Energy Policy 60 (2013) 70–80

Contents lists available at SciVerse ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Viewpoint

Practical implementation of liquid biofuels: The transferability of the Brazilian experiences

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HIGHLIGHTS

- A systemic cause–effect analysis was carried out on biofuel program success.
- Main questions concerning implementation of liquid biofuels in Brazil were studied.
- Main weakness aspects of biofuel logistic were treated.
- During selection of benchmarking strategy. What needs to take into account?

ARTICLE INFO

Article history:
Received 17 July 2012
Accepted 16 April 2013
Available online 25 May 2013

Keywords:
Supply chain management
Liquid biofuels
Energy planning

ABSTRACT

The main purpose of this paper was to carry out a systematic analysis of the particularities and trends pertaining to the development of biofuels in Brazil—a country which has demonstrated its leadership in this field during the last 40 years. The Brazilian experiences with biofuels are often used as references for decision making by other developed and developing countries. The transferability of Brazil's biofuels practices would be appreciated by many researchers and energy policy markers across the world. This work uses an adapted 5W2H (what, when, where, why, who, how, and how much) analysis technique to answer a variety of questions about the subject. The data, facts, and figures herein are offered as resources for other researchers and policy makers seeking benchmarking. Also, this work discusses the main certainties and uncertainties of the sugarcane agro-industry, and also goes into detail about the ethanol supply chain structure, its management, and particularities. Finally, this research analyzes the central aspects of biofuels implementation in Brazil, lists the most important aspects to consider during a selection of possible standard biofuels, and presents the main aspects of the National Program of Biodiesel Production and its sustainability.

1. Introduction

In terms of biomass, at least two factors make Brazil widely known: (1) the Amazon Forest[1] with its huge biomass potential, and (2) the success of biofuels programs implemented by the Brazilian government.

On the one hand, the existence of the Amazon—the world's largest tropical forest—and its ecological vulnerability have forced the government to adopt measures to reduce the environmental impact of anthropogenic activities in this region. A recent report noted a significant decrease in the deforestation of the Amazon[2] due to environmental policies and collaboration pacts supported by the government in recent years. For example, the Sustainable Development Plan of the Amazon (*Plano Amazônia Sustentável* or PAS) (Sustainable Development Plan of the Amazon, 2008) was developed by the Brazilian Federal Government in collaboration with the Brazilian State Governments localized in this region. Sophisticated and high-tech methods to control deforestation have

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[1] More than 60% of the Amazon territory belongs to Brazil.

[2] According to the National Institute for Space Research, satellite images show that a 6418 km^2 area was deforested over a period of 12 months, the smallest since 1988 when it began making annual estimates of deforestation in the Amazon jungle. The data also points to a gradual reduction of deforestation in that region, whose highest value was observed in 2004. Since that year the levels of deforestation have fallen by about 75% (Ana Tomás, 2012).

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http://dx.doi.org/10.1016/j.enpol.2013.04.038

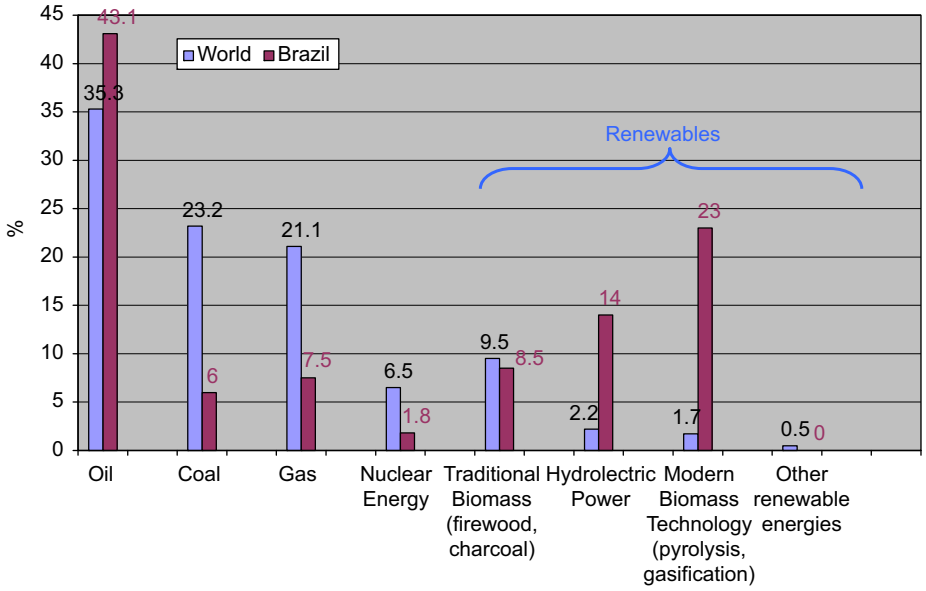

Fig. 1. Energy matrix composition utilized by the world versus Brazil.
Source: FAOSTAT, 2011.

been used in this vast territory, such as: optimization software with a satellite system, remote sensors, and the Global Positioning System (GPS).

