=100&DrivenCase=2	Couldn't use because of data reliability concerns

Estimate baseline fuel economy and CO_2 emissions

- Vehicles data obtained for the fuel economy and CO_2 emissions (called here reference data) are coded based on the vehicle model codes used in the Bahraini registration system. With regard to the fuel economy data, the reference data includes city MPG, highway MPG, and combined MPG. The last one is used for the calculations

- Four main elements of the Bahraini LDVs data set are utilized to obtain fuel economy and CO_2 emissions for new LDVs, namely the vehicle make, model, year of manufacture, and the engine size.
- The percentage of Bahraini vehicles that match specifications of reference data has exceeded 50 % (Table 3). However, some of the data are removed in order to represent all categories. The removal process is based on the engine capacity to allow a satisfactory weight distribution of the sample and to well represent the entire population (Table 3).

Table 3: Total number of LDVs used for the calculations

Year	LDVs	LDVs with calculated fuel economy	%	LDVs with calculated fuel economy (after data refinements)	%
2005	25,019	11,015	44.0	7,853	31.4
2008	32,229	14,553	45.2	9,404	29.2
2010	20,479	9,256	45.2	4,018	19.6
2012	28,552	15,012	52.6	7,610	26.7

- Pivot tables are then created to calculate the weighted average fuel economy and CO_2 emissions of new LDVs in Bahrain using the following equations (GFEI, no date):

$$Harmonic\ average\ annual\ fuel\ economy = \frac{Total\ sales\ in\ the\ year}{\sum_1^n \frac{sales\ model\ i}{fuel\ economy\ model\ i}}$$

$$Average\ annual\ emission = \frac{\sum_1^n sales\ model\ i * emission\ model\ i}{Total\ sales\ in\ the\ year}$$

- The fuel economy estimate is then converted from Corporate Average Fuel Economy (CAFE) to New European Driving Cycle (NEDC) using the Test Cycle Conversion Tool: http://www.theicct.org/sites/default/files/info-tools/GlobalStdReview_Conversionfactor_May17_v1.xlsx .

ANNEX 2: SAMPLE OF THE DATA

TOTAL REGISTERED VEHICLES IN USE ON ROAD UNTIL 30 NOV, 2013

YEAR OF MANUFACTURE	FIRST_ISSUE_DATE	VEHICLE MAKE CODE	VEHICLE MAKE	VEHICLE MODEL CODE	VEHICLE MODEL	ENGINE SIZE	WEIGHT	FUEL TYPE CODE	VEHICLE TYPE CODE	VEHICLE TYPE	PLATE TYPE CODE	NUMBER OF AXLES	NUMBER OF CYLINDERS	Plate Type	NUMBER OF VEHICLES
2012	20/12/2011	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	1
2012	27/12/2011	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	1
2012	02/01/2012	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	1
2012	12/01/2012	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	1
2012	24/01/2012	14	CHEVROLET	8102	TRAVERSE	3600	2253	1	64	JEEP	1	2	6	PRIVATE	1
2012	26/01/2012	14	CHEVROLET	8102	TRAVERSE	3600	2253	1	64	JEEP	1	2	6	PRIVATE	1
2012	01/02/2012	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	2
2012	01/02/2012	14	CHEVROLET	8102	TRAVERSE	3600	2130	1	64	JEEP	1	2	6	PRIVATE	1
2012	02/02/2012	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	1
2012	09/02/2012	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	1
2012	16/02/2012	14	CHEVROLET	8102	TRAVERSE	3600	2130	1	64	JEEP	1	2	6	PRIVATE	1
2012	23/02/2012	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	1
2012	05/03/2012	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	1
2012	11/03/2012	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	1
2012	12/03/2012	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	1
2012	28/03/2012	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	1
2012	01/04/2012	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	1
2012	02/04/2012	14	CHEVROLET	8102	TRAVERSE	3600	2130	1	64	JEEP	1	2	6	PRIVATE	1
2012	04/04/2012	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	1
2012	12/04/2012	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	1
2012	17/04/2012	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	1
2012	26/04/2012	14	CHEVROLET	8102	TRAVERSE	3600	2094	1	64	JEEP	1	2	6	PRIVATE	2
2012	03/05/2012	14	CHEVROLET	8102	TRAVERSE	3600	2130	1	64	JEEP	1	2	6	PRIVATE	2
2012	09/05/2012	14	CHEVROLET	8102	TRAVERSE	3600	2125	1	64	JEEP	1	2	6	PRIVATE	1

ANNEX 3: TABLES

Table 4: Passenger vehicle number vs. population size and real GDP in Bahrain between 2000 and 2010.

