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1

INTRODUCTION

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The ethanol produced from sugarcane is considered as one of the most competitive alternative energy to substitute liquid fuels derived from hydrocarbons. The light and medium oil distillates are more difficult to replace. Its uses are specific, especially in the transportation sector. In this particular niche, biofuels, stand as the only renewable energy option currently feasible without requiring the scrapping and replacement of the fuel distribution infrastructures and of the transport equipments. Among biofuels, ethanol from sugarcane is by far the more attractive alternative in economic and energy terms as well as environmental sustainability is understood, especially energy balance and emission of greenhouse gases. The energy requirements of ethanol industrial processes are all covered by the sugarcane by-products (mainly bagasse). This singularity is the most attractive feature of cane over almost all other agro-energy crops.

The central advantage of sugarcane is the high energy yield of this crop and the high proportion of fermentable sugars directly into ethanol (1/3 of the energy content). The high proportion of sugar ensures the reduction of energy requirements of sugarcane ethanol in relation to the cereals rich in starch ethanol, which is crucial to ensure its competitiveness[1]. The other key advantages of the sugarcane is the use of bagasse in the industrial process and recycling of vinasse, filter cake and ash, a very common practice in Brazilian plants. These wastes become important inputs in the production process that contribute to greater competitiveness of the sugarcane. The technologies, however, in use in the Brazilian agro-industry still rely largely on incremental innovations made on technologies acquired from abroad. There is enormous potential for progress in energy productivity of sugarcane that has yet to be tapped.

The Brazilian sugarcane agro-industry has a long history in the country, and is characterized by the development of technologies with immediate application. However, since Proálcool, in 1975, this complex production system began a virtuous path of expansion, supported to a large extent on the ability to incorporate new technological knowledge and translating it into productive advances. One reason why the sugarcane industry could survive over the long period of low oil and ethanol prices, which followed the counter-oil shock, was its diversification into the international sugar market. The Brazilian sugar exports expanded considerably during the 1990s supported by technological developments started with Proálcool. Thus, the technological system converges to a hybrid ethanol-sugar production model, with a distillery attached to a sugar refinery known as the "Brazilian model".

However, this process of technological learning, which proved effective in the 1990s, is still weak when compared with the potential develop-

[1] In the other hand, it is worth to mention a grain crop: corn. This has 70% starch, which is hydrolyzed to glucose, giving values for sugars even higher than sugarcane. A problem of corn – and other cereals – is the fact that they have no residue, such as sugarcane bagasse, as the waste materials are all left in the field.

ments of the sugarcane agro-industry, with the advent of rising international oil prices and increasing pressure to reduce emissions of greenhouse gases. Indeed, sugarcane bioethanol stands today as an excellent renewable alternative with reduced emission of greenhouse gases compared to fossil fuels. In addition, the state of the art technologies and availability of land for agricultural expansion puts Brazil in a unique leadership position within the global context, as being practically the only country with the ability to expand ethanol production significantly.

This chapter aims is to identify research problems for the team participating in this project (Public Policies for Ethanol), using process Technology Roadmapping. Chapter 2 presents the long-term vision, built by the team for the sugarcane industry of the State of São Paulo. Based on this view, the chapter establishes the goal of Technology Roadmapping, highlighting the scope of the research and the goals to be met by the sugar and ethanol industry. It presents the current status of the industry through the description of its products and services, customers, suppliers and processes. The chapter also indicates market trends that will require adaptations in current processes in order to comply with their respective demands and provides a list of the main limiting factors (e.g. regulatory, stakeholders, budget etc), to establish a long-term vision. Chapters 3 to 6 deal with each of the four components of the Technology Roadmapping – Genetic Improvement, Management, Hydrolysis, and Thermoconversion – presenting a description of these components. Finally, policy options are summarized in the final chapter of this book.