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Why should Brazil to implement mandatory fuel economy standards for the light vehicle fleet?

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ABSTRACT

Ethanol production and the diffusion of flex-fuel vehicles are successful examples of renewable energy in the transportation sector in Brazil. Despite these achievements, challenges regarding the Brazilian fleet, composed of inefficient light-duty passenger vehicles (LDPV), need to be addressed. In this regard, political measures have been implemented, for instance voluntary labeling and fiscal incentives related to fuel economy targets. However, there is still room to improve these instruments to capture greater economic and environmental benefits related to fuel economy. In this paper, we present information regarding the Brazilian LDPV fleet, its fuel consumption, its CO_2 emissions and a description of the historical evolution of policies concerning fuel economy in Brazil. Furthermore, we estimate impacts related to the adoption of mandatory fuel economy standards (MFES), in terms of fuel economy and CO_2 emissions reduction. This analysis indicates that 18,626 million liters of gasohol E-22 and 16,274 million liters of ethanol E-100 can be saved up to 2035. The related reduction of CO_2 emissions is also significant, about 62 Gg of CO_2.

1. Introduction

Many studies [16,17,32,34,38,43,55,9,54] have highlighted the intensive use of light-duty passenger vehicles (LDPV) as one of the main causes of the increased CO_2 emissions in the world. In fact, the LDPV fleet should reach about 2 billion units by 2050, which means 0.9 billion of additional units from 2014, representing an increase of 3 billion tons of CO_2 annually released into the atmosphere if not were implemented strong policies to address this problem [36]. Besides higher GHG emissions, a larger LDPV fleet also means more time of traffic congestion in urban centers, which is already a critical issue in many cities across the world. Moreover, a great number of fuel inefficient LDPV with obsolete technology is still operating and it aggravates the air pollution, causing several health problems like respiratory diseases and death, consequently increasing health costs [23,39,44]. World Bank [67] points out that only in the year 2013 5.5 million lives were lost due diseases related to air pollution and it costed about US$ 225 billion to global economy.

To tackle the emissions problem and to address other issues as oil security and technology innovations, many countries have introduced mandatory or voluntary measures to reduce vehicle's fuel consumption and its related CO_2 emissions. Mandatory standards can be effective mechanisms for limiting or promoting specified energy technologies [22,59]. However, a higher level of regulatory enforcement is required to monitor direct government investments and mandatory standards when these policy mechanisms are set up. In the other hand, voluntary standards are used to incentivize the market to adopt best energy technologies and practices.

While voluntary measures have a non-binding nature, wherewith automakers can choose whether they will or will not to commit with fuel economy measures, in mandatory measures the automakers are to required participate in fuel economy programs and comply with a set of regulations to reach fuel economy targets. Examples of measures are (mandatory or) voluntary fuel economy standards, (mandatory or) voluntary emissions standards, and (mandatory or) voluntary labeling. Generally, these measures are implemented in association with other mechanism such as vehicle taxation and charges connected to emissions performance, fiscal incentives to automakers, incentives for fuel efficient and low emissions vehicles such as hybrid electric vehicles (HEVs). These measures also can include rewards and/or penalties if the agreements are not fulfilled [33,52,64,35,12,5,36].

Voluntary measures are easier to implement and therefore have been adopted in most countries. However, voluntary agreements between governments and automakers have shown less effective results

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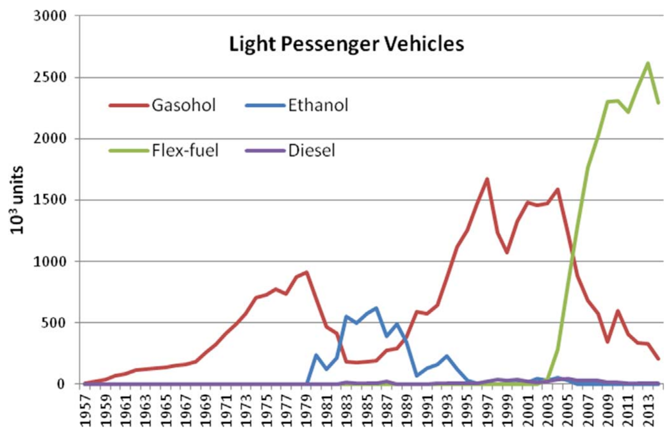

Fig. 1. - Sales of new light passenger vehicles by fuel type 1957–2014.
Source: ANFAVEA [3].

considering fuel economy targets [56,16,50,49,40,42,63,28,24]. In fact, the European Union and countries as Japan, China, South Korea, Canada, USA and Mexico switched to mandatory systems, which have already produced larger results in terms of controlling fuel demand and reduction of carbon emissions [41,63,30,27], even though the success of these mechanisms seems to be dependent on how the policies are designed [33,5].

