CLEANER AND MORE EFFICIENT FUELS AND VEHICLES IN BELIZE

Establishment of a baseline for the fuel economy of light duty vehicles

(2013 - 2016)

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Acronym

CAFÉ	Corporate Average Fuel Economy
CBA	Cost Benefit Analysis
CEGESTI	Centro de Gestión Tecnológica e Informática Industrial
CO_2	Carbon Dioxide
CO_2/km	Carbon Dioxide per kilometer
CMMCh	Centro Mario Molina Chile
CNTMP	Comprehensive National Transportation Master Plan of Belize
GFEI	Global Fuel Economy Initiative
IEA	International Energy agency
ITF	International Transport Forum
LEG	Liters of Equivalent Gasoline
LDV	Light Duty vehicles
MPG	Miles Per Gallon
NDC	Nationally Determined Contributions
NEDC	New European Driving Cycle
OECD	Organization for Economic Co-operation and Development
PM	Particulate matter
PCFV	Partnership for Clean Fuels and Vehicles
SIB	Statistical Institute of Belize
SUVs	Sport Utility Vehicle (Jeep)
UCDavis	University of California Davis
UN Environment	United Nations Environment

Acknowledgements

This publication has been prepared within the framework of the project: Cleaner and More Efficient Fuels and Vehicles. The project has the support of the United Nations Environment Program (UN Environment), the Global Fuel Economy Initiative (GFEI), Partnership for Clean Fuels and Vehicles (PCFV) and the financing of the FIA Foundation, the European Union and the Global Environment Facility.

The project is being implemented by UN Environment in cooperation with the Ministry of Energy, Science, Technology and Public Utilities and with the assistance of the technical partners of the Global Fuel Economy Initiative, especially Fundación Centro de Gestión Tecnológica e Informática Industrial (CEGESTI) and Centro Mario Molina Chile (CMMCh).

The members of the working group that represented the different institutions and key actors contributed to the discussions on the fuel saving policy in the country, allowing CEGESTI to consider the opinions and views of all the interested parties.

Executive Summary

The rapid increase in global fuel consumption threatens sustainability as fossil fuel reserves are limited and rapidly reduced. For developing economies that are not oil producers, fuel prices stagger economic growth as the trade balance leads to greater fuel imports. The country's dependence on imported fossil fuels creates an economic burden.

The global increase of the vehicle fleet in the coming decades, especially in developing economies, will have a monumental impact on health, the environment and the climate. The International Energy Agency (IEA) estimates that fuel consumption and CO2 emissions from cars will double between the years 2000 and 2050.

- **Growth of the global fleet of light duty vehicles**

  Close to 1 billion today to more than 2.5 billion by 2050.

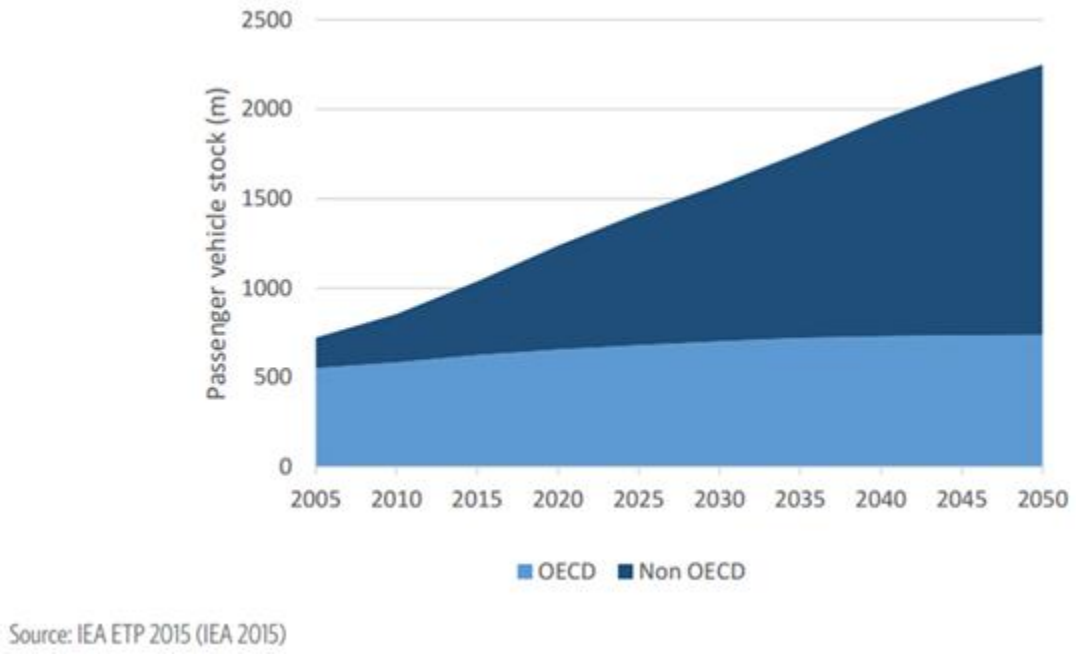

Figure 1 GROWTH OF THE GLOBAL FLEET OF LIGHT DUTY VEHICLES

As seen on Figure 1, the global vehicle fleet will triple by 2050 (from ~ 1 million to ~ 2.5 + billion), 90% + growth in non-OECD countries, very few non-OECD countries have policies Worldwide, vehicles account for almost half of fuel consumption and CO2 emissions in the transport sector.

For these reasons, the **Global Fuel Economy Initiative** (GFEI) was established to initiate the debate on policy development. The Global Fuel Economy Initiative seeks to promote the efficiency of vehicles in fuel consumption as a contribution to climate change, energy security and sustainable mobility. The GFEI has established that improving the fuel efficiency of road vehicles is a cost-effective and accessible method to stabilize or help reduce CO2 emissions from road transport. The process of determining trends in fuel efficiency and CO2 emission standards begins with the compilation and synthesis of vehicle inventory.

Scope and Objective

This study aims to establish a baseline fuel economy estimate for light duty vehicles (LDV) that entered the Belize fleet in the past four years. Light duty vehicles for this purpose are defined as all passenger vehicles and light duty commercial vehicles, no more than 3.5 gross vehicle weight (GVW). The overall objective of this study is to estimate fuel savings and compare the performance of several vehicle segments with respect to the baseline. The research hopes to facilitate policy discussions by providing a scientifically-sound assessment of the fuel economy of light duty vehicles that enter the fleet. The researchers, with the support of experts from the GFEI, take into account the current situation in the country and the results analyzed with the GFEI Fuel Economy Policies Impact tool (FEPIT). A deep knowledge of the starting point will allow legislators to choose the right combination of technology and political instruments necessary to achieve national objectives in the field of emissions, energy security and efficiency.

Data and Methodology

Information about the vehicles registered in Belize in 2013, 2014, 2015 and 2016 was obtained from the Belize Custom & Excise Department and the Statistical Institute of Belize, through the Ministry of Energy, Science, Technology and Public Utilities.

The data provided consisted of 32,207 Light Duty Vehicles (LDV) in total for these 4 years. These vehicles consist of less than 3,500 kg of gross weight and included details on descriptive variables.

The methodology for baseline estimation adopts the estimator prescribed by the GFEI toolset, using the average harmonic fuel economy of the fleet and interpreted as the average fuel economy of vehicles registered in the base year.

Firstly, the information for the typographical errors was cleaned and then the names of the vehicle models were identified and the improvement of the description of the vehicle was made. The collection of data with model names was carried out through the use of Internet websites and other relevant literature. The main data fields for the development of fuel economy databases for vehicles, namely fuel consumption in liters per 100 kilometers (L / 100 km) and CO2 emissions in grams per kilometer (g / km) , were obtained mainly from the US, Chilean, Mexican and European government websites or database. The test cycles (vehicle operation patterns) used in the USA, Europe and Japan are; Corporate Average Fuel Economy (CAFE), New European Driving Cycle (NEDC) and Japanese Fuel Consumption Index (JC08), respectively. The methodology developed by the International Council on Clean Transportation (ICCT) was used to convert the values of the CAFE and JC08 test cycles to the corresponding values of the NEDC.

Study Results

Based on available data, the harmonic mean fuel economy of newly registered LDVs in Belize in the year 2013 is 13,76 Lge/100km, for 2014 was 13,94 Lge/100km, for 2015 was 14,13 Lge/100km and for 2016 was 13,98 Lge/100km. It is important to emphasize that the fuel economy values obtained are quite high, and this is due to the fact that the fleet of light vehicles is composed principally of old vehicles of the type SUV and pick up.

According to the results obtained from the baseline study, the total vehicle new registrations in the years 2013, 2014, 2015 and 2016 was of 32,207 Light Duty Vehicles. There is no information on the growth of average annual number of vehicles according to segment or the years of antiquity of the vehicular fleet.

In Belize most vehicles, and in general public transport, use gasoline or petroleum fuels. Most mechanics and importers of cars do not recommend diesel vehicles so they are found in lesser quantities (Tillett, Locke, & Mencias, 2011). The country does not have any refinery plants, and the Ministry of Finance sets the prices for the three (3) major refined imported oil products: kerosene, diesel and gasoline (regular and premium). All refined oil products (gasoline, diesel, kerosene, and aviation gasoline) are imported mainly from United States, Mexico and Venezuela under the Petro-Caribe Agreement and transported to Belize via ocean tankers.

The Belize Bureau of Standards is the only entity responsible for developing standards, and according the standards for both regular and premium unleaded gasoline, the sulfur content is 0.10%, or 1,000 parts per million, max of the same weight of total sulfur content (ASTM Test D-2622).

The baseline study of Carbon Dioxide (CO_2) emissions of the new vehicle registrations in Belize during the period 2013-2016 shows that the average CO_2 emissions per year (in grams per kilometer) range between 323.19 – 330.31 g CO_2 / km.

During these years there is an increase in SUV´s and pick-up´s, so the increase in carbon dioxide emissions is directly related to the increase in the importation of this type of vehicles. The pick-up is determined as the vehicle that emits the most CO_2 emissions.

Up to 2016, there was no emission standards for new vehicles in Belize, no new vehicle type-approval system and mechanism for checking/certifying second hand vehicles, and no incentives applied for cleaner vehicles (e.g. CO_2 and non-CO_2 pollutants and no policies in place to promote more fuel efficient vehicles).

Introduction

This publication has been prepared within the framework of the national project: Cleaner and More Efficient Fuels and Vehicles. The project is supported by the United Nations Environment Program (UN Environment), the Global Fuel Economy Initiative (GFEI) and the Partnership of Clean Fuels and Vehicles (PCFV).

The objective of this document is to facilitate the preparation of a first diagnosis of trends in the performance and emissions of the national automotive market for the development of a strategy for energy efficiency in road transport. The document also incorporates recommendations to reduce emissions of fuels and vehicles, the recommendations for the reduction of Particulate Material (PM), have been prepared as part of the activities of the Partnership for Clean Fuels and Vehicles (PCFV) and the Global Fuel Economy Initiative (GFEI).

At the XIX Meeting of the Forum of Ministers of the Environment of Latin America and the Caribbean, the Regional Plan of Action on Atmospheric Pollution was adopted. It was agreed to "reduce the contribution to priority pollutants from the region ….and improve air quality in urban areas of the LAC region". The transport sector was recognized as the main source of air pollutants in the region.

The results presented below will be shared in a workshop led by the Ministry of Energy, Science, Technology and Public Utilities, involving key actors from the private and public sectors, including representatives of relevant government institutions, automotive, energy and fuel sectors.

What is fuel economy?

Fuel economy refers to the fuel used in relation to the distance traveled (Fulton, 2014). The terms fuel economy, fuel efficiency and fuel intensity are interchangeable terms. Fuel economy is measured by country, and what objectives are involved in terms of policy. For example, fuel savings are measured in liters per 100km (L / 100km) in Europe, kilometers per liter (km / L) in Japan and miles per gallon (mpg) in the United States. In short, the fuel savings is the rate of energy consumption.

Improving fuel economy means increasing trips per unit of fuel use, which reduces the overall fuel usage for a given distance traveled. Automobile fuel economy can be achieved with the help of pricing strategies and taxation, technologies, behavioral changes and integrated planning techniques. There are a number

of benefits of improving fuel economy, including reduced costs for car users, improved air quality, increased energy security and reduced CO2 emissions.

Global Fuel Economy Initiative[1]

The Global Fuel Economy Initiative (GFEI), launched in early 2009, is a consortium formed by the United Nations Environment Program (UN Environment), the International Council on Clean Transport (ICCT), the Foundation for the Automobile and Society (FIA Foundation), the International Energy Agency (IEA), the International Transport Forum (ITF) and the California Davis University (UC Davis).

The mission of the GFEI is to facilitate large reductions in greenhouse gas emissions and the use of petroleum through improvements in the automotive fuel economy in the face of rapid growth in car use worldwide. **The overall goal is to reduce by half the fuel consumption in light duty vehicles in kilometers, and the CO2 emissions in grams per kilometer (g / km)**. From 8 liters per 100 kilometers (L/100km) in 2005 to 4 liters per 100 kilometers (L/100km) by 2050.

The GFEI has estimated that, based on vehicle technologies that are already or will be on the market within the next few years, a 50% improvement in the fuel efficiency of vehicles worldwide can be achieved and, consequently, they could reduce the consumption of energy in more than 6 billion barrels of oil per year until the year 2050 and the CO2 emissions of automobiles to almost half of their current levels. However, in order to achieve these benefits, it requires the concerted action of the sectors involved and the issuance of regulations that regulate the energy efficiency of vehicles.

The 3 main activities of GFEI are:

1. Data development and analysis of fuel savings potentials by country and region.
2. Support for national and regional policy formulation efforts.
3. Awareness activities among stakeholders (for example, vehicle manufacturers)

[1] https://www.globalfueleconomy.org/

Partnership for Clean Fuels and Vehicles[2]

The Partnership for Clean Fuels and Vehicles (PCFV) is the leading global public-private initiative promoting cleaner fuels and vehicles in developing and transition countries. The PCFV supports countries to reduce air pollution and greenhouse gas emissions from road transport by applying fuel quality improvements and proven vehicle technologies in use in leading global auto markets. The main focus areas are the elimination of lead in fuels; the reduction of sulphur levels in fuels and the promotion of cleaner vehicle technology.

