International Conference on Applied Energy 2019
Aug 12-15, 2019, Västerås, Sweden
Paper ID: 647

CLIMATE ACTION IN ENERGY TRANSITION INTO ROAD TRANSPORT TO ENSURE FUTURE MOBILITY IN ALGERIA

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ABSTRACT

In recent decades the oil demand in the transport sector is continuously increasing with rapid increase in the population growth and economic development, resulting in more greenhouse gas (GHG) emissions. Road transport sector in Algeria contributes the most in emissions due to 100% fossil fuel consumption. Government of Algeria launched the National Energy Efficiency Program (PNEE) in 2011 to reduce CO_2 burden in the transport sector. The program was revised in 2016 with major objective of saving 15 million tonnes of oil equivalent (Mtoe) of energy consumption by fuel products. The objective of this study is to evaluate the impact of energy efficiency policies of Algeria on road transport sector in context of carbon footprints. In this work two scenarios i.e. Business as Usual (BAU) and Energy Policy scenarios were developed to determine the carbon emission reductions. The BAU scenario was developed based on historical data while the policy energy scenarios were prepared based on government energy policy program which was to promote liquefied petroleum gas (LPG) and natural gas in the road transport. The results described that implementing the government policy targets led to use of less polluting fuels and hence, reduction in CO_2 emission to the environment.

Keywords: Energy Transition, Sustainability, LPG Vehicles, Road Transportation, Climate Mitigation.

1. INTRODUCTION

The share of energy consumption is 33% in the Algerian transport sector, which is the second dominant entity after the households being the largest with 44%, and industrial energy consumption being 22% of the total [1].

Generally, transport sector in Algeria depends upon hydrocarbon sources particularly Diesel and Gasoline. Petroleum products consumption in road transport covers 95%, followed by flight and rail, having 3% and 2% respectively. The consumption of diesel, gasoline and LPG in road transport in 2017 were qualified as absolute values 9112 ktoe, 4375 ktoe and 539 ktoe, and are presented as percentages 65%, 31% and 4% respectively [1]. It is evident that due to rapid growth in population from 31 million in 2001 to 41 million in 2017 [2], the energy consumption in road transport is increasing rapidly. It is also stated according to[3] [4] [5], that the automobile vehicles on road are growing abruptly from 4 million to 6 million from the year 2009 to 2017. In the context of energy efficiency, the government of Algeria made a program and developed an agency after presidential decree of 1985 under the Ministry of Energy, known as the National Agency for the Promotion and Rationalization of the Use of Energy (APRUE). The main objective of this agency was to develop the national energy management policy for energy efficiency via promoting energy efficient fuels and providing subsidies [6]. The APRUE developed the new regulation in the field of energy efficiency dated 28th July, 1999, which was the control of Energy [7].

The aim of this paper is to analyse the trend of energy consumption in Algeria into various sectors with primary focus on the road transport sector. Two scenarios were developed to determine the carbon foot prints in BAU and energy policy scenario. The BAU scenario was made on current and historical data, while the energy policy scenario was made based on the

Selection and peer-review under responsibility of the scientific committee of the 11th Int. Conf. on Applied Energy (ICAE2019).

government targets, in order to compare the energy impact with energy transition in road sector energy mix.

2. METHODOLOGY

The methodology applied in the research focused on two scenarios namely: Business as Usual (BAU) and Energy Policy scenario with focus on the road transport sector. Fig 1 shows the flow chat of main steps of the methodology and given below the text to describes each individual block of the flow chart to achieve the results.

