João Furtado; Vanderléia Radaelli. "SUPPORT INSTRUMENTS FOR R&D ON ETHANOL", p.73-86. In Luis Augusto Barbosa Cortez (Coord.). **Sugarcane bioethanol — R&D for Productivity and Sustainability**, São Paulo: Editora Edgard Blücher, 2014.
http://dx.doi.org/10.5151/BlucherOA-Sugarcane-SUGARCANEBIOETHANOL_11

9

SUPPORT INSTRUMENTS FOR R&D ON ETHANOL

João Furtado and *Vanderléia Radaelli*

INTRODUCTION

Brazilian alcohol, recently renamed ethanol, is typically a Brazilian development, though hardly recognizable as such. The Brazilians' self-image comprises being erratic, often discontinuity-prone, incapable of persevering to achieve long-range goals. Ethanol, along with such diverse cases as coffee and aircrafts, shows us precisely the opposite: conceived as one of the drivers in the national response to the oil price crisis in the 1970s (together with the nuclear power program and the shift of oil exploitation strategy by Petrobras for a new scenario), the program persisted, painstakingly, for over three decades, having even endured times when oil prices justified its immediate phasing out.

The fundamental reason for the Brazilian success in producing ethanol originates directly from this persistence. The path of the Brazilian ethanol can hardly be attributed to any specific event, capable of determining its currently notorious success. It is essentially the outcome of the accumulation of multiple scattered advantages, usually incremental and cumulative, gained on each step during three consecutive decades.[1] The most remarkable fact along this winning journey is precisely the inexistence of any specific milestone.

The recent growth path seems to be an extension of this logic, which was hitherto so successful. However, would it be adequate for the current stage? Having been a victory in building a production capacity compatible with the Brazilian market, on an efficient basis, would the industry and its supply chain as a whole be capable of moving, in a safe and effective manner, into the forthcoming stage, to create an international market with guaranteed supply and production standards consistent with the practices required by the major countries with potential demand?

This chapter lists and analyzes the key instruments for fostering scientific and technological development of the Brazilian sugar-alcohol complex. The perspective adopted in this analysis uses exactly the aforementioned background: the political instruments aimed at fostering the scientific and technological development of this activity can be consistent for an incremental expansion path such as the one this industry took for the past 30 years, however can they be considered adequate to the ambitions Brazil seems to exhibit in the international scenario of renewable energy, in connection with biomass production?

INSTRUMENTS TO FOSTER RESEARCH AND DEVELOPMENT

Nowadays there is a well-established consensus regarding the existence, in Brazil, of a numerous, diversified, and rich set of instruments and a relatively abundant volume of resources to stimulate the technological development and promote innovative projects. Since the mid-1990s, Brazil has made efforts to promote research and

[1] On this matter, see the paper: Comissão especial de bioenergia do Estado de São Paulo, coordinated by José Goldenberg, on *Desenvolvimento da cadeia produtiva industrial para biocombustíveis*.

development activities – corporate R&D. Taking into account the Brazilian economy's structural shortcomings and the restrictions associated to the macroeconomic scenario, companies were able to find a more varied repository of instruments, adapted to various purposes. Recently, after an initial period of severe restraint on the constitutionally allocated funds for technological development, the Ministry of Science and Technology and the Research Studies and Projects Funding Agency (Financiadora de Estudos e Projetos – Finep), had their budgets strengthened, and began to operate on significantly larger budgets.

Some enlargement of the institutions involved in this endeavor also seems to be taking place. In BNDES, after an initial attempt during President Lula's first term, with the creation (but not the operation) of the Technology Fund (Fundo de Tecnologia – Funtec) and the facilities for fostering innovation (Research, Development & Innovation; and Innovation – Production), the bank's new management seems to have given a different weight to this initiative, as expressed – among other actions – by multiplying the budget of the Technology Fund by a factor of three. The financial effort to foster technological development made by these two federal agencies still awaits a similar move by the two other federal banks: Banco do Brasil (which seems to be taking its first steps) and Caixa Econômica Federal (without any evidence so far). Along what has been traditionally practiced by developed countries, it seems that Brazil today has a clearly drawn regulatory milestone for supporting innovation, with various instruments. Being relatively new, many of these are not yet regularly used by Brazilian companies. However it has not always been so.

Instruments to foster research and development – historical background

The instruments in effect during the 1980s were basically focused on supporting engineering projects, implementation of quality control, and acquisition of foreign know-how. Support mechanisms were centered in financing one or another possibility for reducing monetary escalation. On the other hand, the 1990s featured the process whereby many industries witnessed the shrinkage of some governmental R&D structures, a few rather consolidated, others still incipient[2].

Medium and large-sized companies have access to an important array of incentives supporting innovation. To make it simpler to understand, the major financial mechanisms are split between tax incentives and conventional financing. In this work, the technical mechanisms, so important and that reveal themselves so frail when companies open up as institutions connected to certification, metrology, quality, standardization, intellectual property, calibration and gauging labs, will not be covered. The importance of such technical devices is not commonplace; on the contrary, it is in the competitive edge of companies that begin to embody the innovation and continuous learning culture.