Low sulphur fuels are critical to lowering direct emissions of particulate matter from on-road traffic (that are of great concern due to their health impacts) and black carbon emissions (an important climate pollutant). The PCFV recognizes that fuels and vehicles work together as a system, and that the greatest benefits are achievable by combining cleaner fuels with appropriate cleaner vehicle and emission control technologies. While many developing and transition countries are increasingly implementing cleaner fuel policies, most still lack vehicle emission standards. A strategy that focuses on cleaning the fuels and vehicles in an integrated manner will result in optimal benefits to the countries. For in-use vehicles, effective inspection and maintenance programs will ensure vehicles emit fewer pollutants.

Objectives

This publication has been prepared within the framework of the project: Cleaner and Efficient Fuels and Vehicles. The project has the support of the United Nations Environment Program (UN Environment) and the Global Initiative for Fuel Economy (GFEI).

The objective of this document is to facilitate the elaboration of a first diagnosis of trends in the performance and emissions of the national automotive market of the period 2013 to 2016 for the development of a strategy for energy efficiency in national transport.

The project for cleaner and more efficient fuels and vehicles seeks to generate the conditions for the transformation of the Belize automotive market so that it progressively incorporates more efficient technologies with lower emissions of pollutants. With this transformation, the risk of air pollution for the

[2] http://www.unep.org/transport/pcfv

health of the inhabitants of urban areas will be reduced, international efforts will be made to control climate change and the country's energy security will be increased.

The objective of this study is to establish an estimate of the reference fuel economy for new light duty vehicles (LDV) that entered the national fleet. The research hopes to facilitate policy discussions, provide a scientifically sound assessment of the fuel economy of new light duty vehicles that enter the fleet on a daily basis.

The objectives of the baseline study for the fuel economy of light duty vehicles:

- Develop an inventory of vehicles in the country during the last four years and evaluate the trend in average fuel economy and CO2 and other emissions. Includes: Data collection of the fleet of light duty vehicles for the establishment of the baseline. Calculation of the national fuel economy for 4 years.
- Review existing national regulations and incentives to promote cleaner and more fuel-efficient vehicles.
- Establish the amount of CO2 and other emissions, emission costs and related diseases.
- Report with analysis and recommendations, impact assessment of policies.

Background

Current policies and regulations

Vehicles framework

Transport by land is governed by the Motor Vehicles and Road Traffic Act. The Belize Land Transportation Authority (BLTA) is the government agency in charge of its enforcement under the umbrella of the Ministry of Transport and National Emergency Management (MTNEMO). In 2008, a new regulatory body was formed to improve Belize's growing transportation industry. The new agency, called Belize Land Transportation Authority (BLTA), has legal powers under the Belize Land Transportation Authority Act of 2007. This autonomous body does not depend on government revenue and sustains itself. The BLTA generates its revenue from road permits, operation of the various bus terminals across the country and revenues generated from ticket fines among other things. It may issue road permits with no ministerial interference.

Also Belize is part or the Vienna Convention on Road Traffic, designed to standardize the traffic rules among all contracting parties. Belize signed on to Protocol VI (Regional Transport Policy), amending the Treaty establishing the Caribbean Community.

The Department of Public-Private Dialogue of the Office of the Prime Minister, in collaboration with other entities (Egis, Transconsult, IDB) are working in the elaboration of the Comprehensive National Transportation Master Plan (CNTMP) for Belize. This project has the specific objectives of preparing an extensive diagnosis of the Belizean transport system, generating a short-term action plan (1-2 years), assessing futures need of intercity system in the medium and long term, generating a medium and long-term action plan (3-20 years) and ensuring that the CNTMP is developed through a consultative and participatory process. (Quirós, 2018)

Within the CNTMP there is a general transport sector strategy that derives from the national development strategy (National Development Framework for Belize (NDF) 2010-2030 and Growth and Sustainable Development Strategy (GSDS) 2016-2019). Both strategies emphasize the need for the transport sector to support the tourism and agricultural sectors development with the environmentally friendly and climate

resilience and adaptable infrastructure and supporting policies, with the active collaboration of the private sector. (Quirós, 2018)

The strategy and policy guidelines regarding on environmental protection and climate resilience and adaptation focuses on three main aspects: implementation of environmental regulations; exploring incentives for fleet renewal such as differentiating customs tariffs by age and emissions, limiting the import of salvage vehicles, promoting or temporarily subsidizing green vehicles and maximizing IFI grants for funding; and integration of climate change adaption to transport infrastructure planning. (Quirós, 2018)

In terms of energy efficiency and regulations for reducing GHG emissions, the strategy talks in a medium and long term action plan about the implementation of weighbridges on main trade corridors (by 2025); regulating and enforcing weight limits and dimension of cargo vehicles; and issuing specific regulations for bi-articulated trucks (by 2035). The establishment of an age limit of 15 years for the freight and public transportation fleet (by 2025) can set the path for making the bus and truck fleet much more efficient and can result in the establishment of an air quality standard in the future. Additionally, redesign of the bus network including first class services and coordination of feeder services within rural areas, if done properly, can reduce the number of buses, making the system more energy efficient and reducing fuel consumption, GHG and air pollutants. (Quirós, 2018)

The environmental protection and energy efficiency medium and long term action plan focuses on three proposals. First the implementation of regulation on heavy-duty vehicle emissions by limit the age of the vehicles being imported to the country, based on the EPA or EURO standards (technology). Secondly energy efficiency in LDV by measures grouped in three categories: informational (eco labelling), regulatory (standards) and economic (taxes on new and used vehicles based on fuel consumption). By last electric vehicles (promotion of renewal energy use, development of public charging infrastructure, market conditions, and economic incentives) and biofuels. (Quirós, 2018)

In the final draft of “Growth and Sustainable Development Strategy for Belize 2015-2018 - Version 4.0”, action 4 refers to develop a transportation policy, which will give consideration to the establishment of service standards, the pursuit of desirable environmental standards, and enhanced administration of the licensing of vehicle and drivers.

Fuel quality framework

There is not a unitary legal and institutional framework for regulating fuel refining & processing, or fuel distribution & sale. The Department of the Environment (DOE) sets standards for effluents and emissions from facilities and monitors the environmental impacts of the activities undertaken by entities. The Bureau of Standards, a unit housed within the Ministry of Economic Development, has taken a more active role in differentiating the quality of LPG (imported and local produced); and setting the control price based on quality. This is in addition to its regular function of protecting consumers from fraudulent weights and measures. The Ministry of Finance sets retail prices for the three-(3) major refined oil products: kerosene, diesel and gasoline (regular and premium).

Oil derivates are 100% imported, as the country does not have refinery plants. Fuel dependency is a big challenge for Belize, accounting for approximately 66% of the country's energy supply, mostly applied in the transport sector. Belize's dependency on imported energy sources poses a concern regarding the country's security of energy supply.

To put the transport sector into perspective, the entire annual consumption of gasoline, approximately 3,500 barrels per day, produces about 425,000 tCO_2e. This corresponds to about half of Belize's total consumption of petroleum products.

Transport Sector, is the sector that is responsible for most of the energy demand (over 40%) and most of the GHG emissions (nearly 50%). Approximately 18,410,200 US gallons of gasoline is consumed in Belize each year. It´s assume that 14,000,000 US gallons of this is used in vehicles.

The transportation sector was the largest consumer of energy in 2010, accounting for 46.8% of total secondary energy consumption. Of the fuels used for transport, gasoline accounted for 47.0% of all consumption; diesel for 36.9%; and kerosene (used as aviation fuel), crude oil6 and LPG7 for the remaining 16.1%8.

Overall, the transportation sector accounted for 49% of total net GHG emissions in 2010, although it consumed only 46.8% of total energy. This was mainly due to the fact that all the energy used in this sector was fossil fuel based, compared with the other sectors that used renewable energy sources directly, or indirectly through electricity, to some degree or the other.

In Belize, as in most other Caribbean countries, the government is the largest landowner; the largest fleet owner; one of the largest single employers; and the largest landlord or owner/operator of buildings. It is also therefore the largest consumer of energy, the largest producer of most environmental impacts.

Based on the specification for unleaded gasoline for motor vehicles (Belize standard final draft in April 2017), the total sulfur content for regular and premium gasoline is of maximum 0.10 % mass (1000 ppm). By the other hand the final draft in April 2017 of specifications for diesel fuel (high sulphur, low sulphur and ultra-low sulphur) establishes a sulfur content of 0.5, 0.05 and 0.0015 % wt respectively (5000 ppm, 500 ppm and 15 ppm). (Belize Bureau of Standards, 2017)

Climate change framework

As part of the pursuant to decision 1 CP/21 of the Paris Agreement, Belize presented is Nationally Determined Contribution (NDC). Belize mitigation potential is framed on an action-based approach, covering multiple sectors. In terms of the transport sector, the idea is the development of a domestic transportation policy and implement the National Transportation Master Plan, where the objective is to achieve at least a 20% reduction in conventional transportation fuel use by 2030 and promote energy efficiency in the transport sector through appropriate policies and investments, based on year 2015. The methodology for emissions accounting will be developed as part of the Transport Policy and Transport Master Plan, follow by the consideration of internationally recognized and used tools.

Air quality

Road transport is the largest GHG emitter in Belize with nearly 50% of the total country emissions in 2010 (Gischler, and others, 2014). This was mainly due to the fact that all the energy used in this sector was fossil fuel based, compared with the other sectors that used renewable energy sources directly, or indirectly through electricity. The emissions related to road transport were 263.58, 275.94 and 330.55 Kt CO_2 for the years 1994, 1997 and 2000, respectively.

No studies or any additional information on air quality in Belize could be found. It can only be assumed that the quality of the air decreases proportionally with increase in the emission of gases.

Vehicle Fleet

Light Duty Vehicles

Based on the provided databases, it is decided to conduct an investigation to know the years of antiquity of the vehicles that entered Belize for the first time from 2013 to 2016.

For this they were divided into groups of 10 years with the exception of 2010 to 2017 and 1979 to the oldest vehicle that was from 1958, so it was possible to identify 5 segments. These are detailed below (Table 1):

Table 1 MODEL YEARS OF THE VEHICLES IMPORTED IN BELIZE FROM THE YEARS 2013 TO 2016

Years	Quantity	%
1958-1979	28	0,09%
1980-1989	262	0,81%
1990-1999	5398	16,77%
2000-2009	18322	56,91%
2010-2017	8185	25,42%

As you can see in the table, more than half of the vehicles imported in the course of 2013 to 2016 come from the segment from 2000 to 2010. Followed by the newest vehicles from 2010 to 2017. It is possible to determine that in Belize vehicles with 20 years or less from the current year are mostly imported for sale.

It's noteworthy that the overwhelming majority of Belize's vehicle stock is secondhand; this has consequences in respect of fleet efficiency, reliability and emissions. And there is no accurate data on either passenger-miles or fuel used, whether gasoline, diesel or LPG. Belize's population is small and scattered throughout the country. Consequently, infrastructure provisioning is always a challenge because of large capital requirements for such infrastructure, but having low utilization rates.

An analysis was carried out to determine the origin of the imported vehicles and the following countries were determined as those that most vehicles sell or buy from Belize:

Table 2 COUNTRY OF ORIGIN OF THE VEHICLES IMPORTED IN BELIZE IN THE YEARS 2013 TO 2016

	Canada	China	Guatemala	Japan	South Korea	Mexico	Thailand	USA	Other
2013	71	58	67	277	55	64	150	3384	100
2014	71	108	124	322	87	70	163	4308	135

2015	239	464	256	731	195	360	246	11736	214
2016	154	260	115	375	113	236	143	6245	107
TOTAL	**535**	**890**	**562**	**1705**	**450**	**730**	**702**	**25673**	**556**

The United States is the largest exporter of vehicles to Belize with a total of 25673 vehicles from 2013 to 2016. In second place is Japan with 1705 vehicles in the same period, followed by China with 890 and Mexico with 730. It is necessary to consider the ease that the Belizeans have of bringing vehicles by land from their neighboring countries such as Guatemala and Mexico, and even from the United States passing through Mexico.

To carry out this analysis, the euro car segmentation was used. The models segments to be based on comparison to well-known brand models set by the European Commission according to the market share. These segments have been defined as:

- A: mini or city cars (Fiat 500, Opel Adam, Citroën C1, Hyundai Eon, Mitsubishi i-MiEV, Renault Twingo)
- B: small cars (Renault Clio, Ford Fiesta, Kia Rio, Opel Corsa, Peugeot 208, Volkswagen Polo)
- C: medium cars (Volkswagen Golf, Honda Civic, Honda Civic, Mazda3, Suzuki Ciaz, Renault Mégane, Toyota Corolla)
- D: large cars (BMW 3-Series, Volkswagen Passat, Chevrolet Malibu, Ford Fusion, Peugeot 508, Subaru Legacy, Volkswagen Passat)
- E: executive cars (Audi A6, Mercedes CLS, Cadillac CTS, Chrysler 300, Tesla Model S, Acura TLX)
- F: luxury cars (Mercedes S-Class, BMW 7-Series, Porsche Panamera, Maserati Quattroporte)
- S: Sport coupés (BMW Z4, Lotus Elise, Mazda MX-5, Porsche Boxster, Mercedes-Benz SLK Lamborghini Aventador, Pagani Zonda, Porsche 918 Spyder)
- J: Sport utility cars, also known as Sport Utility Vehicles (SUV) (Ford Expedition, Hyundai Santa Fe, Jeep Grand Cherokee, Volkswagen Touareg, Volvo XC90 Range Rover, Cadillac Escalade, Toyota Land Cruiser)
- M: Multi-purpose cars (Chrysler Town and Country, Kia Carnival, Citroën C4 Grand Picasso, Renault Espace, Toyota Sienna)
- Pick-up: pick-up cars (Dodge Ram, Ford F-150, GMC Sierra, Nissan Titan, Toyota Tundra, Ford Ranger, Chevrolet Colorado, Mitsubishi Triton/L200, Nissan Navara, Toyota Hilux)

The analysis shows that the J segment vehicles were the most imported in Belize from 2013 to 2016. The imports of this segment correspond respectively to 43% of the total imports in 2013, 49% in 2014, 50% in 2015 and 52% in 2016.