Year	Vehicles	Population	Real GDP (BD Million)
2000	216679	637,582	2996.9
2001	229780	661,317	2981.5
2002	250978	710,554	3192.6
2003	273230	764,519	3665
2004	293801	823,744	4224.5
2005	314033	888,824	5060.6
2006	337545	960,425	5960.3
2007	366732	1,039,297	6945.6
2008	399546	1,106,509	8328.8
2009	428957	1,178,415	7377.5
2010	452222	1,234,571	8245.6

Source: CIO, 2011; CIO, 2012; MOF, 2011

Table 5: Gasoline consumption in Bahrain between 2000 and 2010 (TJ)

Year	Gasoline consumption
2000	3014350
2001	3143120
2002	3429410
2003	3639380
2004	3837740
2005	3933800
2006	4232630
2007	4303160
2008	4681990
2009	4945000
2010	5157350

Source: BAPCO, 2010

Table 6: Total number of registered vehicles in Bahrain between 2000 and 2012

Year	Vehicles number
2000	216679
2001	229780
2002	250978
2003	273230
2004	293801
2005	314033

2006	337545
2007	366732
2008	399546
2009	428957
2010	452222
2011	475150
2012	501481

Source: General Directorate of Traffic, 2012

Table 7: Carbon emissions from transport sector in Bahrain between 2000 and 2010

Year	CO2 emissions
2000	1462.61
2001	1500.09
2002	1712.48
2003	1863.74
2004	2021.64
2005	2350.25
2006	2458.99
2007	2587.22
2008	2906.78
2009	2928.59
2010	2905.25

Source: PMEW, 2012; own calculations.

Table 8: Average fuel economy (L/100km) and CO_2 emissions (g/km) for new LDVs in Bahrain in 2005, 2008, 2010 and 2012

Year	Average fuel economy (CAFE)	Average fuel economy (NEDC)	Average CO_2 emissions (g/km)
2005	10.5	12.1	247.1
2008	10.6	12.2	249.0
2010	10.7	12.2	251.0
2012	9.6	11.1	229.6

Table 9: A comparison between the average fuel economy of new LDVs registered in Bahrain, USA, OECD, and non-OECD countries in 2005, 2008, 2010 and 2012 (L/100 km, CAFE)

Year	2005	2008	2010	2012
Bahrain	10.5	10.6	10.7	9.6
USA*	7.8	7.5	7	6.6

Source: *RITA, 2013

Table 10: A comparison between the average fuel economy of new LDVs registered in Bahrain, OECD, and non-OECD countries in 2005, 2008, 2010 and 2012 (L/100 km, NEDC)

Year	2005	2008	2010	2012
Bahrain	12.1	12.2	12.2	11.1
OECD*	8.1	7.6		
Non-OECD*	7.5	7.6		

Source: *GFEI, 2013b

Table 11: A comparison between the average CO2 emissions from new models of passenger vehicles in the EU and Bahrain in 2005, 2008, 2010 and 2012 (g CO2/km)

Year	2005	2008	2010	2012
EU*	162.4	153.6	140.3	-
Bahrain	248.5	250.4	252.4	230.9

Source: *EEA, 2013

Table 12: Total new vehicles, new LDVs and gasoline LDVs in Bahrain in 2005, 2008, 2010 and 2012

Year	Total new vehicles	New LDVs	%	Gasoline LDVs	% of LDVs
2005	29395	25019	85.1	24946	99.7
2008	40395	32229	79.8	32161	99.8
2010	24939	20479	82.1	20439	99.8
2012	35219	28552	81.1	28439	99.6

Table 13: Average curb weight and engine size of new LDVs in Bahrain in 2005, 2008, 2010 and 2012

Item	2005	2008	2010	2012
Average curb weight (kg)	1685	1753	1731	1718
Average engine size (cc)	3191	3417	3061	2955

Table 14: Number of new LDVs per year of first registration

Item	2005	2008	2010	2012
Registered a year before the year of manufacture	5444	5669	3390	5216
Registered at the year of manufacture	13327	22550	14931	21143
Registered between one and three years after the year of the manufacture	2912	2769	2156	2191
Registered at more than three years after the year of the manufacture	3294	1174	0	0
N.A.	42	67	2	2
Total	25019	32229	20479	28552