The launch, in 1993, of the Industrial or Agricultural Technology Development Programs (Programa de Desenvolvimento Tecnológico e Industrial – PDTI; Programa de Desenvolvimento Tecnológico Agropecuário – PDTA)[3], which granted tax incentives to companies having technological innovation, underscores the acknowledgment that the organizational restructuring wave, mostly based on control and quality promotion activities, would not suffice to compete in the international market, in an open competition scenario.

In the transition from a R&D model associated to large state-owned companies to a prevalence of private companies, the government established an array of Industry Funds, inspired on the Oil Fund created in 1998 (by the ministers, then in office, Raimundo Brito and José Israel Vargas, on 12/01/1998). It was from the *Oil Fund* model that

[2] ERBER, F. S.; AMARAL, L. U. Os centros de pesquisa das empresas estatais: um estudo de três casos. In: SCHWARTZMAN, S. (Ed.). **Ciência e tecnologia no Brasil, política industrial, mercado de trabalho e instituições de apoio**. Available at: <http://www.schwartzman.org.br/simon/scipol/summ2.htm>.

[3] Tax incentives prescribed by PDTI and PDTA were ruled out since 2006, with the migration to the regime set forth by Law n. 11 196.

several other *Industry Funds* were created in 1999, setting an important stage in consolidating the instruments for supporting innovation[4].

At the same time the discussion on Law n. 10 973 would begin, though it had a slow cruise through the Legislative system and, at the outset of President Lula's term, was neglected for almost two years, until it was finally passed in December 2004 (Law n. 10 973 of December 02, 2004). Later, though not without some legislative uneasiness Law n. 11 196 of November 21, 2005 was passed.

Instruments to foster research and development – elements from International experience

The experience with OECD countries shows that tax incentives to foster innovation are more important and effective than financial incentives to stimulate private investments in R&D. In most of these countries there is a perception that market incentives are insufficient to generate an adequate volume of investments in innovation.[5] By reducing R&D costs, tax incentives allow to raise the current value of the research at the same time that they allow allocating such investments to different industries, companies, and projects.[6] Generally, the leading actions connected to tax incentives involve reducing the Income Tax as a result of investments made in R&D. Most recent data indicate that 20 member countries grant tax incentives for R&D. In 1995, only 12 countries practiced this kind of incentive.[7] In 2005, waived taxes in some OECD countries were: US$ 5 billion in the US; US$ 2 billion in Canada; US$ 1 billion in both France and UK and between US$ 300 and 400 million in Mexico, Australia, Belgium and Spain.

TAX INCENTIVES

Law n. 11 196 of November 21, 2005 brought some important advances regarding the instruments for promotion and development.[8] The most important among them is the automatic application of tax incentives, which highlights a very significant difference from the previous devices, which depended on prior approval by the Ministry of Science and Technology, and associated, as seen by their users, to the technical difficulty of assessment, bureaucracy, slowness, and, at least in the times required by companies, subject to market requirements. In the time elapsed from the application to the approval, companies often alleged having given up on continuing with the project. In the system introduced by the new legal instruments, the company selects the project, and posts its investments (expenses) to a specific account. Afterwards, all it has to do is to send an annual report to the Ministry of Science and Technology, which on its turn will send the pertinent documents to the Federal Revenue, for auditing purposes.

Chapter III of Law n. 11 196, in its articles 17 through 26, sets the incentives granted to companies investing in technological innovation. The concept of technical innovation is quite broad: "the conception of a new product or manufacturing process, as well as adding new functions or features to the product or process that cause incremental improvements and an actual gain in quality or productivity, *resulting in more competitiveness*

---

[4] List of industry funds: Aeronautics, Agriculture, Amazônia, Waterways; Biotechnology, Energy power, Spatial, Hydro, Computer Science, Mineral, Health, Transport, Petroleum; Infrastructure, Funttel, Yellow Green Fund, each one with their own sources for financing.

[5] NELSON, R. The economics of invention: a survey of the literature. **Journal of Business**, University of Chicago Press, vol. 32, p. 101, 1959; ARROW K. J. The economic implications of learning by doing, **Review of Economics Studies**, n. 29, p. 155-73, 1962.

[6] ROSENBERG, N. Why do firms do basic research (with their own money)? **Research Policy 19** (2) p. 165-174, 1990.

[7] OECD SCIENCE. Technology and Industry Scoreboard, 2007.