Below is an analysis of the composition of the fleet per year.

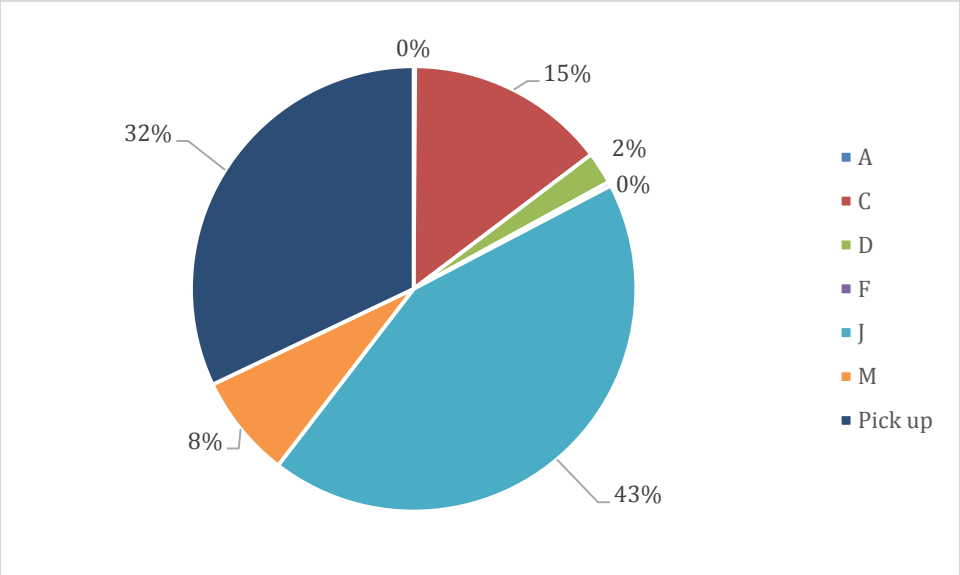

Figure 2 DISTRIBUTION OF IMPORTED VEHICLES ACCORDING TO THEIR SEGMENT, YEAR 2013

In 2013 the majority of imported vehicles in Belize were from the J sector (Figure 2Figure 3). These vehicles represent a 43% percent of the total imports. The second most imported vehicles where pick-ups who represent a 32% of the total importations.

The total imports for each segment where: A segment 4 cars, C segment 530 cars, D segment 85 cars, F segment 11 cars, J segment 1567 cars, M segment 273 cars and Pick-up segment 1166 cars. There´s a clearly preference for Belizeans for big cars.

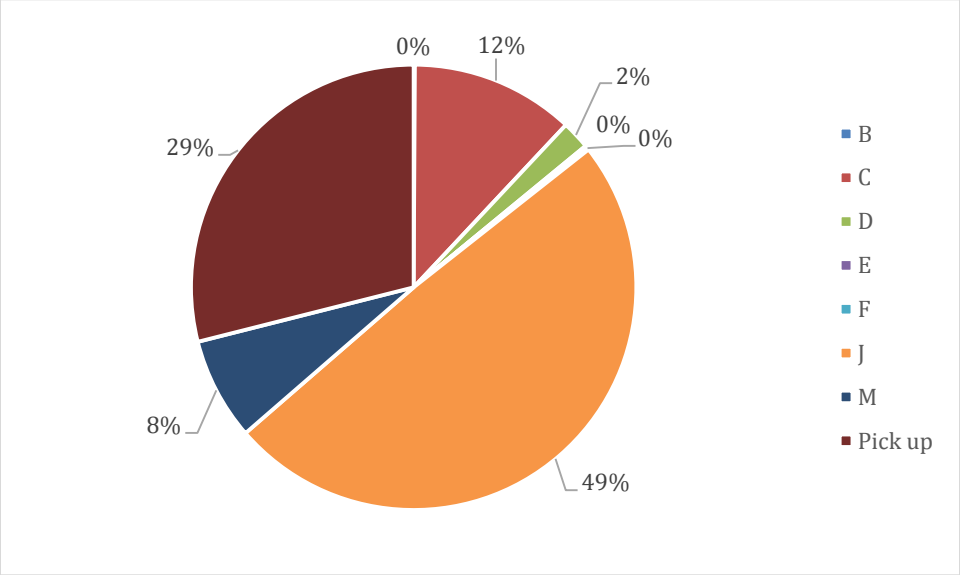

Figure 3 DISTRIBUTION OF IMPORTED VEHICLES ACCORDING TO THEIR SEGMENT, YEAR 2014

For 2014, the J segment represent almost halve of the total imports in that year (Figure 3). It is emphasized that the Belizeans have preferences for SUV cars (big cars). The second most imported vehicles where the Pick-ups and the third the C segment cars. It´s almost the same behavior from 2013 in car preferences for Belize.

In 2015 the half of the total imports (50%) where cars from the J segment, follow up by Pick-ups (see Figure 4). We can confirm the same behavior from the previous years, the preference for the J segment from Belizeans. Continuing from the most to least imported on 2015 the M segment came fifth, D, B, E, and F respectively.

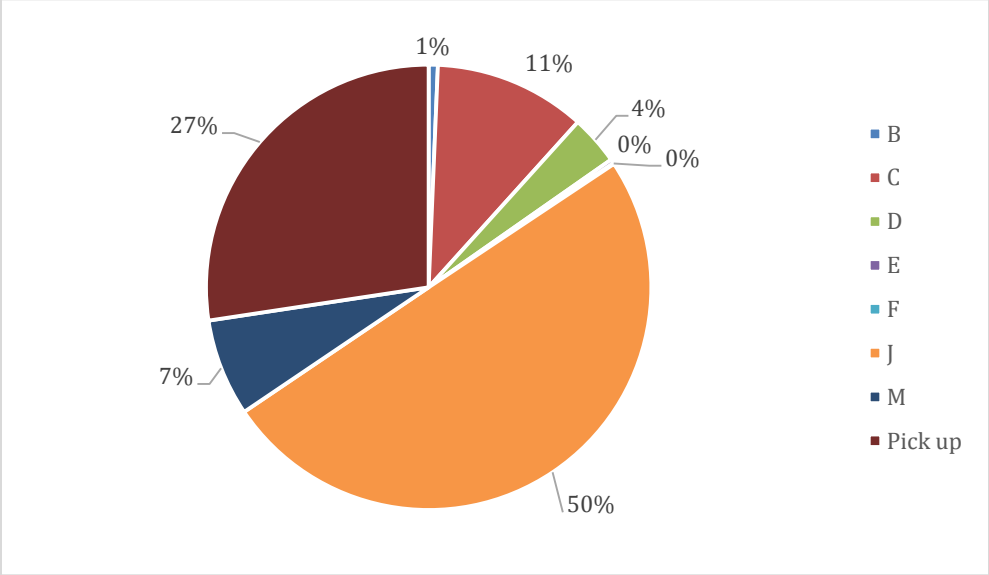

Figure 4 DISTRIBUTION OF IMPORTED VEHICLES ACCORDING TO THEIR SEGMENT, YEAR 2015

For 2016 the majority of imported cars where from the J segment with 52% of the total, it´s the first time on this for years that J segment was more than the total 50% (Figure 5). Pick up segment repeat as the second most imported segment, with a 25% of the total imports. The C segment comes third in imports with 11%, then M segment with 8%, D segment with 2% and B segment with 1%.

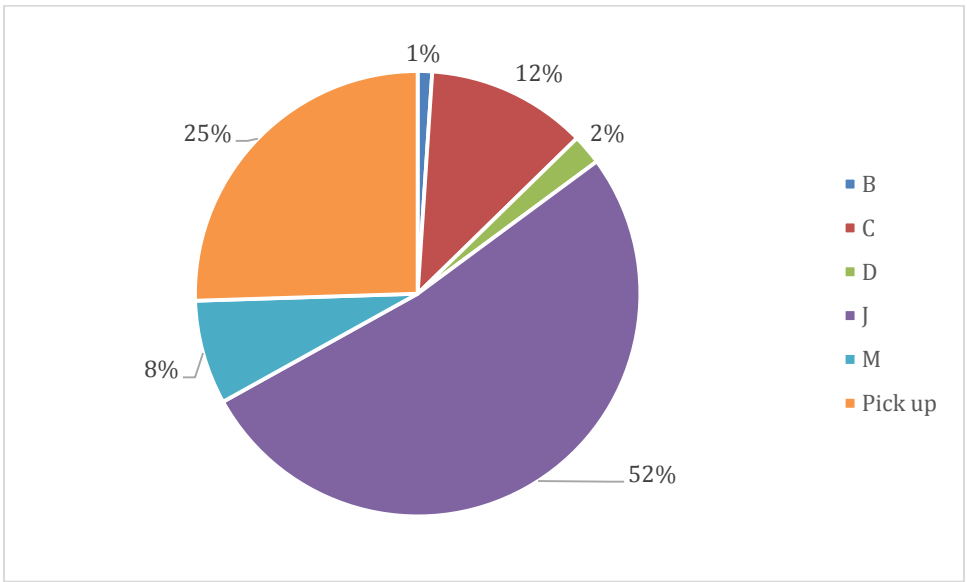

Figure 5 DISTRIBUTION OF IMPORTED VEHICLES ACCORDING TO THEIR SEGMENT, YEAR 2016

As a way of summary you can identify trends on the import preference of vehicles in Belize. The segment with the highest number of imports during these 4 years of study were those of the J segment and in second place the pick-up segment. The other segments vary according to the year but by similarities between them it is not relevant. The important thing is to emphasize the preference for vehicles that are high or 4x4 and have a second use. For example greater capacity to travel in difficult terrains and higher load capacity, this make them both require a higher consumption of fuel.

In addition, a study was carried out with the brands imported according to the years of study and these were the results:

- For 2013:

Table 3 MAKE OF THE VEHICLES IMPORTED IN BELIZE IN THE YEAR 2013

Make	Quantity	%
ACURA	10	0,28%
BUICK	6	0,17%
CADILLAC	11	0,30%
CHEVROLET	280	7,70%
CHRYSLER	47	1,29%
DODGE	298	8,20%
FORD	668	18,37%
GEO	43	1,18%
GMC	64	1,76%
GREATWALL	54	1,49%
HONDA	205	5,64%
HYUNDAI	60	1,65%
INFINITI	10	0,28%
ISUZU	144	3,96%
JEEP	106	2,92%
KIA	90	2,48%
MAHINDRA	111	3,05%
MAZDA	191	5,25%
MERCURY	14	0,39%
MITSUBISHI	94	2,59%
NISSAN	237	6,52%
PONTIAC	16	0,44%
RENAULT	4	0,11%
SATURN	58	1,60%
SUZUKI	12	0,33%

TOYOTA	703	19,33%
VOLKSWAGEN	100	2,75%

- For 2014

Table 4 MAKE OF THE VEHICLES IMPORTED IN BELIZE IN THE YEAR 2014

Make	Quantity	%
ACURA	5	0,11%
BMW	9	0,20%
BUICK	6	0,13%
CADILLAC	11	0,25%
CHEVROLET	282	6,33%
CHRYSLER	50	1,12%
DODGE	321	7,21%
FORD	911	20,45%
GEO	49	1,10%
GMC	46	1,03%
GREATWALL	94	2,11%
HONDA	220	4,94%
HYUNDAI	72	1,62%
ISUZU	137	3,08%
JEEP	153	3,44%
KIA	151	3,39%
LANDROVER	16	0,36%
LEXUS	4	0,09%
MAHINDRA	73	1,64%
MAZDA	240	5,39%
MERCURY	20	0,45%
MITSUBISHI	161	3,61%
NISSAN	261	5,86%
PLYMOUTH	9	0,20%
PONTIAC	12	0,27%
RENAULT	4	0,09%
SATURN	63	1,41%
SSANGYONG	7	0,16%
SUZUKI	39	0,88%
TOYOTA	910	20,43%
VOLKSWAGEN	118	2,65%

- For 2015

Table 5 MAKE OF THE VEHICLES IMPORTED IN BELIZE IN THE YEAR 2015

Make	Quantity	%
ACURA	30	0,25%
BMW	72	0,59%
BUICK	18	0,15%
CADILLAC	16	0,13%
CHEVROLET	940	7,74%
CHRYSLER	160	1,32%
DODGE	835	6,87%
FORD	2602	21,41%
GEO	60	0,49%
GMC	115	0,95%
GREATWALL	259	2,13%
HONDA	534	4,39%
HYUNDAI	243	2,00%
INFINITI	16	0,13%
ISUZU	196	1,61%
JAGUAR	5	0,04%
JEEP	460	3,79%
KIA	396	3,26%
LANDROVER	29	0,24%
LINCOLN	21	0,17%
MAZDA	695	5,72%
MERCURY	100	0,82%
MITSUBISHI	376	3,09%
NISSAN	918	7,55%
OLDSMOBILE	4	0,03%
PONTIAC	75	0,62%
RENAULT	8	0,07%
SATURN	176	1,45%
SSANGYOUNG	4	0,03%
SUBARU	12	0,10%
SUZUKI	130	1,07%
TOYOTA	2399	19,74%
VOLKSWAGEN	213	1,75%
VOLVO	34	0,28%

- For 2016

Table 6 MAKE OF THE VEHICLES IMPORTED IN BELIZE IN THE YEAR 2016

Make	Quantity	%
CHEVROLET	444	6,84%
CHRYSLER	95	1,46%
DODGE	482	7,42%
FORD	1421	21,89%
GEO	21	0,32%
GMC	90	1,39%
GREATWALL	218	3,36%
HONDA	266	4,10%
HYUNDAI	114	1,76%
INFINITI	14	0,22%
ISUZU	110	1,69%
JEEP	246	3,79%
KIA	208	3,20%
MAZDA	372	5,73%
MERCURY	62	0,95%
MITSUBISHI	182	2,80%
NISSAN	485	7,47%
PLYMOUTH	6	0,09%
PONTIAC	45	0,69%
SATURN	73	1,12%
SUBARU	19	0,29%
SUZUKI	61	0,94%
TOYOTA	1353	20,84%
VOLKSWAGEN	86	1,32%
VOLVO	20	0,31%

It can be observe in Figure 6 a preference for some specific brands: Chrysler, Ford, Geo, and Nissan, which have constant sales in these period of years. On the contrary, it can be observed five specific brands (Chevrolet, Dodge, Ford, Toyota and Volkswagen) which do show a year in which their sales soared, which can be associated with the entry of new models, stronger marketing, or errors in the registered information.

