INTERNATIONAL INTELLECTUAL PROPERTY INSTITUTE

The Brazilian Energy Revolution

Lessons from the biofuel industry boom

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Introduction

Brazil is a leading developer of biofuels and a leading promoter of the increased use of flex-fuel automobiles. Not only are these decisions showing positive benefits in reducing carbon output for environmental health, but also Brazil has established itself as a technology exporter that brings positive economic benefits. This economic benefit relies on science and technology policy, research and development activity, as well as the need for intellectual property protection. The objective of this paper is to review the evident economic benefits of biofuels in Brazil and analyze the close relationship between technological development and intellectual property protection.

Biofuel development in Brazil is tightly associated with the objective for the country to become self-sufficient on this alternative energy source. By exploring the Brazilian biofuel development we will identify the main actors that make possible research and development in the country. Brazil has taken biofuel production from an idea to a tangible industry that has found protection in the public and private sectors of Brazil.

A combination of innovation policy, intellectual property and research and development is essential for the continued success of the biofuels industry. Success of this industry is important to placing Brazil in a position to become a global exporter of new biofuel and clean technology. Technology Transfer and intellectual property have been directing public policies to reach an economic development that has to be protected through IP enforcement; this is a clear example of how developing countries with robust IP systems can become key players in the world. The report will conclude with a discussion of how IP is essential to the protection of investment in innovation, and will explain how biofuel has impacted Brazil's economy.

In a November 2005 speech addressing the National Conference on Science Technology and innovation, Nobel laureate Allen MacDiarmid emphasized the need to produce and distribute renewable energy:

> The future of the world depends on renewable energies. Clean energy production results in water economy to the plantations, and with more water in plantations we can minimize the social and economic differences and violence.[1]

What is Biofuel?

Biofuels are made from biological materials: a renewable fuel that is derived from biological matter, e.g. biodiesel, biogas, and ethanol.

Ethanol is an alcohol-based, clean burning fuel produced from renewable feedstocks. It falls within the category of high-octane fuels, meaning it is highly efficient.

[1] The 3rd National Conference of Science, Technology and Innovation brought together more than 2 thousand scientists, businessmen and representatives of various ministries, in Brasilia, from November 16 to 18, 2005. http://www.revistapesquisa.fapesp.br/?art=1350&bd=1&pg=1&lg=en

The World's leading developers and researchers of biofuel technology, Brazil and the United States, have acknowledged the importance of an alternate fuel source, in this case ethanol. According to the (CTC) Copersucar Sugar Technology Center the development of this technology has to be multifaceted including identifying and researching appropriate raw materials (sugar cane thus far is considered the best source), studying agriculture and farming techniques, analyzing refining and manufacture processes including biorefineries, and understanding the economic, environmental and social effects.[2]

Regionally, the two nations intend to help third countries, beginning in Central America and the Caribbean, to stimulate private investment for local production and consumption of biofuels**.** [3]The United States and Brazil expect to undertake feasibility studies and technical assistance in partnership with the Inter-American Development Bank (IADB), The United Nations Foundation, and the Organization of the American States (OAS).[4]

Brazil produces two types of ethanol, anhydrous and hydrated. Anhydrous is absolute and water free, and is used as gasoline oxygenator in several countries, as well as an alternative to highly pollutant additives. Hydrated ethanol is used to power alcohol and flex fuel vehicles with a 4% water addition.[5]

Brazil started this process strengthening the local knowledge base, and focused in the domestic demand creating and building research facilities that could produce new innovations that eventually will lead to partnerships and make possible the transition to biofuels.

Ethanol is produced by extracting the starch, purifying, saccharifing, fermenting, distilling and dehydrating. This process is known as first generation ethanol production. Today new technology is being tested and used to what is called second generation of biofuels. The idea is to produce ethanol from cellulosic biomass materials found in plants. The importance of this process is that it allows more of a given crop to be used in the production of biofuels, maximizing output per hectare. They also maximize the need to plant additional feedstock at the expense of trees or to divert crops away from uses as food. If scientists can develop a firm understanding of the chemistry and biology of cellulose and of the microorganisms needed to break it down for processing, they will be able to unlock the great potential of biofuels as a viable, sustainable, alternative energy source.[6]

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[2] www.ctcanavieira.com.br

[3] On March 9, Secretary of State Condoleezza Rice and Brazilian Foreign Minister Celso Amorim signed a memorandum of understanding to advance cooperation on biofuels. The agreement highlights the importance of biofuels as a transformative force in the region to diversify energy supplies, bolster economic prosperity, advance sustainable development, and protect the environment. http://www.state.gov/r/pa/prs/ps/2007/mar/81589.htm

[4] *Ibid.*

[5] Biocombustibles. Isaias C. Maccedo e L.A Horta Nogueira.2005. Cadernos NAE.

[6] A Blue print for green energy in the Americas. Strategic Analysis of Opportunities for Brazil and the Hemisphere. Prepared for the IADB by Garten Rothkopf P. 36

Not all biofuels are the same. There are significant differences between first and second-generation biofuels – and between biofuels of the same generation. First-generation biofuels are made from food crop feedstocks while second-generation biofuels are made from agriculture and forestry waste, such as woodchips and straw. The manufacture and use of biofuels also vary in cost, performance and CO2 emissions.[7]

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Possible Raw Materials

The main sources of sugar required to produce ethanol come from fuel or energy crops. These crops are grown specifically for energy use and include corn, sugarcane and wheat crops, waste straw, willow and popular trees, sawdust, reed canary grass, cord grasses, jerusalem artichoke, myscanthus and sorghum plants. There is also ongoing research and development into the use of municipal solid wastes to produce ethanol fuel. Biodiesel is an alternative fuel similar to conventional or fossil diesel. Biodiesel can be produced from straight vegetable oil, animal oil/fats, tallow and waste cooking oil. [8]

Unlike corn, in which the starch in the kernel has to be broken down into sugars with expensive enzymes before it can be fermented, the entire sugarcane stalk is already twenty percent sugar, and it starts to ferment almost as soon as it's cut. Cane yields 600 to 800 gallons of ethanol per acre, more than twice as much as corn.[9]

Sugarcane is itself an enormously efficient production unit: every ton has an energy potential that is equivalent to 1.2 barrels of petroleum. Brazil is the largest world producer of sugar cane, followed by India and Australia. On average, 55% of Brazilian sugarcane is turned into alcohol and 45% into sugar. Sugarcane is grown in Brazil's

[7] http://www.shell.com
[8] http://www.esru.strath.ac.uk
[9] National Geographic Magazine. Joel K. Bourne, Jr. October 2007. p 48.