[8] Law n. 11 196 was regulated by Decree n. 5 798/2006 and amended by Law n. 11 487 of June 15, 2007 by including article 19-A (known as the Rouanet Law of Innovation). This additional article covers financing by companies of research projects in Scientific and Technology Institutions (Instituições Científicas e Tecnológicas – ICTs) (as defined by Law n. 10 973/2004) previously approved by a permanent Committee (Ministry of Education and Culture – MEC, Ministry of Science and Technology, and Ministry of Development, Industry and Foreign Trade). ICT research projects have to be submitted to MEC for approval, by public call.

in the market". The major tax benefits set forth by this law are:

- exclusion, from the net profit and the Social Contribution over Net Profit (Contribuição Social sobre Lucro Líquido – CSLL) calculation basis, of the amount corresponding to up to 60% of the total disbursements classified as operational expenses by the Corporate Income Tax (Imposto sobre a Renda da Pessoa Jurídica – IRPJ) legislation, effected with R&D in the period;
- this exclusion may reach 80% if there is an increase in the number of researchers dedicated to research and development;
- if a *patent* or *a plant varieties registration* is granted[9], this percentage may be increased by 20%;
- therefore, the incentive may reach a 200% deduction (100% of expenses + 60% for the incentive to R&D + 20% for the increase in the number of researchers + 20% for the patent or plant varieties registration granted);
- reduction of 50% on the excise tax (tax over industrialized products) owed in purchasing machinery, equipment, or instruments for R&D;
- accelerated devaluation and amortization of equipment and intangible goods, respectively, for R&D;
- credit of 20% (until 12/31/2008) of the Income Tax withheld at the source levied on money sent abroad to pay royalties, technical support or specialized services used in R&D;
- Income Tax rate reduced to zero on money transfers abroad made with the purpose of registering and preserving brands, patents and plant varieties.

Data released by the Ministry of Science and Technology referring to the year 2006 show that 130 companies used tax incentives to technological innovation relative to Law n. 11 196. The Brazilian government waived R$ 229 million in taxes upon computing all tax incentives from Law n. 11 196, compared to R$ 1.44 billion in investments by companies. There are not yet estimates available on future gains in production, income, and tax collection associated to these tax incentives.[10] Expectations are that tax waivers will increase in the next few years as a result of changes in corporate strategies and increased knowledge by the companies on the implementation of Law n. 11 196, which unfortunately is as of today surrounded by legal uncertainties.

Among the OECD member countries, some important differences are found, and these apply to the Brazilian case. In the Netherlands and Canada, for example, tax incentives have been preferentially directed to smaller than large companies. Spain, Mexico, China, and Portugal grant incentives regardless of company size. In Brazil, only those companies that choose to pay taxes on actual profits may benefit from the tax incentives prescribed by Law n. 11 196. This implies in an additional effort to adapt the instruments existing in smaller companies, e.g., attaching such benefits to state taxes or social charges.

FINANCIAL INSTRUMENTS

The major federal agencies in terms of financial incentives, especially refundable loans, are Finep and BNDES. At state level, Fapesp, Fapemig, Fapesb and Fapitec have been on the rise.

Finep is a federal public company under the Ministry of Science and Technology, created in 1967.[11] Its mission is to promote and finance sci-

[9] A plant variety registration is understood as that plant subtype with specific features, originated from research. It is a cultivated plant variety, developed by means of systematic research and selection efforts, and not the original type found in nature.

[10] The recently finished survey by the Study Group on the Organization of Research and Innovation (Grupo de Estudos sobre Organização da Pesquisa e da Inovação – Geopi), on the incentive programs for technology innovation of Fapesp (Pipe) shows very favorable results, considering the extremely embryonic characteristics of most of the companies supported.

[11] FERRARI, F. A. O Fundo Nacional de Desenvolvimento Científico e Tecnológico – FNCT e a Financiadora de Estudos e Projetos – Finep. Revista Brasileira de Inovação, v. 1, n. 1, p. 151-187, 2002.

entific and technological research and innovation in companies, universities, research centers, and other public institutions and private organizations, *mobilizing funds and integrating instruments for the economic and social development of the country*.

Finep's action unfolds into two main fronts: 1) Scientific and technological research Fostering Agency; and 2) Technology development and innovation Fostering Bank. The first focuses on ICTs, with non-refundable resources. The second has a wide array of programs, with various instruments: refundable resources – loans, and non-refundable resources, as economic subsidies, partnerships with ICTs, and other instruments, and investments as venture capital.

Each one of these instruments is described below, as per their official characterization.

Refundable credit facilities

They comprise credit granted to institutions that demonstrate payment capability and conditions to develop RD&I projects. The grace and amortization periods, as well as interest rates and other charges, vary according to the features, the loan type, the project and the borrowing institution. Refundable credit types are the following:

a. Pro-innovation: loan at reduced interest rates for research, development, and innovation of goods, services or for technology empowerment of Brazilian companies. The loans of this type are made with financial charges that depend on the project characteristics. The focus of this program is on innovation in a product, process, or service that contributes to improving the organization's competitiveness.