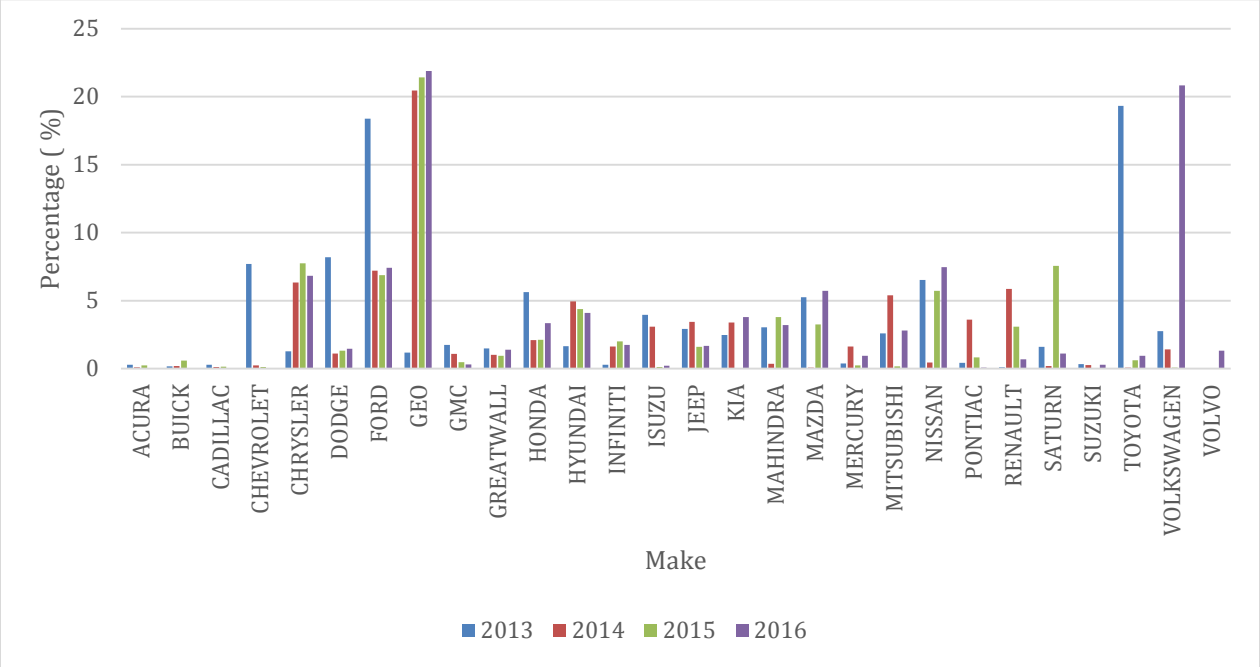

Figure 6 MAKE OF VEHICLES IMPORTS FROM 2013 TO 2016

Heavy Duty Vehicles

Most of the public transport buses in Belize are old school buses imported from the USA, mainly Bluebird or Thomas school buses, and about 80% are diesel. (Quirós, 2018)

Estimates of the average bus fleet age is around twenty-five (25) years. Old buses are relatively cheap, however, this results in frequent failures, high maintenance costs, high emissions, and high consumption of fuel (about 0.50 - 0.75 of gallons per mile). Some public transportation companies report that 75% of operation costs are related to fuel consumption. (Quirós, 2018)

Given the fact that almost 65% of households don't own a vehicle, the public uses mainly taxis, minivans and buses as their means for land transport. Public transportation is therefore essential for economic and social advancement.

Currently the country has identified as public transport baseline a lack of vehicle and license database (registration is done by DoT and the municipalities separately, no integration of data and lack of tools to define policies on vehicle fleet age, emissions and taxes) and a lack of organization on bus transport sector (inappropriate bus stop infrastructure, very old fleet, lack of data on bus passengers, oversupply/ lack of policy on permits issuing, and few formally constituted public transport companies). (Quirós, 2018)

Conclusions

The following aspects are concluded in relation to the legislative history and the normative framework of Belize:

- There is no current taxes (of circulation and registration) based on the CO_2 emitted by the vehicles.
- This baseline on LDV fuel economy aligns with the medium-term horizon established in the CNTMP.
- There is a draft of standards for diesel and gasoline.
- 100% of the country's fuel is imported.
- As part of the NDC mitigation plan, Belize wants to achieve a reduction of 20% of the fuel consumption of all the country.
- There are no studies of air quality, or air quality monitoring stations, this being urgent for the country to be the emissions from the transport sector very important for the country.

- Both the fleet of light vehicles and buses in Belize have a fairly old average age.
- The newly registrations data shows that vast majority of vehicles in Belize are imported from USA.

GFEI Methodology

This study uses the GFEI methodology as a basis for the collection and estimation of data. The GFEI uses 2005 as the reference year, and recommends the collection of data every 2 years thereafter.

The overall objective of the baseline establishment exercise is to obtain information on the weighted average fuel economy of newly registered cars for at least one historical year. This fuel economy reference information is required to:

- Evaluate the status quo
- Define future objectives of average fuel economy
- Measure the progress of the weighted average fuel economy of newly registered cars

In a second step, the data can be completed to obtain information about:

- Segmentation of the vehicle market by size and fuel economy class.
- Average purchase price of the vehicle

This additional information is necessary to use the FEPIT tool, as well as a tool to design rates, FEEBATE, which GFEI provides free of charge. These simple and easy-to-use models can help:

- Identify appropriate policy measures to achieve the fuel economy goal (FEPIT)
- Quantifying the impact of the policy in terms of estimated fuel economy improvements (FEPIT)
- Designing a feebate scheme (Feebate tool)

The fuel economy baseline should only include vehicles, which are recorded for the first time in a given year in the respective country. Depending on the country, this set of vehicles includes new cars and used imported cars. The fuel economy baseline accuracy is sufficient if the fuel economy data can be added to at least 85% of all new vehicles registered in a year.

The absolute minimum information required for each vehicle includes:

- Make and model of the vehicle and, if possible, the "configuration" (this is usually indicated by the manufacturer through a sub-model number or other designation, it may indicate the type of transmission, category of finishes, optional accessories, etc.)
- Model production year
- Year of first registration, if different from the year of the model
- Fuel type (diesel vehicles emit more CO_2 per liter of fuel compared to gasoline See Carbons Trust conversion factors in the references section below)

- Engine displacement
- Country of manufacture or import
- New or second-hand import
- Fuel savings calculated by model and base of the test cycle. This can be done either by obtaining data from the country of origin or from the manufacturer (see links in the Resources section below), or by testing a selected sample of vehicles. For more information on vehicle emission test cycles, see the summary of test cycles here)
- Number of sales per model (unless you want to make a list showing each vehicle individually, which may take a long time)

Additional information that would be useful for more advanced analysis and should be collected, if possible, includes:

- Vehicle information / identification number
- Injection system type
- Body type
- Type of transmission and other details of the vehicle configuration that are available
- Vehicle carbon footprint
- Vehicle net weight
- Certified emission level
- Vehicle use (private, public, rental, etc.)
- Vehicle price

The baseline establishment exercise includes the following steps:

1. Establish the reference year (the GFEI uses 2005)
2. Set the data points that should be collected to calculate a robust baseline
3. Find and evaluate the available sources of LDV vehicle registration data and their quality
4. Calculate the average annual fuel economy of the baseline and other characteristics for new registered vehicles
5. Repeat the same exercise using a uniform methodology at regular intervals

The GFEI prescribes the harmonic average fuel economy as the estimator of the entire fleet to characterize the fuel economy of new vehicles entering the market in the base year. The equation is shown in the Calculation section of the fuel economy baseline and interpretation of the economy. This methodology has been adopted by other countries such as Kenya, South Africa, Indonesia and Chile. For Belize the researchers selected 2016 as the base year to use the most up-to-date and complete information that reflects the vehicle's current technology.

Calculation of fuel economy baseline

Once the fuel economy data is available for at least 85% of new registered vehicles, the weighted average fuel economy can be calculated using the following equation prescribed by the GFEI:

$$FE = \frac{\sum_{i}^{n} Reg_i \times FE_i}{\sum_{i}^{n} Reg_i}$$

With:

FE = weighted average fuel economy

Regi = number of new registered vehicles of type i

FEi = fuel economy of type i vehicle

Implementation tool of the Economic Policies of the GFEI

(Fuel Economy Policies Implementation tool - FEPIT)

This technical document uses the fuel economy policy implementation tool of the GFEI (FEPIT) to estimate the current fuel and estimated fuel economy for the year 2020 with a business-as-usual scenario and a policy support scenario. These projections will serve as the basis for Belize's recommended fuel economy objectives. They will also be used to highlight improved fuel economy (both potential and realized), highlight national trends, identify beneficial policies and identify potential costs.

The GFEI FEPIT methodology is the following:

1. The data of the LDV national fleet and tax systems are acquired from official sources.
2. The data is "cleaned" to be compatible with the data entry requirements of the tool.
3. The data is inserted into the tool and the projection algorithms are executed.
4. The projections and the recommended fuel saving policies are highlighted by algorithms and further developed by expert analysis.

For more information on the GFEI methodology, see Annex 3.

Challenges and data limitations

- The Excels, with the information of the new vehicle registrations, provided by Belize Custom & Exercise Department and Statistical Institute of Belize is incomplete, and the number of records differ significantly between the four years provided.
- The recorded data have many spelling errors, in terms of make and model name.
- The engine size of the vehicles is mix between engine size and number of cylinders.
- The vehicle class column has errors, so the European Car Segment was used instead of the classification provided in the database.
- Important information required to develop the analysis was missing, like transmission data, and fuel type.
- A few quantity of vehicles had to be eliminated of the database, because no information about fuel economy was found in the emission factor sources.
- The models sometimes did not correspond with vehicles of the manufacturers.
- Vehicles with errors in the years of make could not be taken into account for the study.
- Sometimes it was impossible to know the manufacturer using only the model since there are several models with the same names and different manufacturers
- There is no pattern or standard to register vehicles in customs records so they write almost anything and with spelling errors
- In the absence of transmission information, fuel type data and errors in the displacement of the vehicle, it was assumed that the vehicles were mainly coming from the United States vehicles, these were mainly automatic transmission and gasoline. Therefore the fuel economy data for the car of the same make and model with automatic transmission was taken.

Vehicle registration data sources

The information of the new vehicle registrations in the country was provided by Belize Custom & Exercise Department and Statistical Institute of Belize, throughout the Ministry of Energy, Science, Technology and Public Utilities.

The role of the Belize Customs and Excise Department is to develop and implement an integrated set of policies and procedures that ensure increased safety and security, as well as developing the necessary platform to promote effective trade facilitation and revenue collection. It is the view of this customs administration that legitimate international trade is an essential driver for economic prosperity. While the SIB is an autonomous body created to collect, compile, extract, analyze and release official statistic related to demographic, social, environmental, economic and general activities and conditions of Belize on an impartial basis and in accordance with professional standards and ethics.

Data cleaning

The database provided by the Belize Custom & Exercise Department and Statistical Institute of Belize was refined by a technical team, in order to obtain the information for the calculation of carbon dioxide (CO_2) emission and lge/100 km, of the new vehicle registrations in Belize in the years 2013, 2014, 2015 and 2016.

First, all the information was filtered to eliminate all the vehicles that are not considered within the scope of this study (heavy vehicles). Then all the remaining information of light duty vehicles was homogenized, so that the make and models were written in the same way. Once the information was filtered and homogenized, the data was grouped by registration number with the help of the Tableau software.

Among the information present in the database provided by the Customs and SIB was:

- Year
- HS Code
- Vehicle make
- Vehicle model
- Vehicle class
- Vehicle year
- Vehicle Identification number (VIN)
- Vehicle engine

- Country of origin

This basic information provided in the database is important, although other data such as the type of transmission, and fuel are essential for the calculation of CO_2 emissions and lge/100km. In order to perform the calculations, it was assumed that since the vehicles are mostly imported from the United States, these are mostly automatic transmission, as well as gasoline fuel. It should be noted that automatic transmission vehicles tend to be more inefficient, therefore this would be the worst case scenario.

Size of the database

The focus of the calculation of the baseline of carbon dioxide (CO2) emissions and le/ 100 km of the new vehicle registrations in Belize, was made only taking into account the European Car Segments mini cars (A), small cars (B), medium cars (C), large cars (D, luxury cars (F), sport utility cars (J), some multipurpose cars (M) and pickups which are cataloged or classified as light duty vehicles, in order to continue with the same methodology that has been used in other countries, in this way, the results obtained could be compared with other baseline studies conducted.

A total of 26, 774 vehicles were analyzed (85% of the total light duty vehicles registered from 2013 to 2016), purified and organized from the database provided by the Customs and SIB.