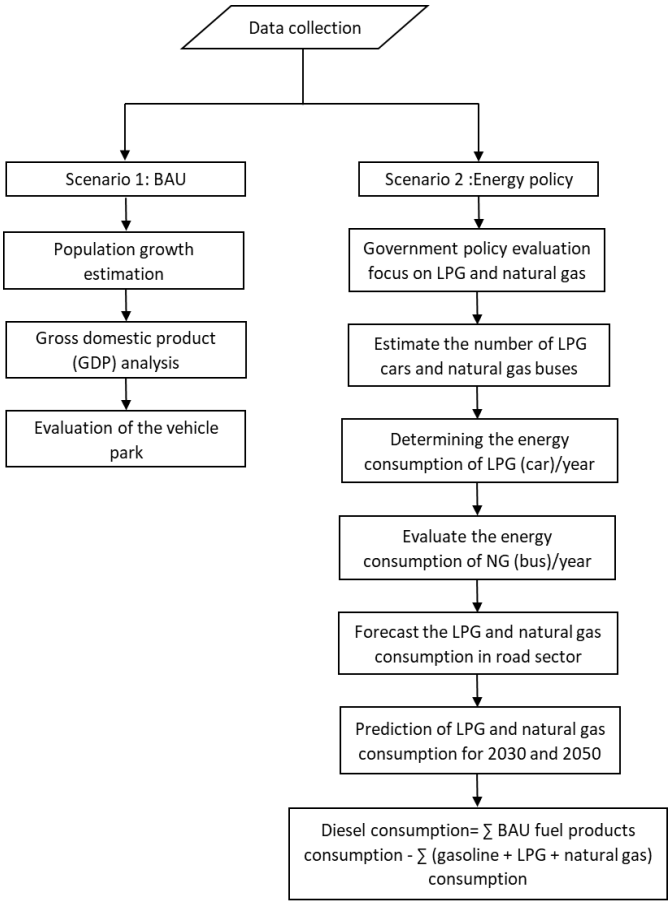

Fig 1. Flowchart reflects the methodology steps to develop BAU and policy scenario

2.1 Business as usual scenario (BAU)

BAU scenario was developed to determine the future demand of petroleum products and to compare by implementing government future energy policy.

Initially future prediction of the population was determined using linear regression with least square method, as described in .

$$Y = bx + a \qquad \text{Eq. 1}$$

Later, the road vehicles and GDP were forecasted using the . It was determined that the population of the country will be 51 and 71 million by 2030 and 2050 respectively with the growth rate of 1.6%. The GDP and road transport vehicles were estimated using the historical data for the year 2030 and 2050 and it is determined that GDP will be 2.65 E+11 and 3.67 E+11 USD and on-road cars will be 9 and 15 million respectively.

More than one decade of the historical data from 2001 to 2017 were collected of the country's energy consumption mix and were projected to 2050 using . It clearly showed that the transport sector being the dominant in the future energy consumption, especially the road transport, hence, became the central focus for further analyses. It can be seen from Fig 2 that the share of energy consumption in the household is higher at this moment compare to transport and industry.

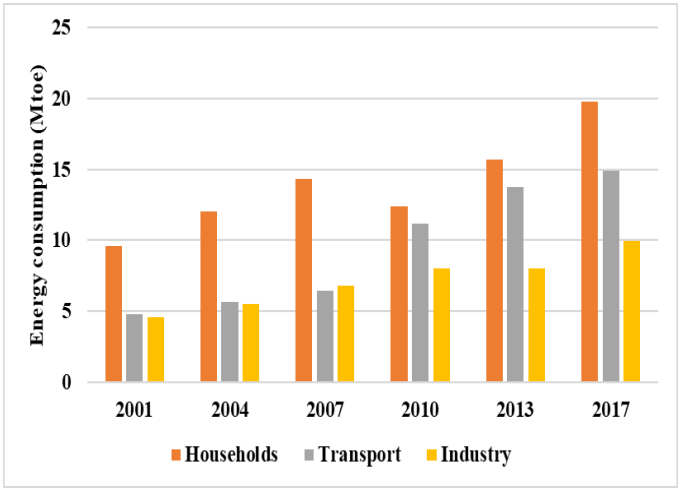

Fig 2. Evolution of energy consumption in different sectors (2001-2017) *[1] [8] [9]*

Fig 3 describes the share of (GHG) emissions by different sectors in Algeria, where the transport sector dominates, hence with more environment negative impact than the household and industrial sectors. It was shown in the Fig 3 that carbon footprints are increasing in the transport sector from 44% to 46% in the year 2002 to 2015 respectively, which push us more to concentrate the study on this sector and try to reduce these emissions in the future.