Central-South and North-Northeast regions, with two harvest periods. When planted for the first time, sugarcane takes between one year and eighteen months to be ready for harvesting and processing. This same plantation can be harvested up to five times, although significant investments must be made in each cycle to maintain productivity.[10]

The fact that the sugarcane crop is semi-perennial (a plant which lives for more than two growing seasons), with a five year cycle, indicates a natural expansion. It is therefore critical to secure markets for this growth and to plan faster development, which would be healthy and crucial for the Brazilian economy.[11]

Alternative fuels are not new to Brazil. The country has been innovating in harvesting methods with sugarcane for ethanol and vegetable oils for biodiesel since 1931.[12] Sugarcane and palm are not the only crops used in Brazil for biofuels, however: soy, sunflower, castor and macauba, a kind of palm tree, among others, are being produced for fuel generation as a response to the oil crisis in the 1970's. At that time, Brazil started searching for energy solutions in a wide variety of crops.

Intellectual Property: A Crucial Role for Innovation:

Brazil has been busy developing and refining their system of innovation. An innovation system is the laws and policies the effect domestic scientific research and innovation. Innovation systems set out to establish how resources are organized for the discovery, creation, development and economically productive application of new technologies. Components of an innovation system include a countries' government policy-making infrastructure, university and government laboratory system, tax laws, and intellectual property laws, among others.[13] This framework creates an environment where innovation can thrive.

The level of innovation within a country is influenced by many factors thereby creating an extremely dynamic system. Countries have devised a plethora of strategies to encourage innovation, and no two systems are identical. Ultimately, the goal of an innovation system is to spur technological innovation and ensure that the innovation makes its way into economic production being adopted and used by private firms.

Innovation is the result of research and development (R&D), and investment in R&D must occur in both the public as well as private realms. Sound innovation systems strike a balance between encouraging public innovation and private R&D by not relying too heavily on one over the other. For the system to optimally function, both sides must be allowed the flexibility to structure licensing and research agreements, and to freely share

[10] http://www.unica.com.br/i_pages/cana_origem.asp
[11] *Ibid.*
[12] February 20th 1931, the Brazilian government forced through decree no. 19717, the mixture of 5% of alcohol in the gasoline imported. Liquid Biofuels for Transportation in Brazil.
[13] Björn Johnson and Bengt-Åke Lundvall, "National Systems of Innovation and Economic Development," in Mammo Muchie, Perter Gammeltoft and Bengt-Åke Lundvall, *Putting Africa First, the Making of African Innovation Systems.* Aalborg University Press, Aalborg Denmark, 2003

technology and knowledge. Such public to private transfers of technology and knowledge are critical for taking an innovation or new technology and turning it into a marketable product.

Crucial for innovation is the interaction among various organizations and firms, often sharing knowledge, technology, facilities, and even researchers. Firms often cannot innovate alone; firms innovate in an interaction with customers, suppliers, other knowledge-oriented enterprises, universities, and sometimes even with competitors. This interaction between research organizations and private firms is important to the health of the overall "system" of innovation.

In order to use emerging technologies as a tool for economic development, developing countries must provide strong legal protection for innovations, and encourage the sharing of new technology for the purpose of commercialization. Strong intellectual property laws provide scientists and researchers with the incentive to engage in important developmental activities and partnership formation while ensuring the creativity that goes into innovation is not a wasted activity. Scientists and researchers can gain economic benefits by licensing their protected inventions and innovations or by developing and marketing their patented products on their own.

These partnerships are founded on economic trust built on strong laws, and clearly defined property rights. Upstream innovators are comfortable releasing investments to multiple parties when they can be sure that the commercial benefit of their contribution will be accordingly appropriated. All partnerships benefit from the same intellectual property infrastructure for technology transfer as the archetypal university-private industry partnership, namely an effective and transparent intellectual property rights system. They can ensure this commercial benefit through the acquisition of intellectual property tools, particularly patents.

Patents are the most powerful instruments of intellectual property with regard to technology transfer. Awarded in return for public disclosure, patents are temporary exclusivity rights granted to innovators. To qualify for a patent an invention must be novel, must make some claim of defined utility, and must involve an inventive step rendering the discovery "non-obvious." The patent instrument provides inventors with a means of exploiting their inventions for economic return for a period of 20 years.

The Brazilian biofuel-development story:

Interest has grown in the use of renewable energy sources. This idea has been driven by the desire to reduce dependency on oil and the effects of climate change. Brazil has taken advantage of its sugar cane potential and has become the world leader in ethanol production. The chemical compound in ethanol is the same whether it is made from corn

(as it primarily is in the United States), sugar cane (Brazil), or from cellulosic materials,[14] such as cassava[15] and palm.

The National Program of Alcohol- PROALCOOL- was created by the decree no.76593 of 1975.This was the first and most successful large scale biofuel program in the world. The objective of the program was to introduce a blend of gasoline with ethanol (gasohol), produced from sugarcane, to the Brazilian market and to incentivize the development of pure ethanol fueled vehicles.[16]

It was not until 1980 that the first patent in the world was given to biodiesel for planes (PI-9007957). This research was done by Centro de Tecnologia da Universidad Federal do Ceara.[17] They adapted a methane-based biodiesel process to the production of ethanol.

In Brazil, concern has grown on this matter. Oil prices, concerns about climate change and the reduction of greenhouse gas emissions will ensure Brazilian ethanol stays on the international agenda. The government has introduced a series of plans and laws that provide incentives for research and development. Its idea is to bring all of the actors together to obtain benefits, which not only boosts its economy, but also allows it to create an interdisciplinary approach to biofuels innovating in the industrial process, increasing the agricultural productivity and exploring by-products.

Main Actors:

The academic sector is represented by universities that focus on R&D. They work with the private and public sector that funds them. The Federal University of Rio de Janeiro (UFRJ) works in its molecular plants genetics laboratory analyzing compounds of ethanol and other plants that can be used as feedstock. This research has produced important intellectual property (I.P) contributions to the production of fuels. The RioBiodiesel domestically obtained a patent for production of biodiesel using sewage in 2003. The UFRJ was part of this process, and in 2004 an international patent was granted.[18]

The Federal Universities of Alagoas, Goais, Sao Carlos, Viscosa, Parana, Pernambucano and Rio de Janiero are connected by The University Network for Sugar-Ethanol Development (RIDESA).This network's objective is to promote research in ethanol derived from sugar cane, and to develop a genetic improvement program for sugar cane,[19] that can reduce diseases in sugarcane by an adequate selection of resistant varieties in programs of genetic improvements. The research carried out by Universities is also

[14] www.eere.energy.gov
[15] Cassava is a shrubby, tropical, perennial plant that is not well known in the temperate zone. For most people, cassava is most commonly associated with tapioca. The plant grows tall, sometimes reaching 15 feet, with leaves varying in shape and size. The edible parts are the tuberous root and leaves. The tuber (root) is somewhat dark brown in color and grows up to 2 feet long.
[16] *Id.*
[17] Kira Tarapanoff. Pesquisiadora Visitante MDIC-STI-FAPEMIG
[18] *Id.*
[19] www.ridesa.org.br

supported by the private sector. The government knows that a partnership with the private sector is required for innovation, economic growth and competitiveness.