Emission factors sources

The emission factors sources for carbon dioxide (CO_2) were the following (order according to use):

- US (EPA) database. https://www.fueleconomy.gov/. Vehicle performance information was provided through this web page.
- Chilean database. http://www.mtt.gob.cl/archivos/5548. Supplied by CMMCh.
- Mexican database. http://www.ecovehiculos.gob.mx/. Vehicle performance information was provided through this web page.
- European database, provided by UN Environment.

The main information required to develop vehicle fuel economy databases is the fuel consumption in L / 100 km and the emission of CO_2 in g / km.

Countries that manufacture vehicles routinely perform fuel-saving tests using standard procedures prior to their authorization for sale. Test methods, including test cycles, may vary by country and region. The test cycles simulate a variety of driving conditions, at highway speeds and at speeds more typical of urban driving.

In most developing economies, vehicles are not tested for fuel savings in domestic laboratories, using national test cycles. Governments often rely on data published by manufacturers when calculating the fuel economy of vehicle stocks.

In the present study, the data obtained were based mainly on the US test cycles, Mexico, Europe and Chile, namely, the CAFE, and NEDC, respectively. Using the methodology developed by the International Council for Clean Transport (ICCT), the values of the various test cycles were converted to the corresponding values in the New European Driving Cycle (NEDC).

The importation of vehicles in Belize is made up of both new and used vehicles, where used vehicles play a very important role. It should be emphasized therefore that it is assumed that the fuel economy of used vehicles is equal to their condition as new.

Results and Analysis on Fuel and Emission Consumption

The essential results obtained after finding the emission factor and / or performance of the vehicles are those shown below:

For these results are used the value of the weighted emissions and the number of vehicles per year, to calculate the annual emission of vehicles. When looking for the emission factor, in case there were different emission factors for the same vehicle, the highest value was used. For each emission factor, the representative model taken for the emission factor was specified, and the emission standard, as explained above, most of the emission factors came from the United States, Chilean and Mexican databases.

The emission standard was specified in cases of use of the Chilean database, for the United States database, the vehicle's performance in miles per gallon (mpg) was verified, and for Mexico the combined yield in km/L (not adjusted value).

The results of the emissions show that Belize's values increase in relation to the increase in the number of records in the import of vehicles. The year of 2015, which was the one with the highest record of new vehicles, was the one with the highest value of g CO_2/km NEDC, respectively. In this specific case it was 330.31 g CO_2/km NEDC, this being the highest value of the four years of study.

The results obtained after data analysis and information processing are shown in Table 7 and Figure 7, Figure 8 and Figure 9.

Table 7 RESULTS OF FUEL ECONOMY OBTAINED IN BELIZE FOR LIGHT DUTY VEHICLES REGISTERED FOR THE FIRST TIME IN THE PERIOD 2013-2016

Year	Number of new registrations	g CO_2/km NEDC	mpg CAFE	lge/ 100 km
2013	3636	323,19	18,70	13,76
2014	4454	326,91	18,45	13,94
2015	12191	330,31	18,10	14,13
2016	6493	325,68	18,29	13,98

It is important to emphasize that as mentioned in the challenges and data limitations subsection, the information of new registrations initially provided by the Custom Agency and SIB (raw database of new records between the period 2013 and 2016) was incomplete and therefore exists a discrepancy between the number of new records of those four years.

- Annual weighted emission average in grams of CO_2 per kilometer under the NEDC cycle

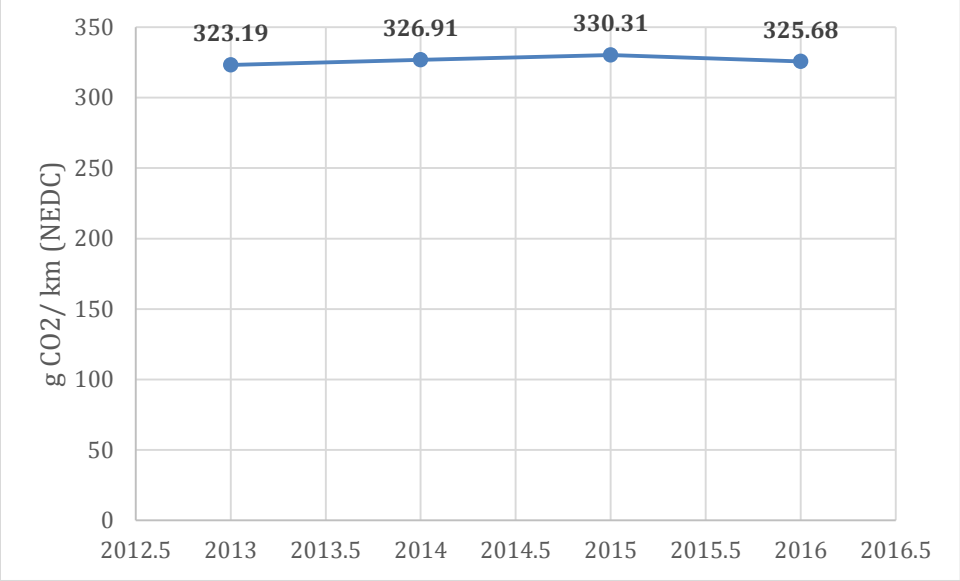

Figure 7 BEHAVIOR OF EMISSIONS IN G CO2 / KM UNDER THE NEDC CYCLE DURING THE PERIOD 2013-2016

- Annual harmonic fuel economy average of the yield in miles per gallon under the CAFE cycle.

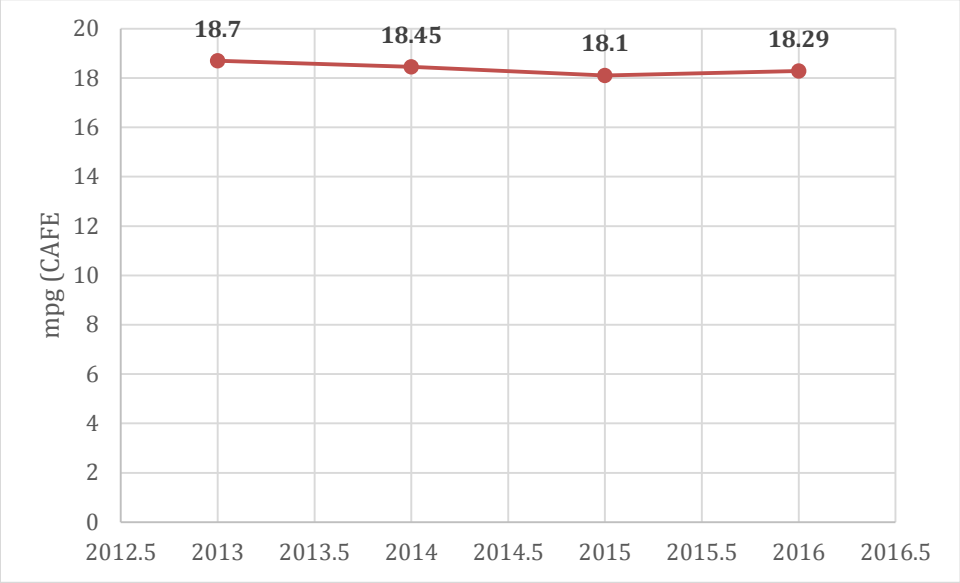

Figure 8 PERFORMANCE BEHAVIOR IN MILES PER GALLON UNDER THE CAFE CYCLE DURING THE PERIOD 2013-2014

- Annual weighted fuel economy average in liters of gasoline equivalent per 100 kilometers.

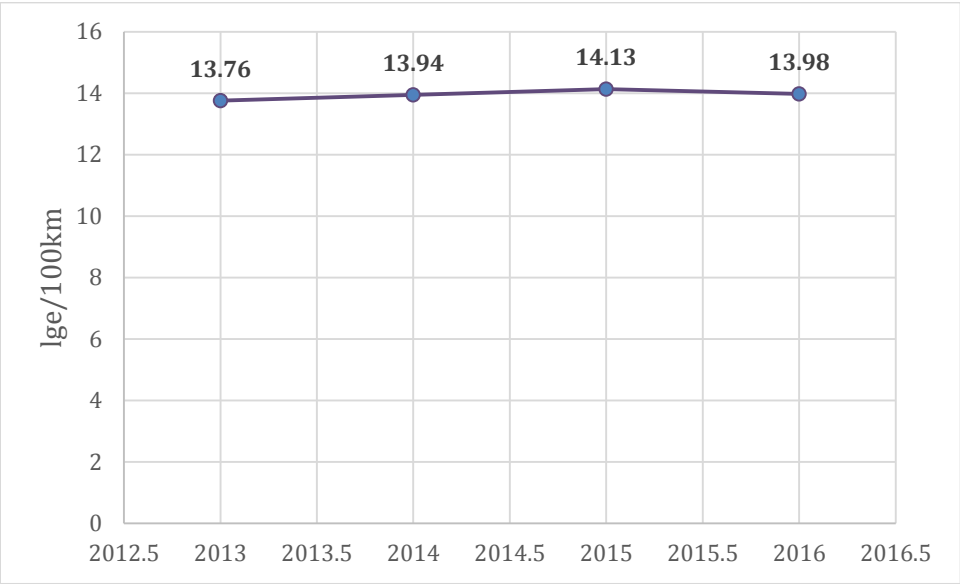

Figure 9 PERFORMANCE OF FUEL CONSUMPTION IN LITERS OF GASOLINE EQUIVALENT PER 100 KILOMETERS DURING THE PERIOD 2013-2016

It can be observed in the graphics shown in Figure 7, Figure 8 and Figure 9 that the behavior of the fuel economy of the light vehicles imported to the country, has remained constant during these 4 years and there is no trend of better efficiency or reduction of CO_2 emissions.

Average annual emissions by vehicle type

In the year 2013, SUVs and pickups are the ones who has the biggest CO_2 emission per km (g CO_2/km) with 350.45 and 370.75 respectively. It´s impressive that even though the J segment has almost an 11% more (400 cars approx.) the biggest CO_2 emissions comes from the Pick-up segment. Also the Pick-up segment has the worst performance, it takes them more gas per mile than any other cars in all different segments.

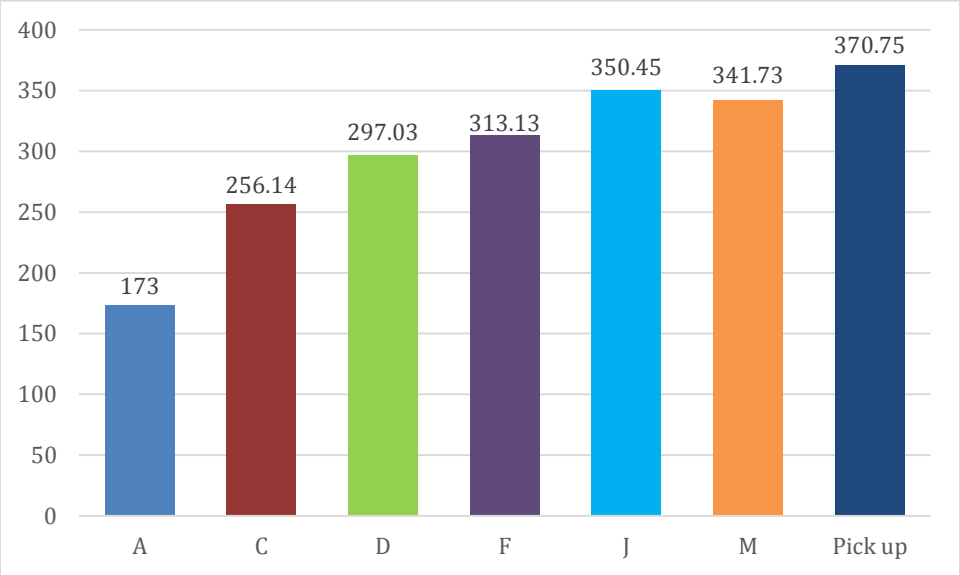

Figure 10 CO2 EMISSION FACTOR (G/KM) IN YEAR 2013

In terms of CO_2 emissions for km (g CO_2/km) the Pick-up segment continues as the responsible for most of the emissions along with the J segment. Even though there´s almost 1000 cars more on the J segment.

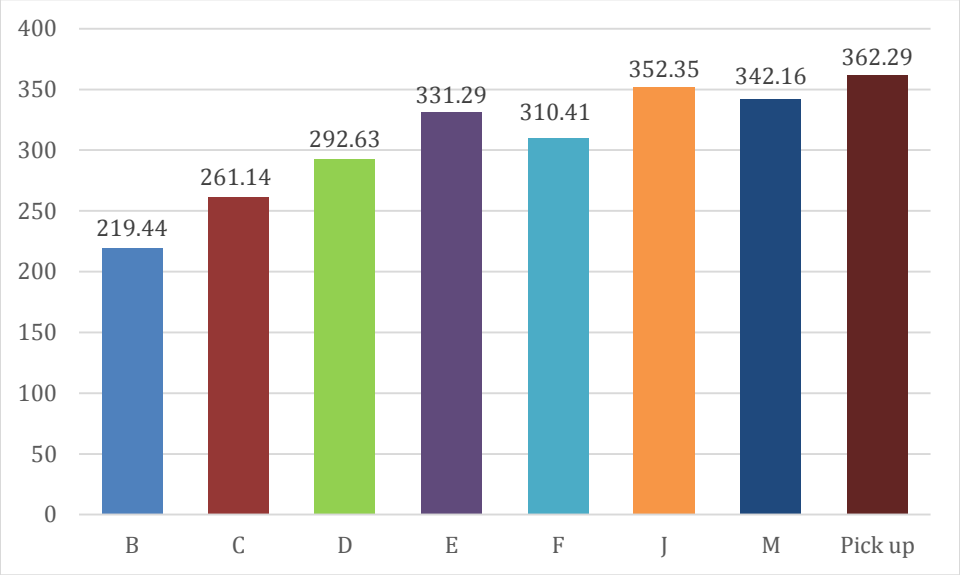

Figure 11 CO2 EMISSION FACTOR (G/KM) IN YEAR 2014

For both years (2013 and 2014) we can see the same behavior in emissions. J and Pick-up segments keep been the ones who has more emissions, M segment just behind, and F, D, C and A or B respectably.