Fig 4 presents the energy consumption by different petroleum products such as diesel, gasoline and LPG. At the moment, the share of LPG in the energy mix is very low compared to the other oil products. It is presented in Fig 4 and we can see that the share of energy consumption of LPG increased to 0.539 in 2017 as compared to 2015, because the government started energy efficiency program in the year 2016.

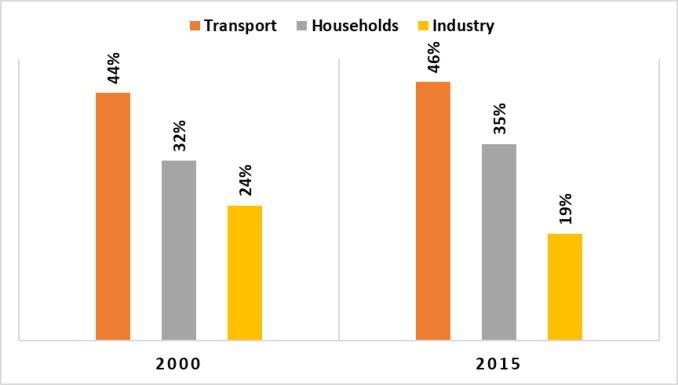

Fig 3. Share of GHG emissions by Sector in 2000 and 2015 *[10]*

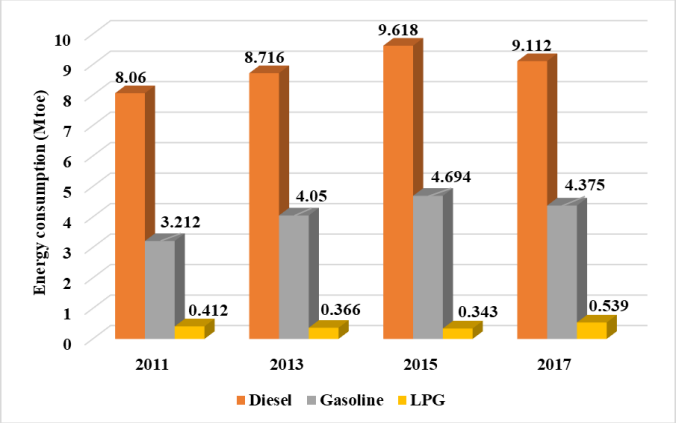

Fig 4. Evolution of energy consumption by different petroleum products (2011-2017) *[1] [9]*

In the BAU scenarios it is assumed that it will follow the trend of historical data from energy consumption by petrol products without adding any new energy policy or environmental parameters.

2.2 Energy policy scenario

In the energy policy scenario, it is assumed that the government policy for road transport sector will be implemented to achieve the targets planned by increasing the use of less polluting fuels such as LPG and natural gas to reduce the CO_2 emissions. Since 2011 Algeria has launched an ambitious strategy plan in the Energy Efficiency Program (PNEE) and the goal of this program was to save more than 15 million toe of energy by the year 2030. This program targeted that 1.3 million vehicles be converted to LPG, the acquisition of 11000 natural gas buses and the conversion of 11000 vehicles to natural gas by 2030 [11] [12]. In this program, the fuel prices were revised in the promotion of LPG and the consumption of diesel and gasoline reduced. Table *1* shows that gasoline and diesel fuel prices were increased, while the LPG price remained fixed from the year 2015 to 2018.

Table 1 Fuel prices in Algeria in USD *[13]*

Type of Fuel	2015	2016	2017	2018
Gasoline	0.17	0.23	0.27	0.32
Diesel Fuel	0.1	0.15	0.16	0.19
LPG	0.069	0.069	0.069	0.069

The program also specified converting 500,000 and 1.3 million cars from gasoline fuel to LPG in the year 2021 and 2030 respectively. At present the government has a capacity of converting 115,000 cars/year and which will be increased after 2021 to 185,000 cars/year [13]. Presently, the agency does not have any plan for 2050 to convert cars from gasoline to LPG. In this work, the assumption has been made for 2050 that same number of cars will be converted from gasoline to LPG, which is around 185,000 cars/year.