On the other hand, Brazil is today the world leader in the use of renewable energy, specifically biofuels. A simple comparison between the composition of the Brazilian and the world's energy matrices is enough to confirm this statement. The percentage of renewable energy utilized in the world is 15% (Fig. 1), but in Brazil it is 43%. The percentage of bioenergy in the composition of the global energy matrix is only 12%, in Brazil it is 30%. Brazil is the second leading ethanol producer in the world, and Brazil has approximately 30 million Flex-Fuel Vehicles (FFV), the largest fleet in the modern world (França and Nogueira, 2008). With its National Program for the Production and Use of Biodiesel (Law 11.097, 2005), Brazil became the first Latin American country to implement this type of program. According to this law, all diesel fuel used in the country should contain 2% biodiesel by volume by 2008, and 5% by 2013.

Many other facts could be cited, but those mentioned above are enough to explain why Brazil is currently a leader on biofuels issues (Worldwatch Institute, 2012). Assessments about the transferability of Brazilian experiences are desirable to many researchers and energy policy markers across the world.

The literature contains many works on Brazilian biofuels, and most of them are on the sustainability of bioethanol (Sparovek et al., 2007; Center for Strategic Studies and Management (CGEE), 2009; Dietrich, 2008; Sorda et al., 2010; Goldemberg et al., 2007; Institute of Agricultural Economics (IEA), 2007; Le`bre et al., 2011; Rodriguez and Ortiz, 2006; Arnaldo Walter et al., 2011). The classical approach of most of these works is to analyze biofuels development, assessing the environmental advantages of substituting biofuels for fossil fuels. Several authors also approach the first and second generation bioethanol production theme (Walter and Ensinas, 2010; Fioravanti, 2009; Thályta, 2011). Additionally, the controversial aspects of the Brazilian ethanol program have been discussed (Rodriguez, 2004; Edmar and Viegas, 2011; Atibaense, 2011). While still other works show different aspects of the Brazilian sugarcane agro-industry (Alonso Pippo et al., 2011a, 2011b), or of a specific issue like solid biofuels (Felfli et al., 2011). There are few studies which explore biofuels in general. The vast majority of studies are about ethanol; the exceptions to this are (CGEE, 2009; Márcia, 2006; Oliveira and Hira, 2009). There is a lack of detailed information about the contexts in which crucial decisions on biofuels were made in Brazil. In others words, questions such as: What happened? Why, where, and when did it happen? Who played the leading roles? How was it done? How much was produced? As these questions indicate, systematized information is missing to support the understanding of particularities, experiences, and circumstances to identify and compare development trends in this complex area of energy planning. For this reason, the main aim of this paper was to develop analyses to support an enhanced comprehension of the scenarios, specificities, and various aspects of the contractual relationships between managers from the public and private sectors in Brazil. Also, it will discuss the influence of historical, geographical, cultural, and social developments pertaining to the present biofuels situation in Brazil. Finally, the present work discusses important aspects to consider with regard to the transferability of the Brazilian experiences.

2. Bioethanol: the flagship of Brazilian biofuel success

It is an indisputable fact that Brazil's liquid biofuels are the best known throughout the world. Bioethanol produced from sugarcane is especially important. Table 1 shows some characteristics of Brazilian ethanol and its most important performance and environmental indicators. Advantages and disadvantages of bioethanol production and its use are also shown.

From the technical and economical points of view, it is cheaper and easier to produce ethanol from sugarcane than from corn. Ethanol produced from sugarcane in Brazil is three or four times cheaper than bioethanol produced from corn in the USA. In order to produce ethanol from corn, an additional step is necessary in the production process; cornstarch must be converted to sugar prior to fermentation. In the case of ethanol produced from sugarcane, the sugar for fermentation is contained directly in the sugarcane juice.

The success of ethanol in Brazil began in the 1970s with the launching of the National Ethanol Program (*Proalcool*). The economic, social, and political circumstances that gave place to the *Proalcool* have been presented and broadly discussed in the works of Macedo (2005), Moreira and Goldemberg (1999), Borges (1986, 1985), Copersucar (1989).