This cooperation is more tangible in biodiesel production. Since this industry is relatively new, the private sector can create new ways to increase production capacity. The Agropalma Group is the largest producer of palm oil in Brazil. Using residues from palm, a new plant was opened in the state of Para using a procedure that was developed in association with the Universidad Federal de Rio de Janeiro (UFRJ). The plant will have a production capacity of nearly eight million liters per year.[20]

Biobras S.A has a technical cooperation agreement with the University of Uberaba to improve seed quality and identify more optimal regions in which to plant, aimed at increasing the sector's productivity.[21]

Private industry carries out important research in its laboratories. The (CTC) Copersucar Sugar Technology Center is a private institution that carries out R&D for new technologies that can be put into practice in agriculture.[22]

The Cooperative of Sugarcane, Sugar and Ethanol Producers of the State of Sao Paulo (Copersucar) has developed a genetic improvement project for sugar cane.

UNICA and Cosan are major players in the Ethanol industry in Brazil and in the world; they not only produce ethanol, but work on related derivatives. Their research is directed to the diverse varietals of sugar cane to strengthen the plant and immunize against plagues that can affect ethanol production.

The Brazilian government has developed a number of biofuels initiatives, at both the federal and state level, and has a number of ministries, state bodies, and support institutions in place to promote the industry and facilitate the growth of the biofuel industry. In Brazil there has always been a clear alignment between biofuels and public policy.

It has been clear for policy makers that this industry cannot be developed on its own. Although the private sector finances most of the research, the government knows that industry-friendly policies are more helpful than trying to maintain a monopoly on the biofuel industry; knowing that Brazil can attract the investment flow needed to achieve the sector's sustainable development.

[20] Biodiesel in Brazil: Overview 2005, 21
[21] *Ibid*
[22] Since the center separated from Corpersucar it has been reportedly struggled to maintain its funding and it remains to be seen whether CTC can sustain its position as a leader in the R&D field. A Blueprint for Green Energy in the Americas. 470

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Brazil's capacity to acquire and absorb technology produced in other parts of the world allows it to improve its own domestic systems. The flex-fuel car (an automobile that can typically use different sources of fuel, either mixed in the same tank or with separate tanks and fuel systems for each fuel. A common example is a vehicle that can accept gasoline mixed with varying levels of bioethanol (gasohol). Some cars carry a natural gas tank and one can switch from gasoline to gas.) Is an example of how public policies contribute to the economy and promotes industrial development while the government gives the automobile industry incentives to produce and expand the flex-fuel technology.

This is the difference between Brazil and other ethanol producing countries. Brazil is not just investing in biofuels production, but also in the necessary biotechnology for the industry to keep up with the challenges of production and innovation.

The flex-fuel car was introduced in Brazil in 2003. Since then sales have grown 74% and, during the last four years, 1,432,037 flex fuel cars have been sold in the local market.[23] Flex-Fuel cars are taxed at a lower rate than regular cars, becoming an incentive that helped the ethanol market in Brazil, by allowing flex fuel technology cars to run on gasoline, alcohol or any combination of the two.

The Ministry of Science and Technology, MCT, handles the funding of R & D carried out by institutions and organizations. The Ministry of Development (MDIC), builds partnerships with productive sectors, through actions that turn in the improvement of the population quality of life, and directs public policies regarding I.P and T.T.[24]

The Ministry of Agrarian Development (MDA) promotes sustainable development in the rural areas.[25] The Ministry of Mines and Energy (MME) carries out directives of politics of agroenergy and the National program of Production and Use of Biodiesel.[26]

[23] Ministerio do Desenvolvimiento, Industria e Comercio; Associacao Nacional dos Fabricantes de Veiculos Automotores-2006
[24] http://www.desenvolvimento.gov.br/sitio/ministerio/ministerio/competencia.php
[25] http://www.mda.gov.br/portal/index/show/index/cod/140
[26] http://www.mme.gov.br/site/menu/select_main_menu_item.do?channelId=9813

The Brazilian program of biodiesel has a strong focus on small farmers' production with special exemption, in most cases, from taxes.

The ANP, National Association of Petroleum, Natural Gas and Biofuels whose job it is to regulate biofuels standards, falls under the jurisdiction of MME. The Ministry of Agriculture, Livestock and Supply (MAPA) wants to stimulate the increase of the farming production and the agrobusiness development, with the objective to attend the internal consumption and to form excesses for export purposes.[27]

The government is also endowed with the INPI (National Institute of Industrial Property), which regulates the use of industrial property and the issuance of patents. INPI plays three basic roles comprised of:

1. Helping government and business build a strong IP system that fosters innovation and competitiveness throughout the economy by improving IP rules in international agreements and strengthening domestic IP related laws and regulation.

2. Promoting the IP system by making it well-known to potential beneficiaries.

3. Operating the IP system itself; ensuring the system's efficiency, efficacy and quality.

INPI has established IP as the central mechanism to promote innovation and innovation policies within the economy. The institution also coordinates national networking by increasing joint initiatives and guiding other institutions to value IP as a positive growth strategy; and conducts seminars and leads research programs on IP through its Academy of Intellectual Property and Development.[28]

The public-private solution

The government has created development for the country via biofuels. IP rights have helped maintain their leadership in the field, and their technology has become a tradeable asset thanks to the protection granted by the country to IP promoting economic development. The biofuel industry has made the Brazilian government analyze and understand the advantages of the patent system, not only for the industry, but for foreign investment.

Petrobras, Petróleo Brasileiro S.A., is a government-owned Brazilian oil company that has kicked-off another technological development stage for biofuel production.
With the bioethanol research project (lignocellulose ethanol) – biofuel produced from agribusiness residues – Petrobras is now entering the second generation of biofuels and contributes to underpinning Brazil's natural vocation for renewable energies.

[27] http://www.agricultura.gov.br/
[28] Jorge Avila, president of INPI. http://www.wilsoncenter.org. August 2007.