In this paper, we present information regarding the Brazilian LDPV fleet, its fuel consumption, its CO_2 emissions and a description of the historical evolution of policies concerning fuel economy in Brazil. Furthermore, we estimate impacts related to the adoption of mandatory fuel economy standards (MFES), in terms of fuel economy and CO_2 emissions reduction. The paper is structured as follows. Section 2 describes the LDPV fleet, the fuel consumption and the respective CO_2 emissions in Brazil. Section 3 shows a review of policies for fuel economy in Brazil, focusing on LDPV. Section 4 describes fuel economy standards and the rationale behind this public policy measure. Technology considerations of MFES are presented in Section 5. Section 6 presents the methodology applied to estimate the potential impacts of MFES in Brazil and the scenarios assumptions. Next, Section 7 provides the simulations results for two scenarios. Finally, Section 8 shows the conclusions and addresses policy recommendations for fuel economy in Brazil.

2. LDPV fleet, fuel consumption and CO_2 emissions in Brazil

In Brazil, despite a large use of biofuels through flex-fuel technology, indicators related to GHG emissions from vehicles and air quality are still worsening [44,45]. In fact, the country has faced an insufficient infrastructure for public transportation in a context where the demand for urban mobility has rapidly increased. Historically, governmental strategy to deal with this lack of access to transportation has followed the automotive industry interests. Tax exemptions for vehicles are a regular practice in the country and it has boosted the sales of new vehicles. Only between the year 2007 and 2014 the fleet size increased 61% [58]. ANFAVEA [3] estimates that the Brazilian fleet will be 95.2 million in 2034, which means a growth of 140% from 2013. However, in most cases, these incentives have been introduced at the expense of fuel efficiency [24]. As evaluates Borba [10], the distance travelled per liter of fuel consumed in 1000 cm^3 vehicles reduced from 12 km/l to about 9 km/l between the years 1995 and 2004. Additionally, it is worth to mention that Brazil still have a low per capita LDPV, something around 0.25 vehicles per person, while in developed countries this value is greater than 0.5. Fig. 1 shows the total annual sales of new LDPV categorized by fuel type.

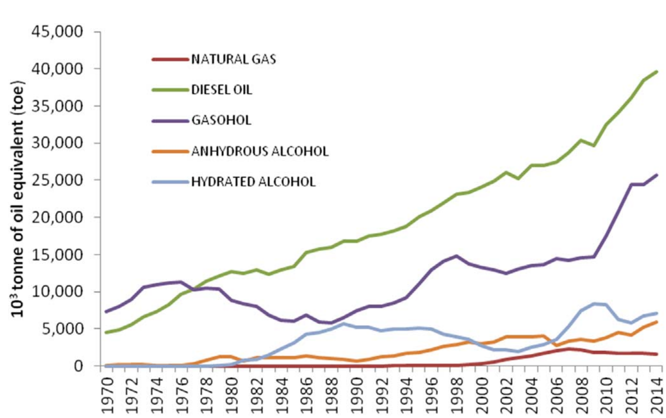

Fig. 2. – Fuel consumption in road transport sector in Brazil.
Source: EPE [18].

Table 1
– CO_2e emissions from Brazil transport sector in 2000 and 2015.
Source: Own elaboration based on [57].

Transportation	2000		2015		Change between 2000 and 2015
Subsector	**Gg of CO_2e**	**%**	**Gg of CO_2e**	**%**	**%**
Air	9605.043	7.4%	11,042.576	5.4%	15.0%
Railway	1402.508	1.1%	3163.404	1.5%	125.6%
Waterway	2991.155	2.3%	3124.031	1.5%	4.4%
Road	115,338.081	89.2%	187,029.033	91.5%	62.2%
Total transportation	129,336.787	100.0%	204,359.044	100.0%	58.0%

The road transportation sector has been the responsible for a great part of the increase in energy demand in Brazil. Between the year 2010 and 2014, there was an increase of 22% in Diesel oil consumption, 46% in gasohol and 55% in anhydrous ethanol according to the National Energy Balance [19]. Fig. 2 shows the fuel consumption in road transportation sector in Brazil by fuel types.

These increases in fuel consumption have been one of the major causes of local air pollution in large Brazilian cities. Table 1 shows CO_2e emissions in transportation sector disaggregated by sub-sectors. Table 2 shows disaggregated CO_2e emissions in road transportation sector for the years 2000 and 2015. The road subsector is the main source of CO_2 emissions and was the responsible for these greater increases, especially for passenger vehicles, which almost doubled its emissions. The National Atmospheric Emissions Inventory for Road Motor Vehicles [45] estimates that the CO_2 emissions from motor vehicles, in the case of light commercial vehicles and motorcycles, could reach 130 million tons in the year 2020. Fig. 3 shows the CO_2

Table 2
CO_2e emissions from Brazil road transport in 2000 and 2015.
Source: Own elaboration based on SEEG (2016)

	2000		2015		Change between 2000 and 2015
	Gg of CO_2e	**%**	**Gg of CO_2e**	**%**	**%**
Passenger vehicles	34,583.205	30.0%	62,595.054	33.5%	81.0%
Trucks	55,898.656	48.5%	85,450.054	45.7%	52.9%
Light commercials	8,537.536	7.4%	13,478.215	7.2%	57.9%
Motorcycles	1,540.484	1.3%	5,791.387	3.1%	275.9%
Bus	14,778.198	12.8%	19,714.321	10.5%	33.4%
Total road	115,338.079	100.0%	187,029.031	100.0%	62.2%