In this work LPG per car and natural gas per bus consumption in each year was calculated, where it is determined that LPG and natural gas consumption at each year increases. However, the consumption of LPG and natural gas is increasing continuously until 2030, because of the Government promotion. Government of Algeria has set target for LPG promotion and natural gas fuel until 2030. To understand the objective of 2050, same assumption has been taken into consideration to determine the LPG and natural gas demand in 2050. The Government targets explains that increase in the consumption of LPG and natural gas, will economized the conventional fuel such as patrol and diesel. Finally, the diesel consumption was determined which is explain the last block of the flow chat in the policy scenario.

To determine the overall greenhouse gas emissions in all the scenarios the share of each individual fuel consumption and emission factors as illustrated in Table 2 were considered. Finally, the annual carbon reduction was estimated in BAU and policy scenario. To develop the future scenarios for 2030 and 2050, the individual fuel consumptions and emission factor of each products added to determine the aggregate values of carbon footprints.

Table 2 Fuels emission factors [14]

Fuels (TE-CO_2/toe)	Diesel	Gasoline	LPG	Naturel Gas
Emission factors	3102.48	2901.45	2641.87	2348.79

3. RESULTS AND DISCUSSION

The results showed the evolution of LPG in future and evaluated the impact on environment with energy mix scenario in road transport. Fig 5 shows future energy consumption by various sectors, where the annual average growths were 2.27%, 2.98% and 2.09% for household, transport and industry respectively. It is also clear from the graph that the energy consumption situation changes in the country in 2030, when the transport sector becomes the largest energy consumption sector among others. This increase in energy consumption trend in transport sector follows the future forecasting up to years 2040 and 2050.

Fig 6 presents the energy consumption by different products in the Algerian road transport sector with BAU scenarios, which is developed based on the historical data. In the BAU scenario the share of diesel and gasoline products are linearly increasing compared to the LPG because in the BAU scenario historical data were taken and no assumptions and other policy parameters are considered.

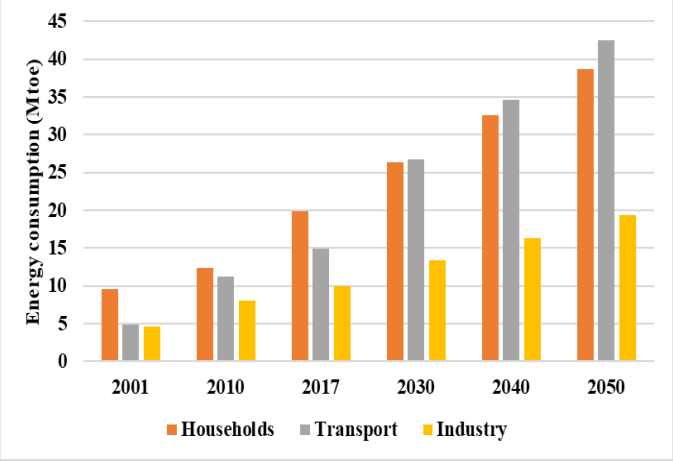

Fig 5. Business as Usual Scenario for Energy Consumption in different sectors in the horizon 2050

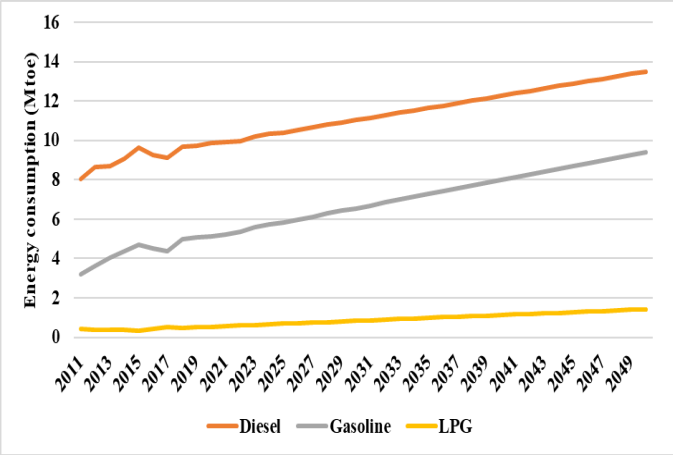

Fig 6. Energy Consumption for petrol products in BAU scenario in the horizon 2050

Fig 7 shows the impact of the implementation of the energy policy on the energy consumption of fossil fuels for the future. From this figure, it is clear that the policy scenario makes it possible to reduce the consumption of the polluting fuels for the beginning of the horizon (2017-2030) and increase the consumption of less polluting fuels. In the same vein, increased in the LPG and natural gas-powered vehicles leads to decrease in the diesel and gasoline demand until the time horizon (2050).