For the CO_2 emissions for 2015 most of them where generated from the pick-up and J segment. The pick-up segment continues as the one who has more CO_2 emissions for km with 375.05 and in second the J segment with 343.12. Then the M segment with 318.77, and we continue with F segments, E, D, C, and B from most emissions to least respectively.

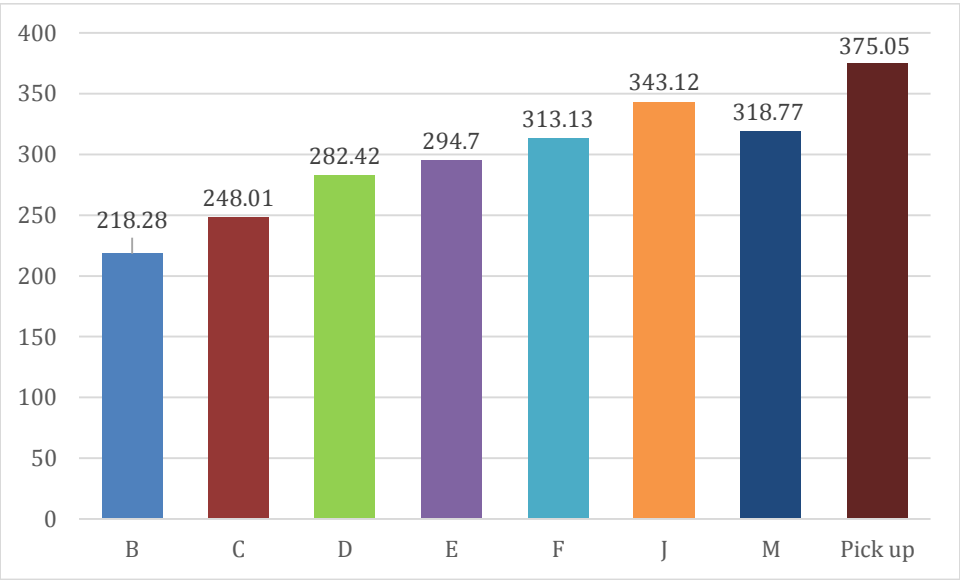

Figure 12 CO2 EMISSION FACTOR (G/KM) IN YEAR 2015

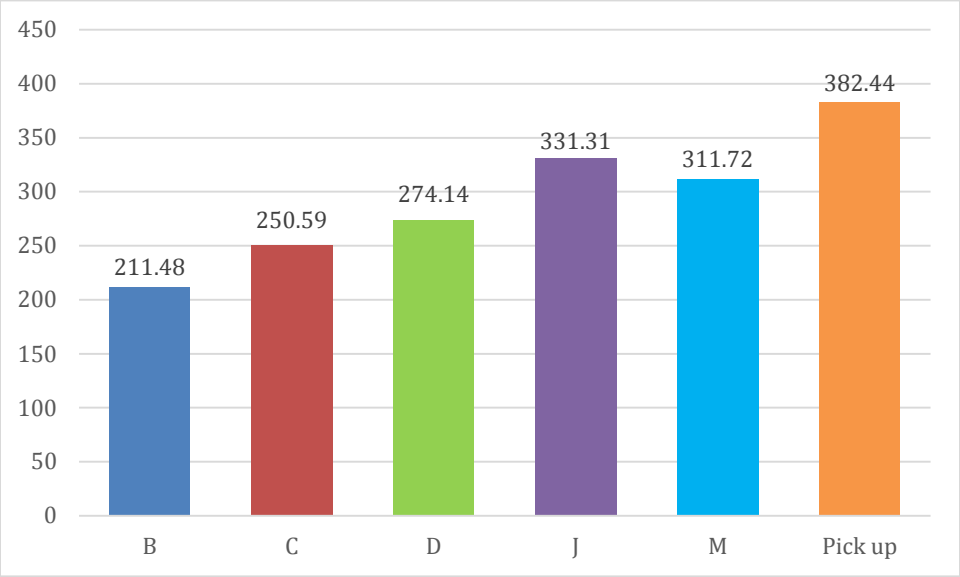

Figure 13 CO2 EMISSION FACTOR (G/KM) IN YEAR 2016

The pick-ups continue as the main contributor to the emission of gases followed by the segment J. The trend is clear in all the years studied. In spite of being the second category or even third category of most imported vehicles, it is demonstrated that they emit the greatest emission of gases. Making them the biggest culprit of the high emission values.

Automotive global market fuel economy analysis

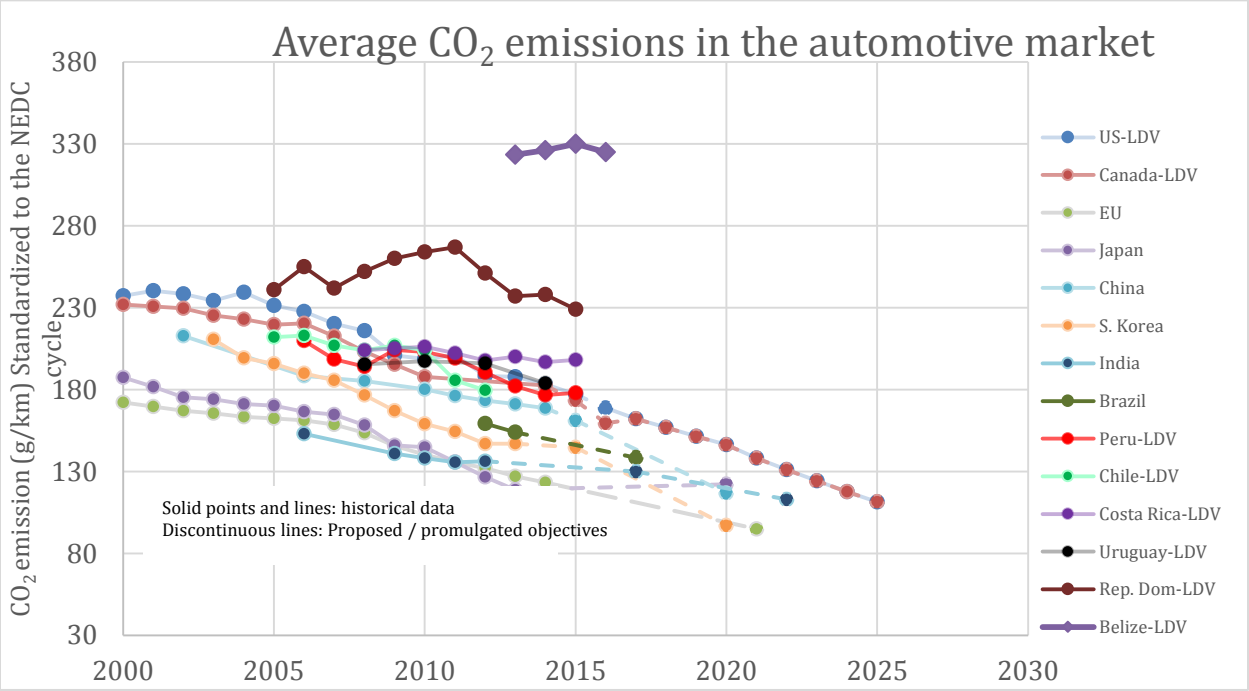

Figure 14 AVERAGE CO2 EMISSIONS IN THE AUTOMOTIVE MARKET

When comparing the average annual emissions of grams of CO_2 per kilometer in the automotive market in other countries and Belize, it can be seen that the amounts of gCO_2 / km emitted by Belize is very high in consideration of the amounts issued annually in other countries. This is due to the high presence of vehicles of the type SUV's or Pick-ups, which make up around 48.5% and 28.25% (respectively) of the total number of vehicles registered in the 2013-2016 period. Noting also that the pick-ups, followed by the SUVs are the most inefficient vehicles, both not considered as city vehicles. Another aspect that has to be taken into account, is that 56.91% of the vehicles imported to the country were manufactured between 2000 and 2009, so we are talking about a pretty old vehicle fleet.

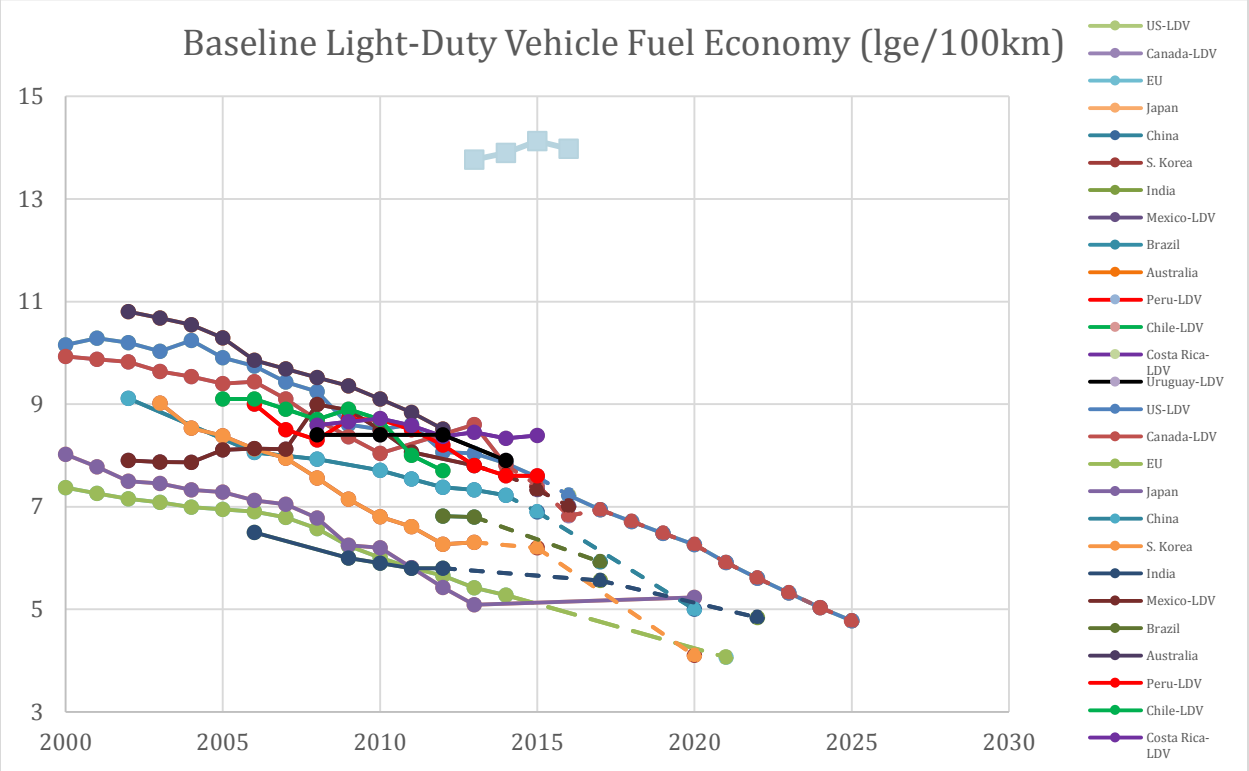

Figure 15 BASELINE LIGHT DUTY VEHICLE FUEL ECONOMY

On the other hand, the performance of light duty vehicles registered for the first time in Belize between 2013 and 2016 is quite inefficient, in comparison with the rest of the countries that have carried out this study and reflects the same behavior. Actually Belize is the country that has the vehicles with the lowest yields and this is due to what was explained above.

Projections with FEPIT Tool

The Fuel Economy Policies Implementation Tool - FEPIT, allows to identify and evaluate different policy alternatives aimed at reducing the fuel consumption of a country's automotive sector. This tool is based on the information established in the base line of emissions and fuel consumption of light duty vehicles, to identify trends from previous years to the most recent ones, and compare them with the objectives of the Global Fuel Economy Initiative - GFEI, as well as with the trends worldwide. In addition, this tool allows the evaluation of the implementation of four different policies aimed at reducing the fuel consumption of a vehicle fleet in a country, based on tax regulations. The policies studied are:

1. Fuel economy target: a fuel economy target identifies the maximum level of average fuel consumption (or CO_2 emissions) computed as corporate sales weighted average on the composition of the new registrations. The target is set for future time horizon and needs to be achieved by manufacturers through technical development or changes in the models mix.

The Global Fuel Economy Initiative (GFEI) has set a target of 4.2 lge1/100 km for new vehicle tested fuel economy in the year 2030. Given that the average fuel economy in 2013 was 7.1 lge/100 km, this target corresponds to an average improvement rate of 3.1% per year. As different countries start from very different starting points, reaching the GFEI target can require either more or less ambitious improvement rates. By default, FEPIT allows to consider the following improvement rates:

- allowing to match the GFEI global target fuel economy of 2030
- corresponding to the GFEI average global improvement rate
- calculated as an average of GFEI global target and GFEI average global improvement rate
- other values entered directly by users.

2. CO_2- Based Vehicle registration tax: through this policy, it is proposed to impose a tax on vehicles, in their registration stage, based on their CO_2 emissions, subsidizing those whose emissions are very low or zero. Through this methodology, it is very important to have a permanent control of the limits of emissions that will be taxed and those that will be "benefited", since, if this control is lost, this policy can become a government subsidy of vehicles with low CO_2 emissions. Through this policy, the acquisition of more efficient vehicles is encouraged.

3. CO_2-Based Vehicle Circulation tax: as in the previous policy, this tax encourages the acquisition of more efficient vehicles, since this policy proposes assigning a tax on vehicle traffic based on CO_2 emissions. Unlike the existing legislation in Colombia, through which a control of polluting emissions is carried out through static tests, through this policy it is proposed to regulate CO_2 emissions under dynamic tests, and to tax those vehicles that exceed the limits established in politics. In particular, this policy must be designed with extreme care, since it is necessary to establish a dynamic of control and standardization of the tests, in such a way that it allows to evaluate all vehicles under the same operating conditions.

