Structuring a Base line Research for Energy Efficiency of Transportation in Ecuador

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Abstract *— Transport is worldwide recognized as one of the biggest energy consumers, with 27% of total energy demand. It also consumes more than 50% of the world oil demand. Likewise, in Ecuador transportation consumes about 46% of the national energy total demand. This consumption is economically correlated, as transport is one of the main activities to promote economic development of societies; Therefore, it becomes a priority to project scenarios where transport accomplishes the economic development of the country in a sustainable way. In order to implement and promote the most desirable program for energy efficiency in transport, it's mandatory to define a baseline that identifies Ecuador's actual situation on research and technology for energy efficiency in transportation. As a consequence a proposed methodology to build up a baseline for research in energy efficiency is introduced in this document.*

Keywords - *transportation, energy efficiency, Base line, energy consumption, Ecuador.*

I. INTRODUCTION

A baseline of any system is used to describe an issue or activity in a specific situation and time [1]. A baseline is defined when an improvement of the system's current situation is required; based on the identification of wastes and weaknesses, proposing and implementing corrective actions, to finally quantify the savings and achievements after the implementation of the proposed improvements.

While transport is worldwide recognized as one of the biggest energy consumers, with 27% of total energy demand, it also consumes more than 50% of world oil demand [2]. Likewise, in Ecuador transportation consumes about 46% of the national energy demand [3]. This consumption is economically correlated, as transport is one of the main activities to promote economic development of societies; therefore, it becomes a priority to project scenarios where transport accomplishes this roll in a sustainable way.

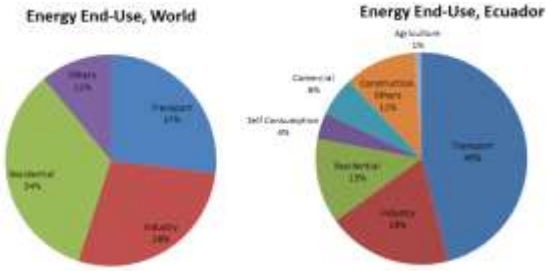

Fig. 1 Energy End-use World vs. Ecuador [3].

Based on these aspects, and understanding that in order to implement and promote the perfect programs for energy efficiency in transport, it's mandatory to define a baseline that identifies Ecuador's actual situation on research and technology for energy efficiency y transportation. As a consequence a proposed methodology to build-up a base line for research in energy efficiency is introduced in this document.

II. OBJECTIVE

Develop a methodology that allows structuring a base line research for energy efficiency of transportation in Ecuador.

III. METODOLOGY

The methodology used for this purpose is based on the fact that a good or service must be transported from one point to another. From this concept identifies that transport can be merchandise or passengers. Additionally, it is considered that several modalities to perform these movements exist today and will have modalities such as air, rail, sea and land; the latter mode has the highest energy consumption in Ecuador with 87% of total energy consumption in transport by 2016 [3].

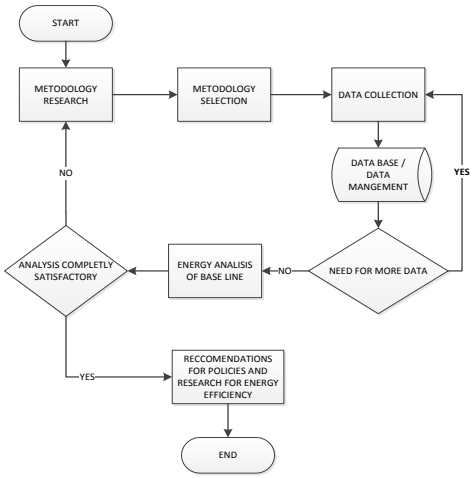

Fig. 2 Process flowchart to define an energy efficiency Base Line.

As a starting point, an exhaustive compilation of information related to the transport sector was carried out (statistical data, papers, technical reports, among others) and served as a basis for structuring the baseline. In addition, information was collected from the key actors and entities of the transport sector in Ecuador.

Subsequently, an energy analysis of each transport mode was carried out, identifying the energy efficiency opportunities in each of them. Finally, based on the results, recommendations are made for policies and research on energy efficiency issues in the sector.

The transport sector is constituted by three transport modes: Terrestrial, maritime and air and each of them keeps a particular behavior and at the same time the multimodality between them.

A. *LAND TRANSPORT*

The land transport sector is the largest consumer of energy and emitter of greenhouse gases in the sector, as well as being a sector with high growth. Thus, the need arises to develop programs for the rational and efficient use of energy for the sector.

The most important potential for energy efficiency is in the freight transport, especially in light load. Based on the information collected, a breakdown of the truck fleet by tonnage was made (Figure 3).