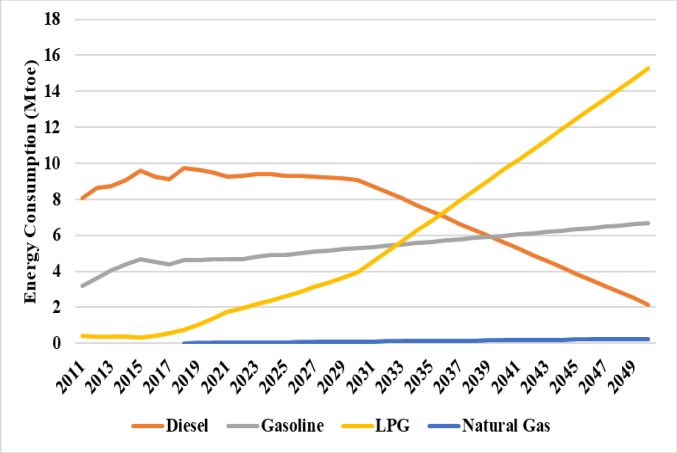

Fig 7. Energy Consumption for petrol products in the Energy Policy scenario in the horizon 2050

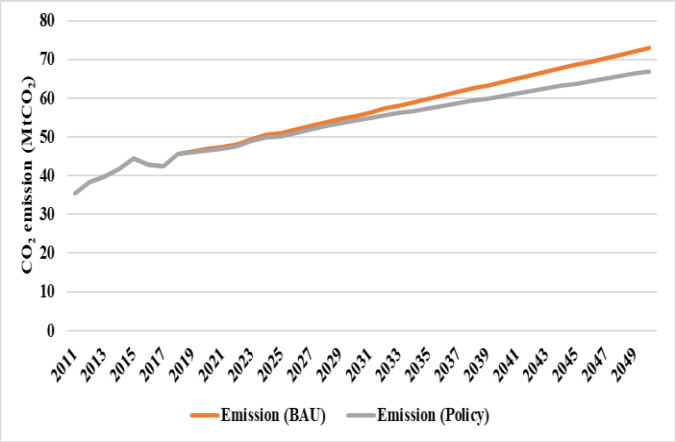

Fig 8. CO_2 emissions comparison between BAU and Policy scenario (2017-2050)

It is shown in Fig 8 that in BAU scenario the total CO_2 emissions in 2050 is 72.9 million tonnes, which is double than in 2011. Whereas in the policy scenario, the reduction in carbon footprints were found to be 8.7 and 75 million tonnes of CO_2 as compared to the BAU scenario by 2030 and 2050 respectively. In the BAU scenario, the petrol products continued to grow and are dominated by diesel and gasoline which are polluting products. In Energy Policy scenario by implementing the government policy targets increased the use of less polluting products such as LPG and natural gas.

CONCLUSION

This paper carried out analyses for the energy transition in the road transport sector in Algeria, to shift from the polluting fuels such as diesel and gasoline to the less polluting fuel such as LPG and natural gas. It is also concluded from the results that increase in the use of LPG will economize the gasoline by 40839 ktoe in the year 2050.

The BAU scenario showed that the transport sector dominates in the future energy demand as compared to the other sectors.

A significant outcome is that, the country has the ability to achieve the national energy policy targets by continuing the promotion of less polluting fuels, as it is found in this study that there is a saving of 8.7 and 75 million tonnes of CO_2 in 2030 and 2050 respectively in energy policy scenario as compared to the BAU scenario. Further research for next step will incorporate the context of hydrogen fuel in the energy supply mix for the future and to determine the CO_2 reduction in comparison to other alternative fuels and scenarios.

ACKNOWLEDGEMENT

This study was financially supported by the German Federal Ministry of Education and Research (BMBF) via its project management agency DLR, under the project "Water and Energy Security in Africa (WESA-ITT)''.

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