After the lab test stage, the bioethanol production project will progress to the pilot scale test phase, at an experimental unit installed at Petrobras' Research & Development Center (Cenpes), at the Ilha do Fundão. Developed in partnership with the Brazilian outfit Albrecht, the lignocellulose ethanol pilot plant is the only one in Brazil using the enzymatic technology.[29]

As the concerns on biofuels grow a public-private sector group co-chaired by Luis Alberto Moreno (president of the Interamerican Development Bank), former Florida Gov. Jeb Bush and Roberto Rodrigues, president of Superior Council of Agribusiness of the Sao Paulo State Federation of Industries was formed. The Interamerican Ethanol Commission was created in 2006 as a forum for disseminating information about ethanol, facilitating private investment in biofuels, and promoting the creation of a hemispheric market in biofuels. At the briefing, Moreno described the private sector as a "crucial partner" in the Bank's biofuels strategy, and he invited questions from the audience, which included 250 representatives of business, government, the research community and the media.[30]

The reductions of ethanol production costs in Brazil have occurred thanks to technological breakthroughs, improved management and investments in infrastructure. These reductions have been achieved in an environment marked by far-ranging discussions of political and economic conditions (governmental support at the beginning, followed by deregulation; liquid fuel policies; construction of an important legislation/regulation framework for environmental and social topics). Advances in competitiveness have been supported by investments (production, logistics) and a significant development and implementation of technologies.[31] The long-standing focus on sugarcane ethanol production has also given the country a competitive edge on the technology. In Brazil, ethanol production is half the price it is in the United States — which primarily uses corn — one-third the price of European production from sugarbeet.[32]

The current sugarcane, sugar and alcohol production situation in Brazil is strong and balanced. It is part of the private sector's job to maintain this strength and balance, projecting them into the next ten years. This requires a series of discussions with the various agents that interact in this process: spheres of government and congress, the automotive industry, fuel distributors and resellers, financial institutions, private and governmental sectors of other countries, etc.[33]

[29] http://www.agenciapetrobrasdenoticias.com.br/en_materia.asp?id_editoria=8&id_noticia=3929
[30] http://biopact.com/2007/04/inter-american-development-bank-to.html
[31] http://unica.com.br
[32] http://www.scidev.net
[33] Eduardo Pereira de Carvalho. http://www.unica.br/i_pages/artigos_palavra.asp

DESTINATION OF BRAZIL'S PRODUCTION 2004/2005 CROP MARKET

	DOMESTIC %	EXPORT%
SUGAR	37	63
ETHANOL	85	15
SUGARCANE	61	39

Source UNICA

The biofuel industry has received political support that has strengthened R&D, mainly because of oil dependency and international oil prices. The balance between ethanol and gasoline has changed over the years (30 years of government promoting biofuels) In 1977 a mandate required a 4.5 % mixture of ethanol with gasoline, since then, the mixture has risen to 25%. Current legislation requires the mixture to be 20-25%.[34]

The need to organize and create a clear policy for research, innovation and technology transfer helped create the National Agroenergy Plan (PNA). Its main goal is to structure research efforts and supports the creation of an agroenergy consortium as well as an agroenergy unit through Embrapa.[35]Embrapa, The Brazilian Agricultural Research Corporation aims to provide feasible solutions for the sustainable development of Brazilian agribusiness through knowledge and technology generation and transfer.[36]

The Ministry of Agriculture, the private sector, Embrapa, the Brazilian Development Bank, the Bank of Brazil and Itaipu Binacional, would integrate this consortium. The main interest in this program is to focus all the plans of research, development and innovation to ethanol and energy cogeneration from sugarcane, biodiesel from animal and vegetable sources, forest biomass and agroenergy and agroindustry residues .[37]

To develop the biofuels market, the Brazilian government has already offered cheap loans to companies interested in building plants. The National Bank for Economic and Social Development provided nearly one billion dollars in financing towards the end of 2006, and could raise that amount by 25 percent in 2007. Over the next six years, Brazil will open one ethanol factory per month on average, bringing the total number from the current 336 to 409 by 2013.[38]

Under the Biodiesel Plan the Brazilian Biodiesel Technology Network was established, integrating 60 research groups that work throughout the country. The MCT will develop laboratory infrastructure to monitor production quality and help new companies on their

[34] Samba Lessons. What Brazil can teach the U.S about energy and ethanol. Tom Philpott and Gordon Feller. Dec 2006.
[35] Plano Nacional de Agroenergia, 6. Ministerio de Agricultura, Pecuaria e Abastecimiento. Brazil
[36] http://www.embrapa.br/english
[37] A Blue print for green energy in the Americas. Strategic Analysis of Opportunities for Brazil and the Hemisphere.Prepared for the IADB by Garten Rothkopf. P. 459
[38] http://ipnews.net/print.asp?idnews=36875

research. [39]According to the Biodiesel in Brazil Overview, 23 states have signed agreements and over 120 projects have been sponsored.

Brazil authorities know what has to be done in order to maintain competitiveness. This is clear in their national and international agenda. A series of agreements has been signed with different countries, looking for technology exchange, technical cooperation, production techniques, uses of ethanol, and partnerships and commercial support that can become lessons for the Proalcool program to promote biofuels and flex fuel vehicles.

Some countries have expressed their interest in obtaining technology that Brazil has already developed in natural gas compression systems, ethanol production for use as a vehicle fuel chemical industry dynamics, and technical and commercial support from Petrobras. Some of these countries are: Nigeria, Pakistan, Italy, France, Germany, EU bloc, South Korea, Japan, India, China and Mexico.[40]

The world is aware of Brazil's production efficiency, and government authorities know this is the way to gain a global market: by increasing efficiency and standards in biofuel production. Recent investments made by some of the richest and most successful people in the world include:

Bill Gates, the richest man in America, allocated $84 million into Pacific Ethanol, Inc. Sir Richard Branson, chairman of the Virgin Group and worth an estimated $3 billion, has plans to invest $300 to $400 million to produce and market this promising alternative fuel. He says: "This is the win-win fuel of the future."

Brazil needs to make sure that any future agreements on disseminating ethanol technology will benefit the country both economically and scientifically. Technology transfer could enable Brazilian scientists to maintain their competitive lead in ethanol production technology.
Ethanol looks set to become a high level commodity in the coming century. And Brazil has the most advanced technology in the world for producing and using it as biofuel. The country should take advantage of its unique position.