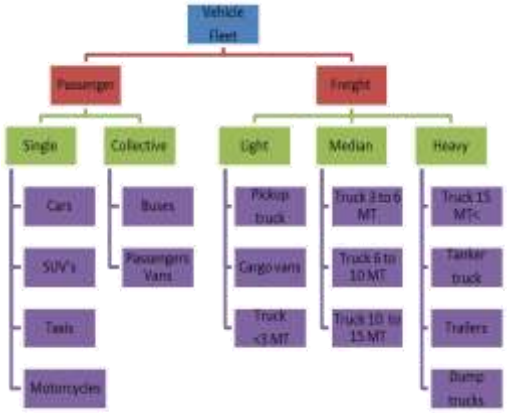

Fig. 3 Vehicle Fleet .

In addition, it was identified that, vehicles that use gasoline are 89,06% of the national fleet including hybrid vehicles, in terms of energy consumed by 2012, 983.496.706 gallons of gasoline corresponding to 56,6%. The vehicles that use diesel as an energy source correspond to 10,90% and their consumption is 752.884.243 gallons corresponding to 43,4%. It should be noted that there is a minimum fleet of vehicles whose source of energy is Liquid Petroleum Gas (LPG) and Electricity, data that can be seen in Figures 4 and 5.

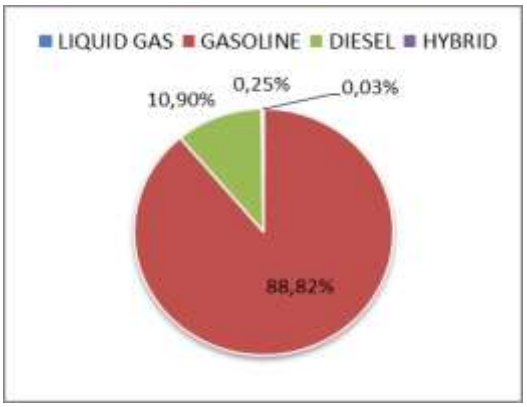

Fig. 4 Distribution of Vehicle Fleet by fuel used.

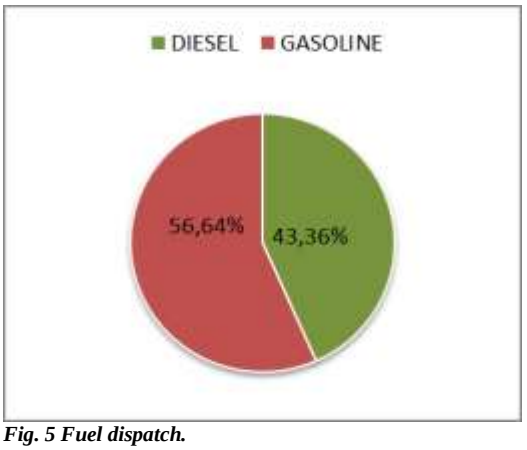

Fig. 5 Fuel dispatch.

Energy expenditure reaches a total of 39 million barrels of oil equivalent (BOE) dispatched in 2012, cars and SUV's use 37% of this type of fuel. Likewise, the light cargo transport conformed in its majority by light trucks and trucks uses 35% of the dispatch. Taxis spend only 6%, and motorcycles have 7% of the demand for this fuel, however they are the vehicles with the highest growth rate in the country.

With these data, a projection was made to the year 2042, of the energy demand of land transport disaggregated by type of vehicle (Figure 6).

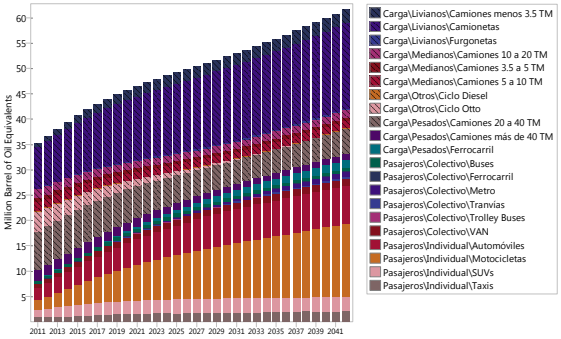

Fig. 6 Energy demand land transport broken down by type of vehicle, Life Cycle scenario [4].

B. *MARINE TRANSPORT.*

Maritime transport is responsible for approximately 4% of global CO2 emissions of human origin [5]. In Ecuador, the maritime sector consumes approximately 5,98 million barrels of oil equivalent, which represents 13% in the transport sector.