   The Pro-Innovation is a loan with reduced charges for research, development and innovation projects involving a minimum amount of R$ 1 million, carried out by Brazilian companies with revenue above R$ 10.5 million. The program offers loans for undertaking RD&I projects with long-range interest rates, deducted in 5% and longer terms (up to 120 months):

   - to increase the company's competitiveness, within the scope of the present industrial policy;
   - that increase the R&D activities in the country;
   - having regional relevance or that are included in local production arrangements, covered by programs of the Ministry of Science and Technology;
   - that result in higher technology density and dynamic production chains;
   - that are developed in partnership with universities, research institutions, and/or other companies;
   - that consider the creation or expansion, in at least 10%, of the R&D teams, hiring graduate (MSc or PhD) researchers.

b. Zero interest: type of loan that prioritizes the speed of the instrument, with reduced bureaucracy, to support projects developed by small and/or micro innovative companies, within their scope, in their business, process or products/services aspects. The Program works as a cooperation between Finep and its statewide partners, specific for micro and small innovative companies, having been already implemented in five states (Bahia, Minas Gerais, Pernambuco, Paraná and Santa Catarina).
   - loan amount from R$ 100,000 to R$ 900,000;
   - simplified form, using digital signature up to the execution;
   - online processing;
   - waives collaterals;
   - payment in 100 monthly installments, without any actual interest (only IPCA escalation).

Non-refundable facilities: economic grant[12]

This type of support to innovation is widely used in most developed countries, being deemed

[12] The economic subvention considers four types: national calls to companies; with state partners, usually foundations that support research, hiring researchers; and Prime (first company) is under implementation.

compatible with the World Trade Organization rules (it is not treated as a subsidy; hence it is not actionable in international courts). It began to be used in Brazil with Law n. 10 973 of December 2, 2004 and it allows applying public funds directly on companies, as a way to share the risks associated to innovation activities or yet to subsidize 40% to 60% of company researchers' salaries.

So far, three public calls were made for innovation in companies. The last one, launched together with the government's new industrial policy, allocates resources around R$ 450 million in six areas chosen by the policy (at least 40% of them will be directed to small companies), among them bioenergy: information and communication technology, biotechnology, health, strategic programs, energy and social development. In the bioenergy area, no less than 157 projects competed.[13]

Other instruments: Research in Companies Support Program (Programa de Apoio à Pesquisa em Empresas – Pappe)

An initiative of the Ministry of Science and Technology, Pappe is a partnership between Finep and the state research support foundations. The program finances R&D activities for innovative products and processes undertaken by researchers who work directly or in cooperation with technology-based companies. The program provides direct support to the researcher, associated to an existing company or a company being created, so that the research project may be funded to result in the development of a new product or process. Recently, Finep renewed a partnership with Fapesp to finance the so-called phase 3 of emerging technology-based companies, that now allows to associate the typical support to technological development (phases 1 and 2) with the support to production and marketing development (phase 3).

Non-refundable facilities: partnerships with ICTs

Finep operates this type in scientific and technological institutions for carrying out research, technological development, and/or company-interest projects.

Investment: venture capital

Finep, through the project named *Inovar*, provides incentives to the entrepreneurial capital for the development of small and medium technology-based companies by means of the venture capital instrument as a mechanism to stimulate technological innovation.

All these loans, in their different types, are applicable – though not exclusive – to the bioenergy area, including ethanol.

BNDES also has presently several instruments to financially support innovation: "a former federal agency created by Law n. 1 268 of June 20, 1952, was classified as a federal public company, with legal status under private law and its own assets, by Law n. 5 662 of June 21, 1971. BNDES is an agency under the Ministry of Development, Industry and Foreign Trade, whose objective is to support enterprises that contribute to the development of the country". Over its path, it has already changed its priorities several times, in accordance to governmental guidelines. It was the bank of the power-transportation binomial, which in good part was the reason for its creation and of the industry that included in its actions the agriculture and export issues (in the 1980s-1990s). It played a prominent role as the financial agent for privatizations (1990s), and – very recently – incorporated the theme of technological development and innovation, after a long period of absence.[14]

The BNDES facilities for technological development and innovation comprise four main programs: innovation capital, innovation, seed capital, and, in a non-refundable scheme, a technology fund – Funtec.

[13] From the three facilities that made up the call on energy, two referred to bioenergy: palmatias and physic nut, with 59 projects and a total demand of R$ 212,879,187.75; and stillage and ethanol, with 86 projects and a total demand of R$ 337,658,009.85. Source: Finep – Financiadora de Estudos e Projetos.

[14] Throughout its long history, BNDES cared for the science and technology theme more actively in the 1970s, when it helped to sponsor some important experiments in implementing and consolidating graduate study programs. Available at: <www.finep.gov.br>.

Innovation capital[15]

The innovation capital is aimed at financing companies in terms of implementation and consolidation of their efforts in technological development and innovation. One of the problems in this type of financing facility involves drawing the separation line between technological development and routine engineering, which typically exists in many large companies, including those that periodically renew their technical features and the design and style of their products.

Technological innovation[16]

This is the redesigned version of a previously existing facility, with several important advantages regarding payment terms and conditions. Possibly, the only adverse condition involved in this redesign is the uncertainty regarding the required collateral: experience has shown that the expression at BNDES' discretion nearly always causes to require them. In case of more modestly-sized companies, unable to access BNDES' facilities directly (they have to go through financial agents, paying a double bank spread), this may mean a restricted access to public credit. This disadvantage for smaller companies is added to the restriction (mentioned on the item of Law n. 11 196) that these companies face in terms of tax benefits.