Vinod Khosla, "guru" of Silicon Valley, co-founder of Sun Microsystems, and one of ethanol's most vocal advocates, has invested millions of his own dollars in private companies involved in the development of ethanol.[41]

[39] www.biodiesel.gov.br
[40] A Blue print for green energy in the Americas. Garten Rothkopf. P 577
[41] http://www.gulfethanolcorp.com/gulf_ethanol_investors.htm

R&D institutional framework:

It is in the interest all of actors in Brazil to find support for their biofuel industry. The government knows that this has to be a joint effort, if each sector pulls depending on their interest; the biofuel program is not going to be successful. Biofuel expansion is not a simple task; the development of strategies that can guarantee a sustainable development will be needed.

Brazilian business is the big winner. The biofuels sector is interested in expanding in the region, helping not only the local companies and economies, but giving neighboring countries the possibility to construct plants, pipelines, making social development an example to the world. The knowledge generated by such R&D activities as well as the learning accumulated by the sugar cane mills resulted in considerable increase not only in sugar cane productivity but also in sugar and alcohol yields. Another significant impact was a drastic reduction of production costs, not only of ethanol but also of sugar cane and sugar. Today Brazil produces both ethanol and sugar at the lowest prices.[42]

In 2004, law No. 10,973 was approved in Brazil. Its main objectives are new treatment of intellectual property, public funds to be granted to enterprises for developing innovative products and services and incentive to the independent inventor. Training and instruction to the technology sector allowing it to withstand external competition as well as to augment its exports through the competitive insertion of Brazilian goods and services with better quality, greater technological content, and higher values added, into the international market[43].

Brazil has built strategic partnerships for cooperation among science and technology institutions and enterprises, sharing infrastructure of federal research and development institutions with enterprises and more interaction of private sector with knowledge generating sector, encouraging technology transfer.[44] Brazil has been taking steps toward strengthening IP protection.

Law No. 10,973 "introduces provisions on incentives for innovation and scientific technology research in the production environment." This law encourages public-private R&D partnerships and enables public subsidies to private technology commercialization initiatives. "With this law, the legislature and executive [branch] have confronted head on the overriding obstacles to technology innovation and commercialization in Brazil."[45]

[42] Lea Velho. Professor of social studies of science. The Development of a Sugar-Based Plastic in Brazil. Article presented at the 2006 Technology Transfer Society Conference.
[43] Brazil, "Ley de Inovacao", Ministerio de Ciencia y Tecnologia, 5 de Dec.2006. http://www.mct.gov.br
[44] www.ahk.org.br
[45] http://knowledge.wharton.upenn.edu/article.cfm?articleid=1339Published: March 01, 2006 in Knowledge@Wharton. The Two Faces of Intellectual Property in Brazil

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The World Trade Organization (WTO) is looking closely at Biofuels explaining why it issued The Agreement on Technical Barriers to Trade (TBT), setting standards, regulations and labeling, that could serve as a channel for the codification of biofuels regulations. The agreement allows countries to establish standards at their discretion, as long as they do not discriminate or create legal barriers to trade. The TBT could support the development of international biofuels standards insofar as it applies mandatory measures that specify the characteristics of products and their related process and production methods.[46]

One measure of the strength of the Brazilian R&D sector is patent registration and grants, both domestically and internationally. According to the World Intellectual Property Organization (WIPO), the use of the patent system has become more internationalized, with residents and non-residents applying for patents across countries and increased utilization of the system by developing countries. Brazil is a signatory to the Paris Convention for the Protection of Industrial Property, which allows investors to file for the equivalent of an international patent, the rights of which would be honored in all member countries.[47]

For socioeconomic development to cope with environmental preservation is not a simple task. The development and implementation of strategies suited to sustainable development will be based on the management of knowledge, including advances in biofuels technology. Sugarcane, like petroleum, generates innumerable products ranging from yeast to herbicides to insecticides, with an important difference: they are biodegradable and inoffensive to environment.

This technology has allowed sugarcane to become more than a fuel source. Sugarcane is an extremely versatile raw material. Using three Kg of sugar and 17.1 kg of bagasse (the fibrous material remaining after the extraction of juice from sugarcane), 1 kg of cane derived biodegradable plastic can be obtained, using other byproducts from the sugar mill

[46] International Food & Agricultural Policy Council, WTO Disciplines and Biofuels: Opportunities and Constrains in Creation of a Global Marketplace. Oct.2006
[47] A Blue print for green energy in the Americas. Strategic Analysis of Opportunities for Brazil and the Hemisphere.Prepared for the IADB by Garten Rothkopf. P 450

as solvents. Bagasse is being used to generate electricity, sugarcane is the force behind the 307 existing ‘energy powerhouses' in Brazil, 128 of which are in fueled by sugarcane grown on 2.35 million hectares of land.

These are mills and distilleries that process biomass[48] from sugarcane to feed an efficient chain: they produce sugar as a foodstuff, electric energy from bagasse burnt in their boilers, hydrated alcohol as a vehicle fuel and anhydrous alcohol to improve gasoline's energy and environmental performance.[49] Sao Paulo offers the best sugarcane infrastructure in the country. Most of its sugar mills have the capacity to burn bagasse to produce energy beyond its own needs. Decree No.2003 passed in 1996 facilitates independent producers to commercially distribute co-generated electricity.[50]

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Luis A Cortez, institutional and international relations coordinator of the State University of Campinas, one of Brazil’s leading research universities said: “Each new refinery would cost some $140 million to build and operate, but the overall program would generate an estimated $ 31 billion in annual exports for Brazil and create 5.3 million jobs, a significant boost for the still-developing country.”[51]

Brazil’s policies have created a great interest not only domestically but internationally. The countries are seeking a way to invest in the technology developed by the Brazilians during the years. The country’s development has blossomed thanks to friendly public policies that not only boost economic development but have a strong relation with opportunities for people in the different production areas. Biofuel consumption is having a positive effect on rural development and the sustainability of the farming industry, including job creation and an increase in the income of rural workers and business. Ethanol’s rise has had far-reaching effects on the economy. Not only does Brazil no

[48] Biomass is organic material made from plants and animals. Biomass contains stored energy from the sun. Plants absorb the sun's energy in a process called photosynthesis. The chemical energy in plants gets passed on to animals and people that eat them. Biomass is a renewable energy source because we can always grow more trees and crops, and waste will always exist. Some examples of biomass fuels are wood, crops, manure, and some garbage. http://www.eia.doe.gov

[49] http://www.unica.com.br/i_pages/cana_origem.asp

[50] http://ethanolproducer.com

[51] http://pubs.acs.org/cen/coverstory/85/852cover.html Chemical & Engineering News: Cover Story-Biofuel Bonanza

longer have to import oil but an estimated $69 billion in oil sales that would have gone to the Middle East or elsewhere has stayed in the country and is revitalizing once depressed rural areas. More than 250 mills have sprouted in southeastern Brazil, and another 50 are under construction, at a cost of about $ 100 million each.[52]

The future of Brazil depends on foreign investment to develop a more competitive industry, acquiring new equipment and technology, planning and building direct investments. Innovation will drive the future of biofuels; new technologies will provide the support needed for the industry to develop new and better ways to produce biofuels. This reduces reliance on crude oil and diversifies national energy production.