Currently there are 4 ports that play an important role within the sector in the country, these are:

- Esmeraldas
- Guayaquil
- Manta
- Puerto Bolívar

According to the Agency for Regulation and Control of Hydrocarbons (ARCH), the maritime and fluvial sector of Ecuador is made up of 3 important sectors [6]:

- Artisanal fishing
- National shipping company
- International shipping company

The national shipping sector is made up of cargo transport, passengers, private transport and sports. On the other hand, the international shipping sector consists of cargo and passenger transport.

III.B.1 DISPATCH OF FUELS BY PROVINCE FOR THE MARITIME SECTOR

The dispatch of fuels allows us to have a clear vision of the energy behavior in this sector. According to the information collected and analyzed, the provinces to which the fuel is supplied are: Manabí, Guayas, Esmeraldas, Santa Elena and El Oro. In the period from January to December 2012, 65.514.932 gallons of fuel were dispatched (Petrol Artisanal Fishing) for this sector. In Figure 7 you can see the dispatch in the provinces that require fuel.

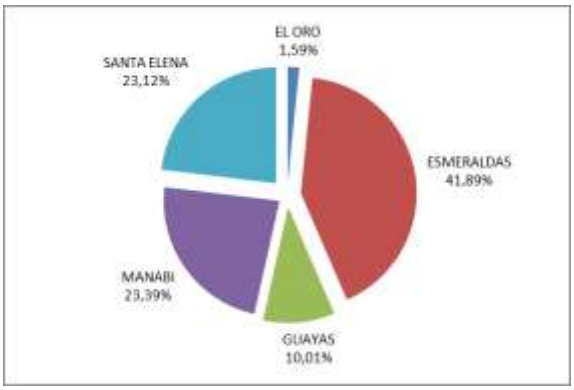

Fig. 7 Fuel dispatch by province [4].

C. *AIR TRANSPORT*

In this mode of transport, an investigation was carried out on the infrastructure, which highlights the existing airports in the country (Table 1).

TABLE 1. AIRPORT INFRAESTRUCTURE IN ECUADOR.

Internationals (4)	Nacionals (11)	Regional (5)
Quito	Salinas	Isabela
Guayaquil	Cuenca	Macas
Manta	Loja/La Toma	Pastaza/Shell
Latacunga	Esmeraldas	Taisha
	Jumandy Tena	Santo Domingo
	Tulcán	
	Esmeraldas	
	Santa Rosa	
	Lago Agrio	
	Baltra	
	San Cristóbal	

The types of fuels used in the Ecuadorian air transport are AVGAS and JP1 or JET A-1 [7], JET

A-1 or JP1, is a type of fuel used in civil aviation, suitable for use in turbines of jet engines. It comes from the distillation of crude oil whose product is kerosene, which is the raw material for the refinery industry. Its use is to supply power to the aircraft, depending on its energy content and the quality of combustion [8]. As shown in Figure 8, the largest share of shipments corresponds to JET A-1, with AVGAS consumption being much lower than 1%.

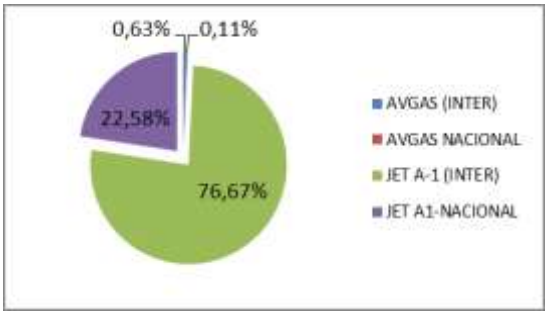

Fig. 8 Fuel dispatches in air transport [4].

III.C.1 CLASSIFICATION OF THE AIR FLEE

The categories established by the Dirección General de Aviación Civil del Ecuador (DGAC) are included in the type of operation of the aircraft. However, these categories have been grouped into 4 types of operation (Figure 9).

Fig. 9 Categorization of air transport [4].

IV. CONCLUSIONS

The results indicate that future research for energy efficiency in transport should be focused on three critical fronts: Being the main problem to attack, waste energy focused on the burden and poor logistics system. The second point the high growth of motorcycles that carry high energy inefficiency. As last and most difficult to combat, that energy inefficiency of a society accustomed to fuels with very low prices because of subsidies.

The land transport sector has been identified as the one with the highest energy consumption in Ecuador, and the sub-sector with the highest energy consumption is cargo transport.

Another important result is the identification of technology and age of the vehicle fleet since an old vehicle is identified as a source of energy waste and with respect to maritime transport, artisanal fishing is identified as another source of energy waste. These results lead us to recognize that The introduction of new technologies compared to the old and less efficient ones, is fundamental for energy efficiency.

The size of the circulating vehicle fleet was analyzed since it is this that defines the national energy consumption. From this analysis it is important to standardize a methodology for the accounting of the annual circulating vehicle fleet in order to update the data annually and have real information.

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