Technology fund – Funtec[17]

BNDES's Technology Fund has existed, by statute, in the BNDES for a long time, however it remained nonfunctional for a considerable period of time. It was reactivated during C. Lessa's term at the bank, however it remained devoid of relevant agreements during this and the two successive terms (Guido Mantega and Demian Fiocca) until very recently, when its resources were multiplied (by 3), and it became functional (L. Coutinho's term). The Technology Fund uses a part of BNDES' profit (which would otherwise be transferred to the Treasury) to grant non-refundable loans for scientific-technological activities. It will manage resources comprising a few hundred million reais yearly, aimed to the established priorities approved by the bank senior management. The priority facilities currently in effect[18] are: renewable energy, health, and **pollutants emission**.

Criatec Program[19]

BNDES' capital-only program is aimed at providing financial support, with capital transfer to newborn companies, deemed innovative by the bank. In most cases, small innovative companies would have great difficulties to fulfill the financial requirements of any financial institution, even a publicly-owned one, and they would hardly honor the financial commitments associated with any traditional loan. For this reason, the capital transfer (seed) is the type recommended for this initial stage of corporate development, mostly when it is associated to innovation. One of the features of the program is its operation by third parties, selected by BNDES.

The Foundation for Supporting Research of the São Paulo State (Fundação de Apoio à Pesquisa do Estado de São Paulo – Fapesp) finances scientific and technological development in the São Paulo state actually since 1962. The São Paulo state Constitution of 1947 determined, in its article 123, that "support to scientific research shall be sponsored by the State, through a Foundation, organized as to be prescribed by law", and added, in a sole paragraph, that "every year the State will endow this foundation, as income for its private management, an amount not lesser than one-half per cent of its ordinary revenue". In the State Constitution of 1989, art. 271 determined an increase to that percentage: "The State shall endow at least

[15] Available at: <http://www.bndes.gov.br/inovacao/linhas_inovacao.asp#capital>.

[16] Available at: <http://www.bndes.gov.br/inovacao/linhas_inovacao.asp#capital>.

[17] Available at: <http://www.bndes.gov.br/programas/outros/funtec.asp>.

[18] Facilities also included, though not being limited to: software, semiconductors, biotechnological solutions for developing Brazilian agriculture.

[19] Available at: < http://www.bndes.gov.br/programas/outros/criatec.asp>.

TABLE 1 BNDES – Funding instruments for innovation.

	Innovation capital	Funtec	Technological innovation	Criatec
Purpose	To support innovative efforts in line with company strategies and included in the Innovation Investment Plans (Plano de Investimento em Inovação – PII), including physical infrastructure and both tangible and intangible assets (comprising support to incubators and technology parks).	To financially support projects aimed at stimulating technology development and innovation with strategic interest to the country, in accordance with Federal Government Public Plans and Policies.	To support research and development projects, with technological risk and market opportunities, comprising the development of new products and/or processes (at least for the domestic market), or significantly improved ones.	To capitalize innovative small and micro companies with seed capital and provide them with adequate managerial support.
Minimum and maximum amounts	R$ 1 million and R$ 200 million.	Defined on a case-by-case basis.	Minimum amount: R$ 1 million.	Maximum amount: 1.5 million in companies with net revenue up to R$ 6 million.
Interest rate	Long-range interest rate (Taxa de Juro de Longo Prazo – TJLP) + basic BNDES remuneration + credit risk fee.	Non-refundable type.	4.5% per year.	
Term	Up to 12 years.		Up to 14 years.	10 years.
Level of participation in financed items	• Small, micro and medium sized entrepreneurs: Up to 100%. • Large companies: Up to 80%.	Limited to 90% of the total project value.	Up to 100%.	
Collaterals			Defined in the operation analysis.	

Source: BNDES, summary by authors.

one percent of its levied taxes to the Foundation for Supporting Research of the São Paulo State, as income for its private management, to be applied in scientific and technology development", and the sole paragraph of this same article determined, when the inflation rate was still very high, that "the endowment set in this article, deducted from the amount to be transferred to municipalities, in accordance to art. 158, IV, of the Federal Constitution, will be transferred monthly, the percentage being calculated on the collection month, and paid on the next month."

The certainty of sizeable and regular resources allowed Fapesp to develop effective programs to support scientific and technological research since its foundation, in 1962. The 1989 Constitution increased significantly these resources, and allowed Fapesp to launch a series of new support programs for scientific and technological research. So, sidetracking the regular programs for supporting scientific and technological research, for researchers with projects developed in the São Paulo state, Fapesp began to support also research developed in companies, either emerging or simply

small (less than 100 employees), by means of the Innovative Research in Small and Micro Companies Program (Pesquisa Inovativa em Pequenas Empresas – Pipe); and in companies of any size, through the Support Program for Research in Partnership for Technological Innovation (Programa de Apoio à Pesquisa em Parceria para Inovação Tecnológica – Pite).