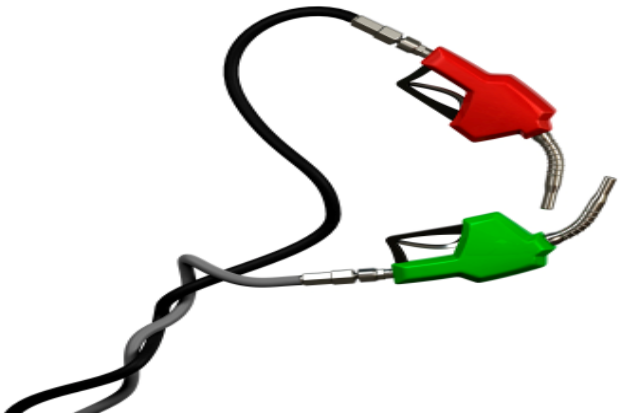
It should be clear that biofuels are not a replacement for fossil fuels (coal, oil and natural gas). Instead, they offer an alternative with a number of attractive benefits. The advantages offered by biofuels, such as lower carbon emissions and competitive production techniques, rely on existing technology. As the billions of dollars poured into biofuels R&D worldwide take hold, these advantages will only increase. Second-generation biofuels, such as cellulosic ethanol, which is proven to be more effective in the reduction of carbon emissions, will be increasingly cost competitive. New technologies will also help address potential drawbacks to biofuels technology, such as the tension between food and energy security. Further, ethanol could one day be used in fuel cell engines, should technology become commercially viable.[53]

Brazil's technology will be needed in the world to create a clean fuel industry, for the last 30 years they have been researching and developing ways to make biofuels work. Miguel J. Dabdoub, one of Brazil's leading chemists, and visionary in alternative fuels said:

> Research is important, but we also have to think a lot about strategic, social and political issues. I'm trying to build a concept where the research helps create partnership with business, business creates demand, and demand creates a market. The most important word in our work is partnership.

Brazil has to work with all the sectors involved in this industry. This is its main challenge: it wants to be a simple producer of biofuels and lose its importance as an innovator in the field, or integrate the production chain, create partnerships and keep developing this industry.

[52] How to beat the high cost of gasoline. Forever. Adam Lashinsky and Nelson D. Schwartz. Fortune Magazine. February, 2006.
[53] A Blue print for green energy in the Americas. Strategic Analysis of Opportunities for Brazil and the Hemisphere.Prepared for the IADB by Garten Rothkopf. P 5



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Industrial development (Intellectual Property and Technology Transfer)

What is happening in Brazil is very peculiar. When we talk about technology transfer we think about the developed countries transferring their know-how to developing countries. Brazil has become the main supplier of biofuels technology for the developed world. The way for Brazil to continue leading this industry is to adapt and adopt technologies that can be transferred to other countries; this is the main reason its policies have to incentivize R&D.

Knowledge exchange is the way to reduce the technological gap between countries and industries. Joint research develops into a joint partnership, and the public and private sector will be working together, instead of one trying to take advantage of the other. R&D in Brazil receives help from multiple sectors.

In the beginning the government exclusively funded this activity, but now public and private researchers are aligned in the key issues surrounding biofuels, technology, industry, competitiveness and infrastructure. Promoting rural and community based development is another driver that has become the explicit intention for a number of biofuel development projects. Building on lessons learned with ethanol, Brazil's ProBiodiesel program has developed measures to enhance social inclusion and promote more equitable ownership and development of the biodiesel market. Provisions include tax incentives for "family agriculture" as well as preferential treatment for harvests that earn "social fuel stamps" which certify the regional distribution of biodiesel crops. Greenhouse gas emissions and climate change concerns are beginning to serve as social drivers of programs, particularly for biofuels. [54]

When Nicholas Burns, U.S under-secretary of state, visited Brazil in early February, he gave an interview to the newspaper O Estado de Sao Paulo that reveals Washington's plan for the region:

[54] www.unu.edu

> We are very dependent on oil. So we have to develop alternative fuels, we have to decrease our gasoline consumption. We produce corn ethanol because we have large cornfields. You (Brazil) produce ethanol from sugarcane. We are both world leaders.
> We control more than 70% of the world market. We believe that this is a connection with Brazil, it is an area in which we can grow together and we can lead the development of a world market with very positive consequences for the environment and for the economy. Biofuels will become the biggest and most positive point of connection between Brazil and the United States.[55]

Biofuels have achieved in Brazil something that all countries would want to emulate, an increase in technological innovation and economic growth. The private sector, Government and Universities have become research partners, aligning their goals and sharing information, and they have created an investigation system that has increased their knowledge base.

With these tools, patents have become necessary to protect technological innovations since they guarantee that the product of their entire R&D will go back to the developers and spur more interest in the field creating an incentive for investors.

These incentives encourage innovation, which in turn contribute to the continuing enhancement of the quality of human life. In return for the exclusive right, the inventor must adequately disclose the patent invention to the public, so that others can gain the new knowledge and can further develop the technology. The disclosure of the invention is thus an essential consideration in any patent granting procedure. The patent system is so designed to balance the interest of inventors and the interest of the general public. [56]

Brazil's government knows its technology has turned into a bargaining tool with the worlds leading economies. Brazil has committed significant resources to developing national science and technology capacity. There is also a growing consensus between Brazil and the U.S. concerning the benefits of sharing science and technology know-how and protecting the intellectual property rights that underlie it. In fact, a number of joint projects and initiatives between the two countries have evolved, and they have included the participation of both governmental and private (industry, university and nonprofit) institutions.[57]

There is a growing concern with the environment and sugarcane crops. In order to reach production goals, the rain forest is going to be compromised and, as such, the Brazilian Constitution devotes an entire chapter to environmental matters, requiring the government to:

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[55] O Estao de Sao Paulo, February 11, 2007.
http://americas.irc-online.org/am/4051

[56] www.wipo.com Understanding Industrial Property.