4. Fuel taxation: this tax is intended to gradually increase the cost of fossil fuels, so that users of vehicles with high fuel consumption, look for a more efficient alternative to transport, thus promoting a reduction in emissions of CO_2 associated with the operation of light duty vehicles. This alternative avoids the

"rebound" effect, that is, the increase in fuel consumption by the fleet, which can be generated by implementing vehicles with lower fuel consumption.

For the specific case of Belize, three fuel economy policies were analyzed, policy 1, 2 and 4 (fuel economy target: GFEI global target fuel economy 2030, vehicle registration tax based on CO_2, and fuel taxation). Policy 3 (CO_2- Based vehicle circulation tax) was not analyzed since it is very complicated to apply this tax to vehicles that are already circulating, since they do not have fuel economy information, and therefore the application of the tax could not be regulated. This is different from the vehicle registration tax for the first time, where it could be required, for example by means of eco-labeling, to the importers the fuel economy information of their vehicles. It would also be necessary to analyze how this would work for the case of imported used vehicles.

For the data entry to the FEPIT tool, 2016 was selected as the base year and 2015 as the previous year. For the analysis, the automotive fleet was segmented through the following fuel consumption ranges:

- less than 9 lge / 100km
- Between 9 and 12 lge / 100km
- Between 12 and 14 lge / 100km
- Between 14 and 16 lge / 100km
- Greater than 16 lge / 100km.

Thus, the composition of vehicles registered in 2016 is presented above in Table 8. The average fuel consumption, in lge / 100 km, of each of the selected ranges was also identified, obtaining the results presented in Table 9. In addition, the current tariff status of light duty vehicle fleet in Belize was analyzed, and it was identified that in the country there are no vehicle registration or circulation taxes based on CO_2 emissions.

Table 8 COMPOSITION FOR BASE YEAR (2016)

Classes	New registrations composition (%)
<9 lge/100 km	4.6
9-12 lge/100 km	24.6
12-14 lge/100 km	17.8
14-16 lge/100 km	21.9

>16 lge/100km	31.2

Table 9 FUEL CONSUMPTION BY SEGMENT FOR BASE YEAR (2016)

Classes	Average fuel consumption (lge/100 km)
<9 lge/100 km	8.33
9-12 lge/100 km	10.80
12-14 lge/100 km	12.95
14-16 lge/100 km	14.77
>16 lge/100km	17.43

Finally, the information associated with the country's fuels was recorded, both the quantity and price of commercialization in 2016, as well as the participation of gasoline and diesel vehicles for the same year, as presented in Table 10 and Table 11 respectively.

Table 10 AVERAGE FUEL PRICE

Fuel	Price ($/gallon)
Diesel	10,12
Gasoline (regular and premium)	9.08
Average fuel price ($/gallon)	**9.60**
Average fuel price ($/litre)	**2.53**

Source: Ministry of Finance, Historical data on fuel January 2012- August 2017

Table 11 AVERAGE FUEL CONSUMPTION OF NEW REGISTRATIONS

Fuel	Composition (%)
Diesel	4
Gasoline	96

FEPIT results

Two scenarios were simulated, the first using as fuel economy target option (policy 1) the target of Belize established in COP 21, and the second establishing the GFEI global target for fuel economy.

Fuel economy with policies

Scenario 1

As part of the Nationally Determined Contribution (NDC) under the United Nations Framework Convention on Climate Change (COP 21), in the year 2015 Belize established a mitigation plan. In terms of the transport sector, the objective is to achieve at least a 20% reduction in conventional transportation fuel use by 2030 and promote energy efficiency in the transport sector through appropriate policies and investment. Assuming that the country target of improving efficiency by 20% by the year 2030 is implemented, FEPIT indicates that Belize can reach a fuel economy of 266.4 g CO_2 / km (11.45 lge/100 km) by 2030 (see Figure 16). The objective suggested by the IEA expert was of 97.8 g of CO_2/ km (4.20 lge/100 km) by 2030. This goal seems to be pretty long for Belize if only these policy is implemented of improvement rate of 1.43% per year, based on 2016 efficiency.

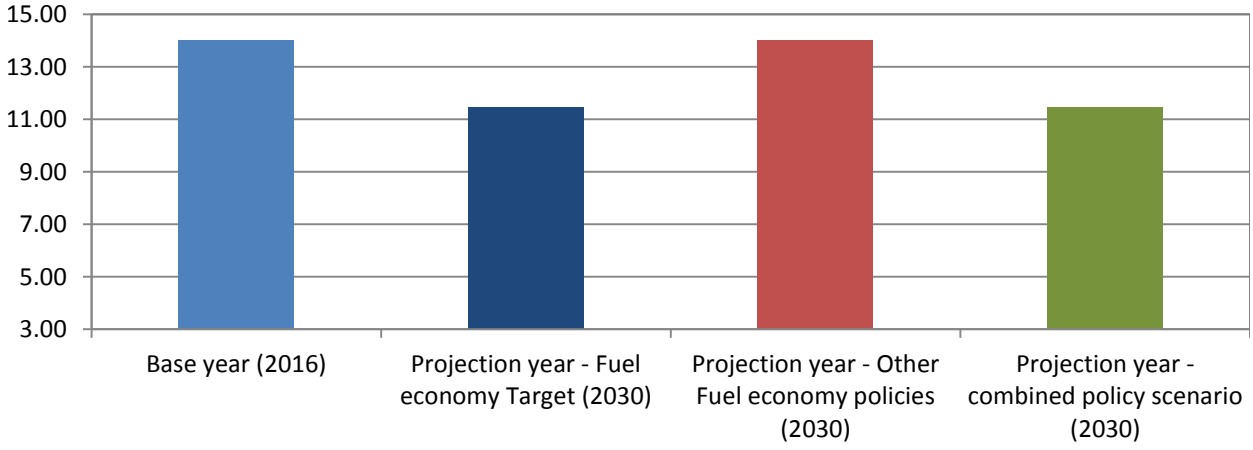

Figure 16 FUEL ECONOMY PROJECTIONS THROUGH THE IMPLEMENTATION OF BELIZE TARGET 2030

Scenario 2

Assuming that the aforementioned policies are fully implemented, FEPIT indicates that Belize can reach a fuel economy of 240.4 g CO_2 / km (10.33 lge/100 km) by 2030 (see Figure 17). The objective suggested by the IEA expert was of 97.8 g of CO_2 / km (4.20 lge/100 km) by 2030. This goal seems to be still quite long for Belize if only these two policies are implemented (Belize would still need to improve its fuel economy by 40.7% in relation to the base year). On the other hand, if the country adopts all these policies and also sets the GFEI goal for 2030 as its target, its average CO_2 emissions per kilometer would be 62.3 g in 2030 (2.67 lge/100km), and Belize will exceed the goals set by the initiative worldwide. It is important to clarify that it is difficult for Belize to achieve this combination result of all scenarios (62.3 g CO_2/km,) which means an improvement of 80.9% in relation to the base year.

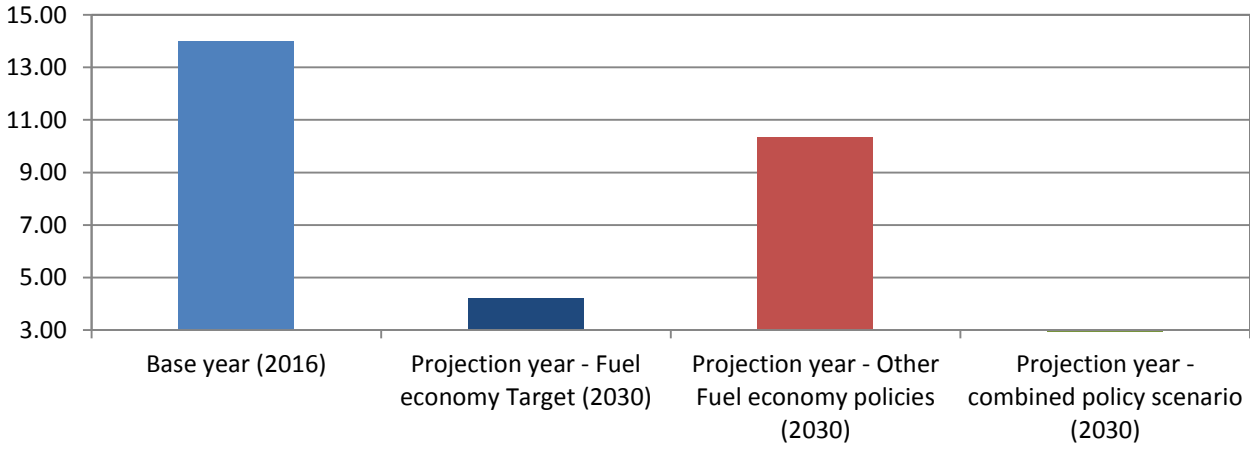

Figure 17 FUEL ECONOMY PROJECTIONS THROUGH THE IMPLEMENTATION OF POLICIES AND GFEI TARGET

Fuel economy without policies

If the status quo remains in Belize, then FEPIT predicts, based on past trends, that the fuel economy of Belize will be 316.0 g of CO_2 / km (13.58 lge/100 km) by 2030 (see Figure 18). So the average performance of the vehicle fleet would only improve by 3% in relation to base year 2016, a reduction that is predicted due to the "natural" technological evolution of vehicles worldwide for those years. This data shows us that Belize would remain as the country with the highest CO_2 emissions.

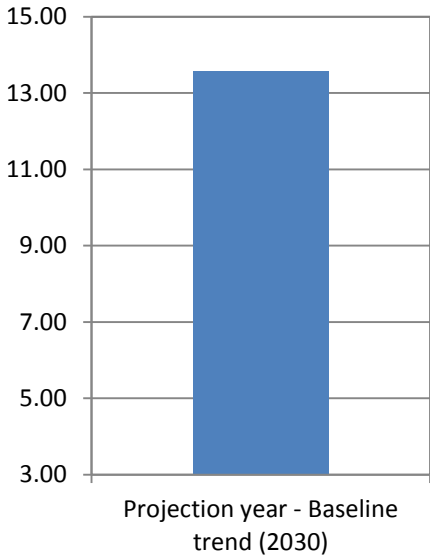

Figure 18 PROJECTION OF FUEL ECONOMY WITHOUT THE IMPLEMENTATION OF POLICIES

Summary and Conclusion

The average fuel economy of the LDV fleet is currently 325.9 g of CO_2/km, improving at a rate of 3%/ year from the year 2016 to 2015, with an anticipated average fuel economy of 316.0 of CO_2/km for 2030, if current trends continue. The analysis of the situation by international experts in fuel saving and projection tools has helped to identify three strategies (tax on vehicular circulation based on CO_2, tax on fuels) through which the government can improve the fuel economy of its fleet of cars to an estimate of 62.3 g of CO_2/km by 2030, which would put Belize in line with international objectives. However, getting Belize to reduce its fuel economy by 80.9% is quite ambitious and difficult, but it gives us an overview of the policies that can be applied at the country level in order to improve performance and therefore emissions from light vehicles. These policies are in line with the National Development Framework 2010-2030 which talks about strategies to promote green energy and energy efficiency through provide incentives to promote energy savings.

From this analysis carried out through the FEPIT tool, it is evident that if Belize is based only on the NDC of improving efficiency of transportation by 20% by 2030, the objectives established by the GFEI program (4.20 lge/100km) will not be reach by 2030, since a fuel economy of 11.45 lge/100km would be projected (improving only 18.3% in relation to the 2016 base year). Even implementing the policies associated with fuel and CO_2-based taxation, the goals established by the GFEI program would not be achieved since an average fuel economy of 240.4 g CO2/km would be achieved (10.33 lge/100 km). This indicates that in order to align with the international objectives of the GFEI program, Belize must establish a more rigorous goals to reduce energy consumption in transportation.

Recommendations

Considering the presented background and the strategic approach, it is concluded that it is necessary to implement a national strategy for a cleaner and more efficient transportation. The quality of fuels and vehicle technologies must be seen under an integrated approach.

The Transport Authority in conjunction with the Customs Department should commission a study to derive a methodology to provide the highway and city average fuel economy of vehicles, which are based on the manufacturer's estimated fuel economy. Assessing the fuel efficiency of used vehicles and how fuel efficiency decreases with vehicle mileage and/or years in operation in general will be a critical aspect of this study.

It will be great to require that permission for Vehicle Importation and Vehicle Licensing be tied to the Minimum VAFE Standard. In order to encourage purchase and use of fuel-efficient vehicles, a portion of import duties and licensing fees should be tied to the actual purchase cost of the vehicle and the other portion should be tied to the Recommended VAFE Standard applicable to the vehicle category (categorized by vehicle class and fuel type).

The cutting-edge technologies require excellent quality fuel, especially low sulfur content. The quality of the fuel must be guaranteed in order to take advantage of these new technologies offered by the international market. Advancing hand in fuel quality with vehicle emission standards will maximize the benefits that can be obtained from these. Elaboration of this strategy is not only necessary, but also timely, for the reasons summarized below:

- The transport sector has a high impact on climate change, air pollution and fuel consumption, if it does not act in a timely manner, these impacts will increase, because the transport sector has enormous growth potential.
- By promoting more efficient vehicles, you can obtain benefits in fuel savings.
- The WHO classified 2012 diesel particles as carcinogenic (Group 1)

Following the current situation, it is recommended:

- It was currently a challenge for CEGESTI to carry out this study with the information available, so for the government of Belize to conduct a baseline study with greater accuracy and comparability, it is required that the government can collect and access higher quality data.