"The Pipe program exists since 1997, and is intended to support the development of innovative research, to be carried out in small companies headquartered in the São Paulo state, on important issues in science and technology that have a high potential of commercial or social return. Projects may be developed either by researchers employed by the small companies or associated with them for the project. The program offers companies located in the São Paulo state access to non-refundable resources for developing technology research projects. This program is based on experiments developed in other countries, and supports research for up to 30 months, with resources that may reach R$ 625,000, being up to R$ 125 thousand for an initial stage (six months), corresponding to the demonstration of the concept, and R$ 500,000 in a second stage (24 months) for achieving the actual objectives. Companies in any industry may submit their projects to the PIPE program, as there is no specific scope or exclusion. The merit of the proposal is the key element for analysis, however the consistency of the person in charge of the research and the company perspectives are also considered in the assessment.

"The Support Program for Research in Partnership for Technological Innovation (PITE) is intended to finance research projects in academic institutions or research institutes, developed in cooperation with researchers in the research centers of companies established in Brazil or abroad and co-financed by them. This Program aims to strengthen the relationship between universities/research institutes and companies, by the execution of cooperative and co-financed research projects. If the research project development is carried out in a cooperative manner, it is expected that its results will contribute to developing knowledge, or technological innovations of interest to the partner company, in addition to contributing to promote knowledge, and the development of highly qualified human resources. Partner companies have necessarily to contribute to financing the research project with some consideration of their own or third-party resources."

Differently from Pipe, Pite requires something in exchange from the companies, an amount that usually represents 50%. In case of more exploratory projects, therefore involving a higher risk, Fapesp's share may exceed 50%; and in case of more secure projects, it may be lower.

SPECIFIC PROGRAMS

In addition to general programs to support R&D and Innovation, there are specific programs aimed at the bioenergy industry development in Brazil.

Fapesp has recently launched a program dedicated to bioenergy: Bioen. Fapesp's Bioenergy Research Program (Programa de Pesquisa em Bioenergia – Bioen) "aims at stimulating and articulating research and development activities using both academic and industrial laboratories to further knowledge and its application in areas related to the production of bioenergy in Brazil". The program is structured in five "divisions": a) Biomass for bioenergy (focused on sugarcane); b) biofuels manufacturing process; c) biorefineries and alcohol chemistry; d) ethanol applications in automotive engines: internal combustion engines and fuel cells; e) research on socioeconomic, environmental, and land usage impacts. As stated by Fapesp, "it is expected that exploratory activities may generate new knowledge and develop highly qualified human resources, which are essential to improve the industry's capacity in ethanol-oriented technologies, and increase its internal and external competitiveness".

- Bioen includes academic research and, when appropriate, establishes partnerships for the development of cooperative research activities between universities and research institutes in the São Paulo state and companies, sharing human, material, and financial resources.

- In these partnerships, the specific details of the themes of interest are specified according to the interest of the private partner and the Fapesp commitment to foster research in the São Paulo state.
- Other agencies, both from the Federal Government and from other states, were invited to participate in the Bioen-Fapesp. The Ministry of Science and Technology, through the CNPq, and Fapemig have already expressed their interest in participating, and other agencies are analyzing their commitment with Bioen.

Embrapa Agro-energy

Embrapa Agroenergia was created in 2006 with the purpose of finding technology solutions for developing agro-energy in Brazil. This Embrapa unit now has 5 platforms of research, development and innovation: fuel alcohol, biodiesel, biogas, power forests and agricultural and forest wastes. The center will develop research with sugarcane, cassava, oilseeds that may be added to biodiesel and other alternative energy sources. The creation of this technology center cost around R$ 10 million. The transfer in 2007 was R$ 50 million. In addition to managing the research carried out by Embrapa, the Agroenergia will also have pilot plants capable of sealing-up laboratory experiments. This will enable the development of additional competencies, in addition to further investigation of the possibilities in partnerships with companies and external institutes. This initiative of Embrapa is an integral part of the National Agro-energy Plan of the Ministry of Agriculture for the 2006-2011 period.

Bioethanol Science and Technology Center (Laboratório Nacional de Ciência e Tecnologia do Bioetanol – CTBE): The federal center was inaugurated in Campinas in early 2008, and will initially be a department of the National Synchrotron Light Laboratory (Laboratório Nacional de Luz Síncrotron – LNLS). The project considers that 150-200 researchers will work at the Center, which will focus its research on enzymatic hydrolysis for producing ethanol from bagasse and trash, in addition to research on low soil impact mechanization techniques to reduce costs associated to planting and harvesting.

Petrobras Bioethanol Project

The project launched in 2007 consists of the first bioethanol pilot plant in the country. The unit was developed by Petrobras' Research and Development Center (Centro de Pesquisas e Desenvolvimento Leopoldo Américo Miguez de Mello – Cenpes) and produces ethanol from sugarcane bagasse or castor bean cake. This is the first project of the company in second generation fuel, produced from agroindustrial waste, which does not compete with the agricultural production of food. The plant is capable of producing 220 liters of ethanol per ton of sugarcane bagasse, the objective being to reach 280 liters soon. Petrobras has already announced its intention to build, in 2010, a semi-industrial ethanol plant. To reaffirm the entrance of Petrobras in ethanol, a partnership was recently announced, with the objective of leveraging the foreign market with the Japanese Mitsui, for the production of 200 million liters of ethanol per year in Goiás. There are other partnerships for the production in the Mato Grosso state.