[57] Lawrence A. Kogan, Esq. How Brazil's Recognition and Protection of Foreign IPRs Can Stimulate Domestic Innovation and Generate Economic Growth. September 2006

- Preserve and recover species and ecosystems
- Promote environmental education and awareness
- Define conservation areas
- Require an environmental impact assessment, among other requirements[58]

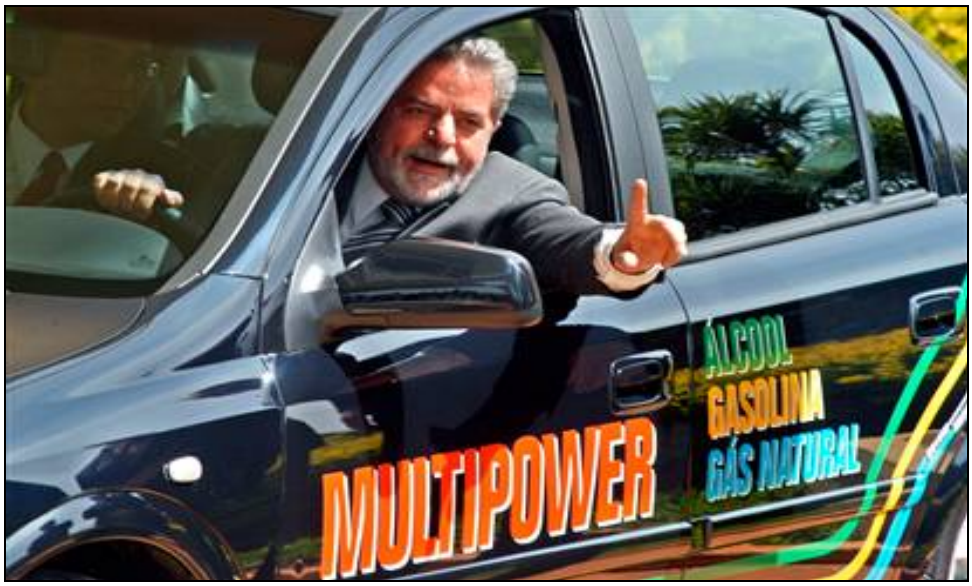
For example, it's no longer possible to consider new investment in Brazil without taking into account the limitations imposed by environmental factors. Projects must not present risks or negatively affect the environment. Environmental friendly practices such as waste reduction, energy efficiency and pollution prevention are commonplace.[59]

The Brazilian government has actively participated in the protection of IP rights. Brazil is a signatory of several conventions, treaties, and agreements that define basic, internationally-accepted standards of intellectual property protection, including, among others, the Patent Cooperation Treaty, a global protection system treaty enabling a single international registration filing to have effect in any of the relevant signatory States. As a member of the Strasbourg Agreement Concerning International Patent Classification, Brazil conforms to the classification treaty that creates classification systems to organize information concerning inventions into indexed, manageable structures for easy retrieval. Brazil is a signatory to the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS).[60]

Patents are very important to Brazil, as they ensure social protection and development it guarantees development of the nation, that have to meet the objectives of benefit for society as a whole. The IP system in Brazil has to be modernized in such a way as to become fairer, more user friendly, less costly, more effective and, above all, socially-conscious.[61]

Brazil's government and new policies have helped companies and R&D enhanced their innovation practices making the country more competitive, encouraging technology transfer harmonizing regional and international standards. The dissemination of modern technologies, and increasing interest in Brazilian ethanol, has led to more investment opportunities in the country. The agribusiness fair Agrishow 2007 held this year in Ribeirao Preto, brought 4,000 foreign investors to Brazil and generated U.S $355 million in deals.[62]

[58] http://www.ethanolproducer.com, http://www.unica.com.br
[59] *Id*.
[60] http://www.wcsr.com
[61] WIPO Conference on the International Patent System, Geneva, March 25 2002. Jose Graca Aranha President INPI (National Institute of Industrial Property, Brazil. National Institute of Industrial Property
[62] http://www.ethanolproducer.com



Iano Andrade / AP File

President Lula welcomed President Bush at Petrobras Transporte S.A. Facility São Paulo, Brazil in March 2007, there he explained the importance of biofuels industry to the world, the 30 years Brazil has spent developing this industry show how public, private and universities can work together generating economic growth:

> In addition to doing the good for humanity with biofuels, we will also be, for the first time, using biofuels as a way to distribute income and create jobs in an unprecedented scale in the history of humanity. Above all, if we analyze what can be done for countries in Africa, if we analyze what to do in poorer countries of South America, and when we look at what we can do in Central America and the Caribbean, where the United States has a partnership with all those countries, and I believe that that partnership between the U.S. and Brazil can, beginning today, really be a new moment for the global car industry, a new moment for fuel, in general, in the world, and possibly a new moment for humanity.[63]

To value the importance of a biofuels one must understand that a considerable number of developing and transition economy countries, which have in agriculture a large of their wealth, are seeing "energy farming" as a way to improve life conditions and the economy in a sustainable way. Therefore support from industrialized countries to biofuels production and its wide use does not represent only a way to lessen dependence on fossil fuels but constitutes an intelligent and cost-effective way to induce progress in less developed parts of the globe. Fuel –ethanol produced in a developing country and used in the developed world is effectively a win-win situation that offers the opportunity of environmental and energy benefits to one side while creates a new source of income and well being to the other side. [64]

[63] http://www.whitehouse.gov/news/releases
[64]http://www.unica.com.br - Eduardo de Carvalho, President of UNICA.

Biofuels, wealth creation and IP rights:

Thanks to IP, Brazil's economic development is producing more research and investments than ever before, this is the only way to keep being a key player and promote economic growth. IP has allowed the biodiesel program to have an enormous effect, reduction of poverty and social inclusion improving the standards of living. If they don't keep this up and choose to become only a producer of biofuels rather than an innovator in the field, they will be replaced by countries that can guarantee protection for investors looking for innovation.

In developing countries, IP protection is the tool to increase wealth and economic development making research efforts pay off creating knowledge and expertise. Brazil has to take advantage of their strong local scientific base, sizeable industrial capacity, large domestic market, biodiversity, well developed communications infrastructure, substantial presence of multinational corporations, and significant purchasing power. Development driven by technology is what biofuels are accomplishing in Brazil. This industry has grown in the last 30 years in ways the Brazilian government never expected; and it is obvious they know what they developed and how to protect it.

> A new approach has been taken since the IP Law entered into force in 1997. And this new approach, combined with other factors, including some macro-economic measures, made possible the increase of almost 70 percent of the local firm's patent filings, as I mentioned earlier. It shows how the mentality is in the process of changing vis-à-vis the Patent System. Brazil will actively participate in the discussions of the future of the patent system.[65]

Brazil has turned ethanol into a great commodity; the government has maintained a constant regulation and supervision of the market, financing R&D, sugar and alcohol mills, and technology support making the biofuels market a drive force. The investments in R&D show how the sugar industry is looked upon not only as a producer of ethanol, but as an industry than can help the country making it more competitive in world markets.