- The government demands that the information about vehicles new registrations is presented in a more detailed manner in order to implement taxes on carbon dioxide emissions. It should be analyze how it could be implemented in the case of used imported vehicles, if there is information.
- Prohibit / establish maximum age in a definitive way the entrance of second hand vehicles to the national market. Including the importation of second hand heavy duty vehicles (especially buses for public and private transport) and progress towards restricting or prohibiting the importation of used light and medium duty vehicles.
- Do cost-benefit studies to promote the use of cleaner fuels.
- Penalize the use of light diesel vehicles, promoting the use of more efficient vehicles with less pollution at the local level.
- Introduce low sulfur fuels (50 ppm or less) nationwide as soon as possible and make them official through new regulations. These will allow to introduce vehicles with the best technologies in the market, especially for diesel vehicles.
- Prepare a vehicle sales information record to have a better perspective of the automotive market. Collecting continuously annual vehicle registration data to determine the trend of fuel savings in the fleet over the years and expand the baseline establishment study to include other types of vehicles, such as heavy vehicles (HDV) and motorcycles. This information will be useful to follow up on the baseline study, evaluate the regulations adopted and estimate the growth of the vehicle fleet. Fuel economy policies (and GFEI goals) can only be achieved if there is a clear understanding between policymakers and the automotive industry, especially with regard to the implementation date.
- Adopt a vehicle labeling policy that provides information to the user about the performance and CO_2 emissions to make a more conscious purchase. For this one labeling is of the utmost importance to ensure that the information placed on the labels is reliable and comes from verifiable sources.
- Create an information platform for the consumer in order to know the performance and CO_2 emissions of vehicles that are marketed in the country.
- Once the information system on vehicle performance is established, study the feasibility of establishing a feebate system (bonus-penalty) to encourage the adoption of more efficient vehicles.
- Promote electric vehicles as an option to reduce energy consumption and the emission of greenhouse gases and other pollutants.

- Define the regulations with the required information that will be mandatory delivery to the competent authority for importers / sellers / vehicle manufacturers.
- Define a clear policy to reduce emissions or increase vehicle performance
- Enforce regulations concerning new and used vehicles that enter the country, incorporating a more comprehensive view, with emission and efficiency standards, of way that allows to contribute to the protection of the health of the inhabitants

Summary of Recommended Actions

Action	Responsible institutions	Comments
Standardize the database of vehicles that are imported to Belize so that the information is clear and accurate.	Belize Customs and Excise Department in collaboration with Statistical Institute of Belize.	The current available information must be organized and reviewed. In addition, the database must be completed by adding information on fuel type, transmission, country of manufacture, origin of the vehicle, the factor and emission standard with which it complies and the weight of the vehicle
Prepare a record of vehicle sales information. Collect annual fuel economy vehicle registration data to determine the trend of fuel savings in the fleet over the years and expand the baseline establishment study to include other types of vehicles	Ministry of Energy, Science, Technology and Public Utilities, Department of Transport of the Ministry of Work, Department of Environment and Belize Customs and Excise Department	In order to follow up on the baseline study, evaluate the regulations adopted and estimate the growth of the vehicle fleet. Fuel economy policies and GFEI goals can only be achieved if there is a clear understanding between policymakers and the automotive industry
Vehicle emissions standard	Belize Bureau of Standards, Department of Environment, and Department of Transport of the Ministry of Work	Demand the entry into the country of better vehicular technologies that goes hand in hand with the improvement in the quality of the fuels, thus contributing to the reduction of emissions and local pollutants, and therefore the quality of the air.
Fuel quality standards	Belize Bureau of Standards and Ministry of Energy, Science, Technology and Public Utilities	These will allow introducing vehicles with better technologies in the market, which take less repairs, which allow greater fuel savings and release less gases that pollute the environment and improve air quality.

Restriction or prohibition on the import of used vehicles	Belize Bureau of Standards, Department of Transport of the Ministry of Work and Department of Environment.	This action is considered important because of the large amount of imported used vehicles
Labeling indicating CO_2 emissions, fuel economy, model, age, type of fuel, tax band, etc.	Belize Bureau of Standards, Department of Environment, Department of Transport of the Ministry of Work and Ministry of Energy, Science, Technology and Public Utilities	The importance of labeling as a preparatory activity for the implementation of fiscal policies makes it an essential component of a fuel saving policy. This action will also help to raise awareness regarding fuel savings

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Annexes

Annex 1. Members of the Working Group

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Annex 2. Map of institutional actors

Annex 3: Baseline study guide

Step by step on how to do the calculations for the baseline study

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As a summary and review of the workshop carried out in Kingston, this brief procedure will reinforce the information presented on how to proceed once you find the data on fuel economy or CO_2 emission factor.

Remember that there's a difference between the drive cycles in which this information is presented; miles per gallon (mpg) is usually given under the United States driving cycle (called Corporate Average Fuel Economy, CAFE) and CO_2 emissions are usually given under the New European Driving Cycle (NEDC).

This document will detail how to calculate the values needed for the baseline study according to the data available: CO_2 emissions under the NEDC (in g CO_2/km) and miles per gallon under the CAFÉ (in mpg).

For when the information is g CO_2/km under the NEDC (from the Chilean and European databases):

1. Find the data on CO_2 emissions for the specific vehicle. For example: 2012 Toyota Yaris, 1500 cc, Gasoline, Automatic transmission.
2. To find the emissions weighted average for that vehicle (in g CO_2/km), multiply the amount of sales/registrations/imports for that specific vehicle by the emission factor obtained in Step 1.
3. To find the fuel economy under the NEDC cycle (in mpg) you have to divide a constant (depending on the fuel the vehicle runs on) by the emission factor. For gasoline vehicles the constant value is 5497; for diesel vehicles it's 6315.
4. Now that you have a value for the fuel economy under the NEDC cycle (in mpg), you have to transform it to miles per gallon under the CAFE cycle. In order to do this the International Council for Clean Transportation developed a very helpful tool. You can use the tool to do the conversion or you can use the equation available in the same document to get the conversion factor. The equation for the conversion factor is 0,0816*ln(fuel economy under NEDC)+0,6243, where * means multiplying and ln means natural logarithm. *After you have the conversion factor you divide the fuel economy in mpg under the NEDC cycle by the conversion factor calculated in this step.*

5. After Step 4 you now have the value for the fuel economy in miles per gallon under the CAFE cycle. Now you need to calculate the harmonic fuel economy average for that vehicle. To do that, you divide the fuel economy value obtained in Step 4 (mpg under the CAFE cycle) by the amount of sales/registrations/imports for that specific vehicle.

The two main values needed to for the base study are the ones obtained in Step 2 and Step 5 (the emissions weighted average and the harmonic fuel economy average. Further in this document we will show you why these are important.

For when the information is in mpg under the CAFE cycle (from the Unites States database):

1. Find the data for the specific vehicle you are looking for. This data will be given in miles per gallon under the CAFE cycle. The database from the USA (www.fueleconomy.gov) is very user friendly. You can compare up to 4 vehicles at the same time.
2. Calculate the harmonic fuel economy average for that specific vehicle by dividing the fuel economy found in Step 1 by the amount of sales/registrations/imports for that vehicle.
3. Now you will need to convert the fuel economy in mpg under the CAFE cycle to mpg under the NEDC cycle. For this you will need a conversion factor. You can use the tool from the ICCT or the equation given in that same document. For this conversion factor the equation is: -0,1033*ln(fuel economy in mpg under the CAFE cycle)+1,473; where * means multiplying and ln means natural logarithm. Notice that there is a minus sign before the first value. *Once you calculate the conversion factor you divide the fuel economy in mpg under the CAFE cycle by the conversion factor calculated in this step.*
4. Now you will have information in miles per gallon under the NEDC cycle that you will need to be able to determine the emissions for that specific vehicle. To calculate the emissions you will need to divide a constant (depending on the fuel the vehicle runs on) by the fuel economy in mpg under the NEDC cycle. For the gasoline vehicles this constant is 5497; for diesel vehicles it is 6315.
5. After you obtain the emissions value, you can now calculate the emissions weighted average for that particular vehicle by multiplying the emission factor obtained in Step 4 by the amount of sales/registrations/imports for that specific vehicle.

The two main values needed to for the base study are the ones obtained in Step 2 and Step 5 (the emissions weighted average and the harmonic fuel economy average.

Results treatment

Now that you have done the previous procedure for several of the vehicles sold/registered/imported into Jamaica, you will need to calculate the emissions weighted average

and the harmonic fuel economy average for all of the vehicles that you found. You will need to exclude all of those for which you could not find the value.

For the emissions weighted average (g CO_2/km under the NEDC cycle):

- Add up all of the values of the emissions weighted average for all of the vehicles found and divide that sum by the sum of all the vehicles found.
- This result will be needed to elaborate graphs that show the tendency throughout the years and also for the information to be comparable to the one from other countries.

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

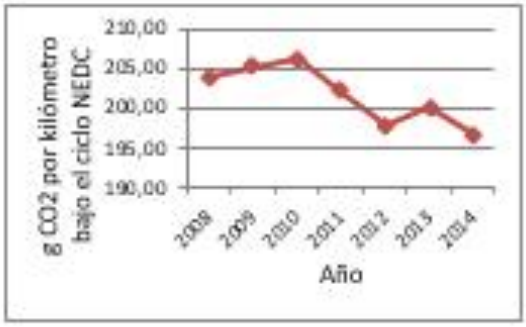
For the harmonic fuel economy average (mpg under the CAFE cycle):

- Add up all the values of the harmonic fuel economy average for all the vehicles found. Divide the sum of all the vehicles found by the sum of all the harmonic fuel economy averages of the vehicles found.
- This result will be needed to elaborate graphs that show the tendency throughout the years and also for the information to be comparable to the one from other countries.

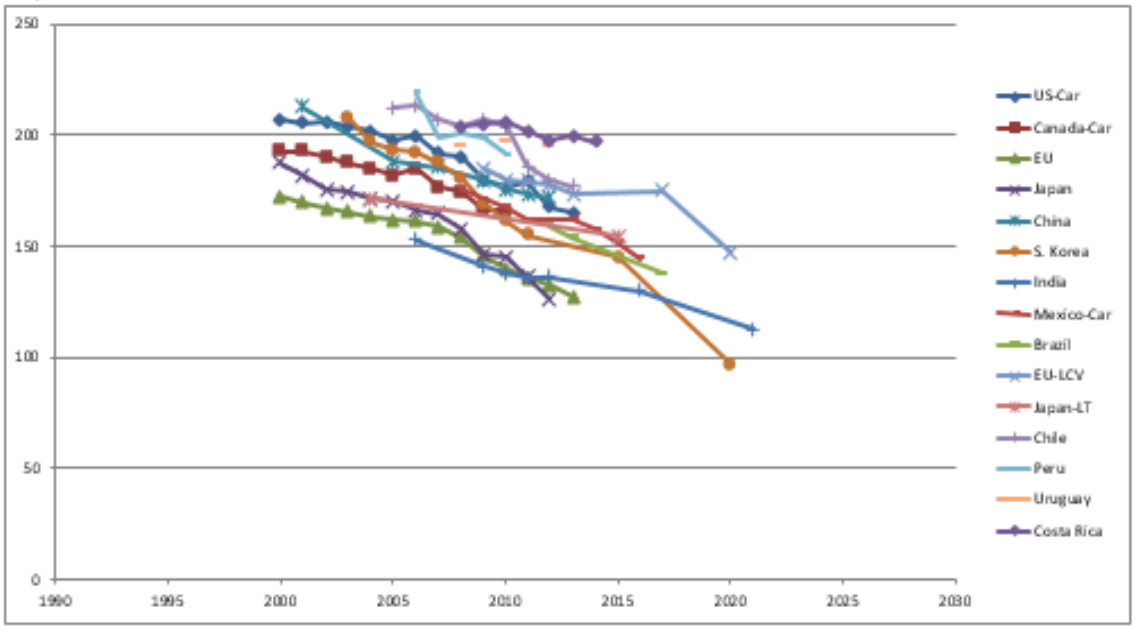
$$Harmonic\ average\ annual\ fuel\ economy = \frac{Total\ sales\ in\ the\ year}{\sum_1^n \frac{sales\ model\ i}{fuel\ economy\ model\ i}}$$

A couple of examples of the graphs mentioned above are shown below. These are the results for Costa Rica and the comparison with the rest of the countries.

- **g CO_2/km under the NEDC cycle during the period 2008-2014.**



- **Comparison with the other countries.**



CONVERSION TABLES

Below are the conversions between units and driving cycles (ICCT, 2014)

Universal Formula	C2 = (a1 * DS + a2) * C1 + d1 * DS + d2				DS: 1 for diesel and 0 for gasoline	
C2	C1		a1	a2	d1	d2
(g CO2 / km)	(g CO2 / km)		[-]	[-]	(g CO2 / km)	(g CO2 / km)
CAFE	NEDC		-0.0975	0.8658	9.852	14.076
NEDC	CAFE		0.0884	1.1325	-7.48	-13.739
CAFE	JC08		-0.1162	0.7212	7.602	36.736
JC08	CAFE		0.0941	1.2749	0.03	-38.423
CAFE	WLTC		-0.0348	0.9318	11.826	-8.827
WLTC	CAFE		0.0587	1.0454	-14.6	12.59
NEDC	JC08		-0.0227	0.8457	-2.891	24.84
JC08	NEDC		0.029	1.143	3.786	-24.907
NEDC	WLTC		0.0486	1.0475	5.037	-22.727
WLTC	NEDC		-0.0494	0.8984	-3.752	28.059
JC08	WLTC		0.0722	1.1532	11.23	-45.172
WLTC	JC08		-0.0653	0.7319	-6.17	53.293

Conversion Units		
From	To	
galon	litre	3.785
Mile	km	1.609
lb	gram	453.592
km/L	mpg	2.35
Mile	km	0.62

Content of CO_2 in fuels					
	Gasoline	Diesel	LPG	CNG	E22
lb/gal	19.5	22.4	13.5	13.7	18.9
g/gal	8845	10160	6123	6214	8588
g/L	2336.86764	2684.4018	1617.83144	1641.79931	2,269