International comparison elements

In 2005, the US government passed the Energy Policy Act 2005[20], which appears as the first initiative since the previous legislature, from 1992, to list a series of initiatives in the energy area. The decree includes the support to research and production involving ethanol.

Other initiatives have come up in various countries, either having as line of action the efforts to fulfill internal energy shortcomings, or to promote concrete actions in policies for science, technology and innovation in these areas. In the various experiments and with different agents, at least two features highlight this scope: public policies are supported in mission-oriented organizations, focusing on great breakthroughs.

Some examples of dedicated programs:

[20] Available at: <http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_bills&docid=f:h6enr.txt.pdf>.

a. National Renewable Energy Laboratory – NREL

The National Renewable Energy Laboratory, which since 1977 has been carrying out research in its field, has its US$ 1.3 billion budget increasing at a rate of about 6% per year. NLRE is the leading laboratory of the Department of Energy in the US, and it has been making several partnerships with the private sector, with the objective of producing ethanol from sources that do not compete with the production of food. DuPont and Genencor, for instance, have signed up a partnership with NREL, with an initial investment that will exceed US$ 140 million. By 2009, a pilot plant will be able to present the technology used and by 2012 production will move into industrial scale.

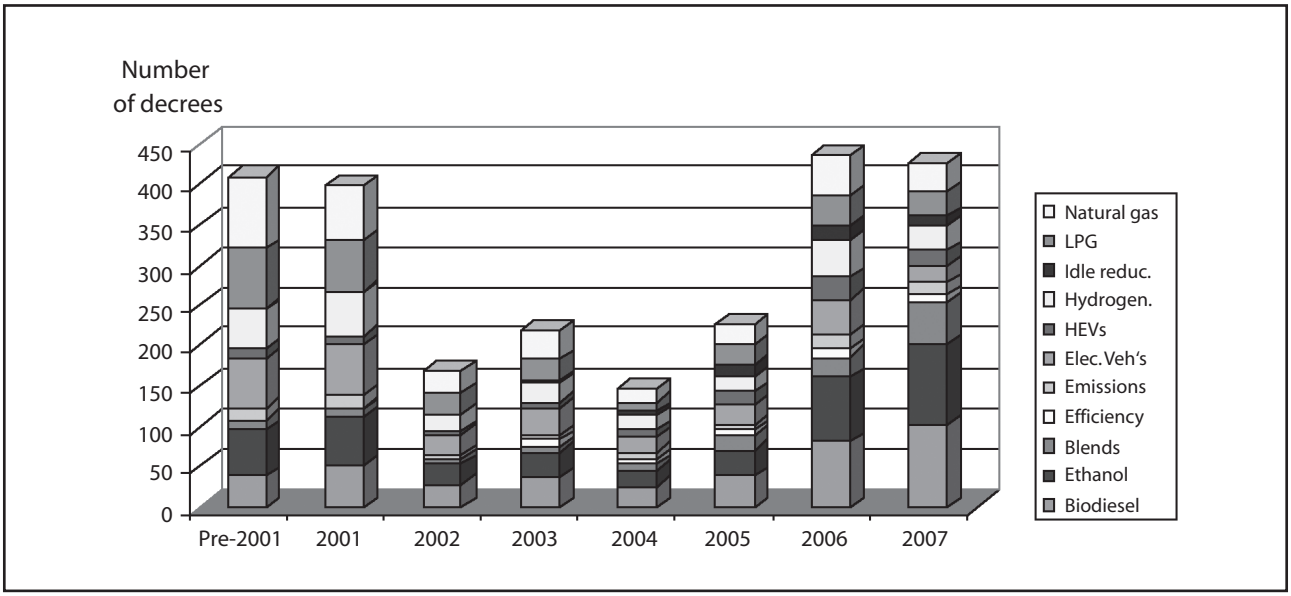
The activities performed by the Laboratory are in line with a series of incentives and provisions to increment renewable energy sources in the US. The graph below illustrates this incentive, quite expressive in terms of ethanol and biomass. In 2007, no less than 200 decrees involving ethanol and biomass were implemented in the US.

b. Biomass — Multi-Year Program Plan of the US Department of Energy

It comprises the actions that will guide the national policy for producing ethanol from cellulose. Last year's budget was US$ 1 billion, and it involved hundreds of projects led by companies, universities and public research laboratories under the Department of Energy.

c. Arpa – E – Advanced Research Projects Agency – Energy

This agency, under to the US Department of Energy, was created in 2007, using the pattern from the already consolidated Defense Agency (Darpa – *Defense Advanced Research Projects Agency*) to support the research projects connected to the development of technology capable of reducing energy imports by 20% over the next 10 years, gaseous emissions and increasing energy efficiency in several industries. The objective of this agency is to convert the advances in science towards technology solutions for the industries involved in energy. For the year 2008, the approved budget for the agency is US$ 300 million, and for 2009 it is "as much as needed". Since its inception, the agency has over 180 highly qualified and highly paid employees. To maintain a strong focus on the research projects and motivation, employees may not remain more than four years at Arpa-E. For managers, the limit is six years.