Brazil, with the accumulated experience of over 20 years, is the only country that has lowered the costs to a competitive level. One of the most important factors has been the development of agricultural technology in sugarcane production. Brazil's success has roused the interest of other countries in the region and created a strong demand.[66]

Thanks to innovation, Brazil's industry is promoting policies designed to stimulate learning, making possible an upgrade in technology managing the technology spillover.[67] This access to technology is playing an important role; the government, universities and industry have realized that sustainable development can be achieved through

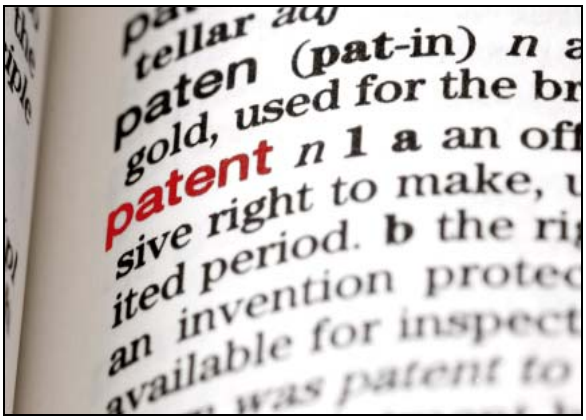
[65] WIPO Conference on the International Patent System, Geneva, March 25 2002. Jose Graca Aranha President INPI (National Institute of Industrial Property, Brazil. National Institute of Industrial Property
[66] http://americas.irc-online.org/am/4051
[67] Effects of economic activity or process upon those who are not directly involved in it.

public/private investments and close partnerships. Technology in Brazil is not copied and applied, technology is being transferred from developing countries, the years of investments and politics have helped biofuel production to be Brazilian. The economic growth is a consequence of the years of work.

Protecting IP is the way to go in Brazil; this is the way to safeguard the current and future investments in the biofuel industry. The processes developed in Brazil are clearly of industrial applicability, utility, they have industrial application, they show new characteristics that are not known in the body of existing knowledge (novelty), and an inventive step (non-obviousness), is shown in the work carried out by scientist in the alternative fuels field. Sugarcane was used to get sugar, and make alcoholic beverages, the use given to this plant for fuel production has an obvious human involvement, and the process to get this fuel is developed by humans that put their knowledge in such an enterprise.[68]

The Paris Convention for the Protection of industrial Property explains industrial in Article 1 (3):

> Industrial property shall be understood in the broadest sense and shall apply not only to industrial and commerce proper, but likewise to agricultural and extractive industries and to all manufactured products, for example, wines, grain, tobacco leaf, fruit, cattle, minerals, mineral water, beer, flowers, and flower.



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[68] *Id.*

The patent owner's exclusive rights generally consist of the following:

- In the case of a product patent, the right to prevent third parties without the owner's consent from making, using, offering for sale, selling or importing for these purposes the product.
- In the case of a process patent, the right to prevent third parties without the owner's consent from using the process; and to prevent third parties from using, offering for sale, selling or importing for these purposes the products which were obtained directly by that process.

The patent holder may give permission, or grant a license, to other parties to use the invention on mutually agreed terms. The patent holder may also sell his right to the invention to someone else, who will then become the new owner of the patent. [69]

In Brazil Trademark rights may only be derived from the registration of the trademark with the INPI, and the user of an unregistered trademark will have no rights even if the trademark has been used in Brazil for years. The registration of the trademark is effective for ten years and can be subsequently renewed for additional ten-year periods. Both the request for registration and the registration itself can be assigned to third parties.[70]

According to Brazilian law, infringement of a registered trademark is a criminal offense. An invention or utility model is entitled to patent protection. These rights allow the owner of the patented invention or utility model to impede third parties from manufacturing, selling, using, or importing the patented invention or utility model, or goods obtained from the patented process. If an invention or utility model results from the work of an employee or a contracted party, the patent right will belong exclusively to the employer or contracting party. Patents for inventions and utility models are granted for twenty and for fifteen years respectively. The infringement of patent rights is a criminal offense[71].

Patents stimulate the creation of new knowledge, and offer benefits to developing countries, like Brazil. In the case of energy, supporting R&D will improve technology and lead to improvements in other developing countries. The possibilities to create and transfer technology in the biofuels are infinite; Brazil has to protect IP especially in areas with potential to have a spillover effect to the other sectors of economy. An example of this is the establishment of an industrial plant to manufacture biodegradable plastic from sugar in Brazil. This development is closely associated with the long term activity of sugar and alcohol production in Brazil, which is based on the natural endowments of soil, climate and geographical extension that favors sugar cane cultivation. The emerge of the plastic industry was only possible because of a specific government scheme to build

[69] http://www.wipo.com
[70] www.inpi.gov.br.
[71] *Id.*

research capacity and knowledge production in biotechnology which also stimulated cooperation between the public and the private sector.[72]

The use of sugarcane Bagasse to generate electricity is today one important outcome from sugar and alcohol mills. All mills installed in Brazil become self sufficient and some of them even supplying the excess electricity to the public grid. Due to difficulties in expanding the generating capacity of the Brazilian interconnected network, as a result mainly of environmental license restrictions to new hydropower plants, the Government is trying to motivate the sugar and alcohol producers to increase their share in the electricity market. [73]

Protecting intellectual property promotes innovation and fosters wealth creation in development countries; Brazil understands the need to promote IP creation, utilization and protection, so that innovations can move from labs and research facilities to the marketplace.

Technological innovation, science and creative activity are the base of social and economic development. Brazil has adapted its laws to their development agenda. IP is an important instrument that has paid off in Brazil, and thanks to this the biofuel industry is possible in Brazil. Without a clear protection to intellectual property all this development will not be happening, other countries or companies would have taken advantage of Brazil's innovation in the field.

The Brazilian Government realized early on that the only way to ensure and guarantee protection, and benefit fully from this enterprise, was in building an IP system strong enough to support increased investment in R&D. This made it possible for the public and private sectors to fund science and technology and R&D .An IP system that protects the interests and priorities of investors creates an atmosphere design to promote invention.

Brazil accomplished to tie technological innovation to national economic objectives, developing a trained work force and personnel that increased resources for R&D, making it possible for the industry to expand and increase technological competence with sustainable development.

[72] Lea Velho. Professor of social studies of science. The Development of a Sugar-Based Plastic in Brazil. Article presented at the 2006 Technology Transfer Society Conference.
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