

Introduction

The sugarcane is one of Brazil's main agricultural products. From it is possible to produce sugar, ethanol, and in some cases, electricity. A major source of opportunity for innovation in this sector is the high biomass production, each ton of processed sugarcane generates 270-280kg of bagasse and 140kg of straw (Canilha et al, 2012). This biomass possessed high energy content, about two thirds of the total energy of sugarcane. Two of the main opportunities for the ethanol industry are the sale of bioelectricity to the grid and the production of second generation ethanol. However, many challenges must be overcome in order to widely take advantage of this potential.

A key factor to understanding the process of innovation is to check the communication of different areas of industry, such as research, policy and industry. Thus, the aim of this work was to identify and analyze the nature of the main challenges and opportunities to innovate in the ethanol industry. This work also proposed to verify if the different areas of the industry (research, industry and policy) are aligned in relation to these opportunities and challenges.

Methodology

To accomplish this work, a literature review was done on the major opportunities for innovation in the ethanol industry. Then interviews with six experts of this sector were made. Respondents were divided into: Policy, Research and Industry in accordance with their activity. Once acquired information about the opportunities and challenges, these were classified according to five categories: external (to the sector), Environmental, Technological, Managerial and Cost. Finally, a comparative analysis of specialists' opinions in different areas was conducted.

Results and Discussions

Commercialization of Bioenergy

The sugarcane industry has always been self-sufficient in energy, and the improvement and replacement of equipment by more energy-efficient engines promoted a potentially marketable surplus energy. Many are the opportunities associated with the sale of this bioelectricity such as: availability of raw materials, complementing the seasonality of hydroelectric (Fig.1), generation is distributed and next to the main consumers, revenue increase of the mill and it is produced from renewable material. However some challenges are also associated with the sale of bioelectricity, the main being associated with cost and competition with other sources.

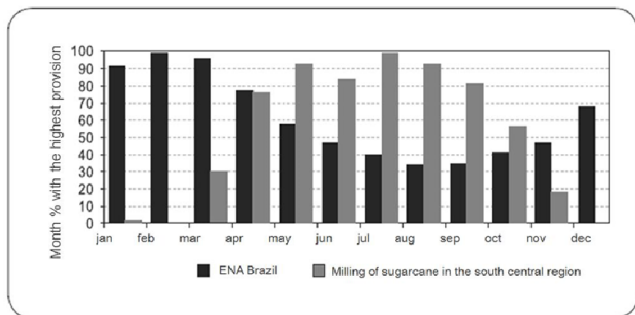


Figure 1: Complementarity between the hydroelectric park and the sugarcane crop. Source: Nyko et al (2010).

Table 1: Opportunities and challenges for the sale of bioelectricity

Opportunities		Challenges	
	Category		Category
Availability of biomass	Cost and Environmental	Investments in more energy-efficient equipment	Cost
Increasing energy demand in the world	External	Investment in connection to the transmission system	Cost
Irregularities of the hydroelectric system	External	Controlled prices that compete with wind energy	External
Complementarity of seasonality	External	Competition with the second-generation ethanol.	External
Renewable source	Environmental		
Flexible thermoelectric.	External		
Produced and distributed close to consumer	Cost and External		
Increases the revenue of the sector	Cost		

Observing the distribution of opportunities in categories (Fig.2a) it is found that: most of the opportunities are external to the industry, which is conducive to innovation because the environment encourages these transformations; three are associated with the cost and two with environmental issues, which is consistent with the concept of sustainable development. However the challenges are associated with external factors and cost (Fig. 2b) showing that innovation depends heavily on the company's capital.

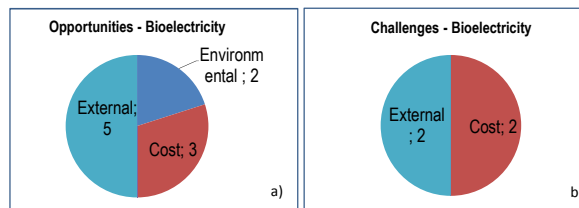


Figure 2: Categorization of opportunities (a) and challenges (b) the sale of bioelectricity.

Experts related to politics had little expectation about this opportunity since investment costs are very high. Experts from industry and research have proven more optimistic, especially when looking the medium and long term returns, due to the equipment lifetime. The management issue was not seen as a challenge by any of the groups.

Second Generation Ethanol

One of the main opportunities for innovation in the sector refers to production of ethanol from lignocellulosic wastes through the sugarcane. The 2G ethanol has the advantages of increasing production without increasing the planted area, not compete with food production and be produced from renewable sources. However, being a developing technology, there are still many challenges related to the development of the steps responsible for the breakdown of lignocellulosic material into fermentable sugars. The logistics of harvest straw from the field has also proved challenging. A summary of the opportunities and challenges can be seen in table 2.

Table 2: Opportunities and challenges for the production of ethanol 2G

Opportunities		Challenges	
	Category		Category
Increased demand for fuel	External	Challenges for the pretreatment	Technological and Cost
Increased demand for biofuels	External	Challenges for the hydrolysis	Technological and Cost
Renewable and abundant raw material	Cost and Environmental	Challenges for fermentation	Technological and Cost
Increased Ethanol Production	Cost	Logistics and transport of straw	Technological and Cost
Does not compete with food production	External	Plant layout	Technological and Managerial
Reducing emissions	Environmental	Scale	Technological and Cost
Bagasse is inserted in the purchase of sugarcane and available in the plant	Cost	Competition with the power generation	Cost
Harvests facilitates the introduction of a plant 2G	Cost		

Analyzing the graphs of Fig.3a, it is observed that the most cost opportunities are related to the increased production of ethanol using cheap and plentiful raw materials. Other opportunities are the external type and environmental type, decisive factors to drive innovation. However, the principal challenge are also related to cost, since the processes are not technologically mature.

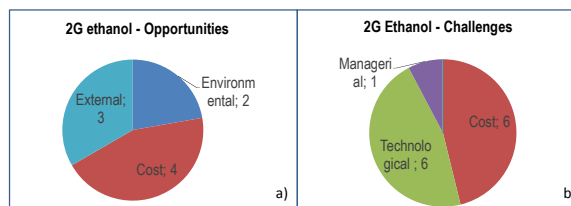


Figure 3: Categorization of opportunities (a) and challenges (b) for ethanol 2G.

Despite great challenges, experts from all areas preview the 2G ethanol as one of the most promising opportunities in the sector, where the cost will be outweighed by the maturing of technology. As one of the main agents of the insertion of 2G ethanol is the R&D, industry experts showed great difficulty to take results coming from universities, referring mainly to the lack of speed in obtaining results and lack of management of investments.

Conclusions

The sale of bioelectricity and 2G ethanol production are very different, with very different product and technology base, however they are strongly related to the future of the ethanol industry because they originated from the same raw material. The results of this study showed that at long term these two technologies have great chances to participate intensely in the ethanol industry, the sale of bioelectricity through the exchange of equipment and 2G ethanol through the maturation of separation and breakdown of lignocellulosic material technologies.

Future Research

This work is the first part of the study of Opportunities and Challenges for Innovation in Ethanol Sector. Other technologies such as biogas, gasification, production of chemical intermediates, among others, are still in progress. Further research also consists in increasing the number of respondents.