GRAPH 1 Laws of incentives by type of technology.

d. ecoENERGY

In July 2007, the Canadian government announced the most concrete initiative in biofuels in that country, involving a budget of US$ 1.5 billion, to be invested over 9 years. The program named ecoENERGY brings a whole array of incentives to involve in research companies interested in generating alternative energies in the country. One of the approved actions is that all gasoline sold in the country should contain an average of 5% of renewable energy by 2010. The country also has a program named ecoAgriculture Biofuels Capital, with a budget of US$ 200 million to be invested in companies that want to expand or build new biofuel producing plants.

e. European Bioethanol Fuel Association (eBIO)

The European ethanol association was created in 2005 and represents about 80% of the ethanol produced in that region. The theme is relatively recent in Europe, though most countries have already created programs for supporting the production on ethanol. France and Germany are the countries with the largest investments in plants and pilot plants. The goal of the European Union is to reduce its dependence on the international market, and make biofuels account for 6% of the fuels used in transportation by 2010, and for 10% in 2020.

Data from Global Subsidies Initiative show that there are 191 units processing alcohol and biodiesel being built in Europe and that by the end of 2008 their number should be 342. A considerable part of this thrust is strongly influenced by the subsidies policy.[21]

ASSESSMENT INSTRUMENTS

Will the political instruments intended to foster scientifically and technologically this activity be consistent to sustain and drive a globally expansive path, as it seems to be drawn from a convergence of economic and environmental circumstances?

[21] Available at: <www.globalsubsidies.org>.

FINAL CONSIDERATIONS

The wide array of existing instruments to foster the scientific and technological development of the fuel alcohol chain, unquestionably varied, constitutes a valuable tool for continuing the successful path taken by alcohol and bioenergy in Brazil. However, is it sufficient to face the challenge Brazil has ahead: to secure a solid position – maybe the leadership – in the global biofuels setting?

The current leadership was built from a path where gradualism and accrual lived together for a long period of time. Gains in yield per hectare were added to gains in saccharose content in the sugarcane, which were taken with the logistic gains to the mills, where the recovery indexes on juice, fermentation, distillation were improved... individual incremental gains, accrued one on each other, multiplied the production over three decades. The merit of this perseverance should not be ignored, despised nor underestimated.

Nevertheless, will this merit, hitherto so essential, suffice for the next phase? This new phase is defined by the perception widespread among a considerable number of countries, mostly those that have been leading the world's scientific and technological development and have occupied prominent positions in the economy, that there is an unavoidable need to shift into a new energy and environmental standard. There are objectives relatively well defined, and every country – or region, in the case of Europe – is seeking solutions that are adequate for their available resources, and their possibilities of using and developing them. In many cases, seeking these objectives is equivalent to a clearly defined mission, a mission similar to others when national security was challenged. The best example of these close akin concepts and policies is in the US, which created, for the energy field, a similar program, even in the name, to what rules the development of solutions for what is called *defense* or *national security*".

The protectionism that hovers over the field of biotechnologies and the international biofuel trade also reinforces the perception that developed countries, many of them having awakened dramatically late for the double problem of the possible

exhaustion of fossil fuels and environmental endangerment, must withdraw – at least temporarily – from the liberal commercial flow while they gain time building their own solutions and renewable energy matrices. Were it not so, how could one explain that a renewable and clean replacement for petroleum, like ethanol, would be subject to trade restrictions that petroleum – pollutant and not renewable – never faced? Intensive, dedicated and coordinated programs by major countries and regions precede and prepare the solutions that may create local production bases for the energy and environmental issue.

The Brazilian advantage is, so far, important but insufficient. If computed exclusively by economic cost elements, it would be overwhelming, as shown by various studies, among them some chapters of this book. As it happens, the bases on which these advantages are seated mingle – no matter how sparsely – with elements that the world – for either legitimate or spurious reasons – vehemently rejects. A second important weakness is associated to product availability, to establishing a voluminous, growing and secure flow, which may render feasible the eventual decision of introducing ethanol in the fuel matrices of different countries. Finally, there is the challenge of using sugarcane and its energy fully. Put together, these are the challenges that we will have to face, if we want to translate the leadership position into biomass production, *partially* associated to natural factors, in a corresponding position to the next *steps* of the biofuel chains, multiplying their volumes by the rational and sustainable use of large territories that only Brazil has available.

It is possible to argue that the existing institutional setup, in terms of organisms, instruments and resources, is sufficient for the undertaking or that at least it is not far below the needs. However, the same cannot be said about the efforts coordination devices, split into levels (state and federal) and sectors (different ministries, departments, and industry agencies). This seems to be the main challenge.