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Brazil's Contribution To Prevent Climate Change - White Paper

2008

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White Paper

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MINISTRY OF EXTERNAL RELATIONS

MINISTRY OF SCIENCE AND TECHNOLOGY

MINISTRY OF ENVIRONMENT

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MINISTRY OF DEVELOPMENT, INDUSTRY AND FOREIGN TRADE

WHITE PAPER

Brazil's Contribution To Prevent Climate Change

WHITE PAPER

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Introduction

1 - INTRODUCTION

Climate change is probably the most significant challenge of the 21st Century. Caused by unsustainable patterns of production and consumption, it is the result of accumulation of greenhouse gases in the atmosphere for the last 150 years, mainly from the burning of fossil fuels.

Recent data and conclusions of the Working Groups of the Intergovernmental Panel on Climate Change (IPCC) indicate, unequivocally, that human activities are responsible for the problem.

The environmental impacts of climate change – which we are already suffering – affect us all, but especially the poorest and most vulnerable. For developing countries, which have contributed very little to the problem, climate change will take a heavy toll on their efforts in pursuit of sustainable development.

The United Nations Framework Convention on Climate Change (UNFCCC) was the path chosen collectively by the international community to create a regime that is both efficient in combating the causes of the problem and equitable in distributing the burden generated by the measures needed to mitigate the problem. The convention's Kyoto Protocol set quantified emission limitation or reduction obligations for industrialized countries, listed in Annex I of the Convention, based on the principle of countries' common but differentiated responsibilities in relation to the problem's cause.

According to the Convention, Annex I and non-Annex I countries have different obligations regarding climate change. The Convention itself recognizes that the share of global emissions originating in developing countries will grow to meet their social and economic needs. In many of these countries, emissions may grow as a result of policies devoted to fighting poverty, such as, for instance, expanding electricity to rural or remote areas. On the other hand, the situation in developed countries that have already provided for the basic needs of their populations is different: in many of them, a major source of emissions is due to superfluous and unsustainable consumption.

It must be stressed, however, that the UNFCCC does not give any country a license to pollute. Since climate change is a global problem, efforts to combat it should also be global. What changes in different countries is the nature of the obligations. The common objective, however, is a future in which development is based on low-carbon consumption.

According to the Convention’s regime, Brazil does not have quantified emission limitation or reduction obligations. However, we are acting decisively and making concrete contributions to tackle climate change.

There are a number of governmental programs and initiatives in Brazil that are resulting in important reductions in the emission of greenhouse gases. Some of them are responsible for Brazil having a comparatively “clean” energy matrix, with low levels of greenhouse gas emissions per unit of energy produced or consumed. Initiatives in other sectors, such as combating deforestation, biofuels and energy efficiency, are also helping to lower the curve of greenhouse gas emissions in Brazil.

Brazil is already doing its part to combat climate change, however, we are ready and engaged to do even more in the context of the global effort needed to address the problem.

Brazil's Circumstances

2 - BRAZIL'S CIRCUMSTANCES

Brazil is a highly complex country of continental dimensions.

With land mass of 8,514,876.6 km^2, Brazil is the largest country in South America. Data from the Demographic Census for 2005 estimated Brazil's population at 184,184,170 (IBGE, 2005), with average population growth of 1.67% per year from 2001 to 2005. In 2005, most of the population (82.82%) lived in urban centers. The country has population density of 19.95 persons per km^2.

In addition to harboring over a third of Earth's tropical forests in the Amazon Rainforest, Brazil also has large phytoecological regions, such as the Cerrado savanna region. It is estimated that Brazil has over 55,000 species of flora, corresponding to approximately 22% of the world's total.

Brazil is a tropical country, with moderate winters. Available water resources are abundant, though not always well distributed or used. With a vast and dense hydrographic network, Brazil has many rivers of exceptional length, width or depth. As a result, more than 80% of the country's electricity is generated by hydroelectric power plants and over 40% of its energy matrix is supplied by renewable sources.

Brazil is a developing country with a very complex and dynamic economy. It is one of the ten largest economies in the world, as well as a large agricultural producer (the country has about 200 million head of cattle and is a major world exporter of a number of agricultural products) and one of the world's largest producers of several manufactured products, including cement, aluminum, chemical products, petrochemical feedstocks and oil.

In 2005, Brazil's GDP was US$ 883 billion and GDP per capita was US$ 4,793.

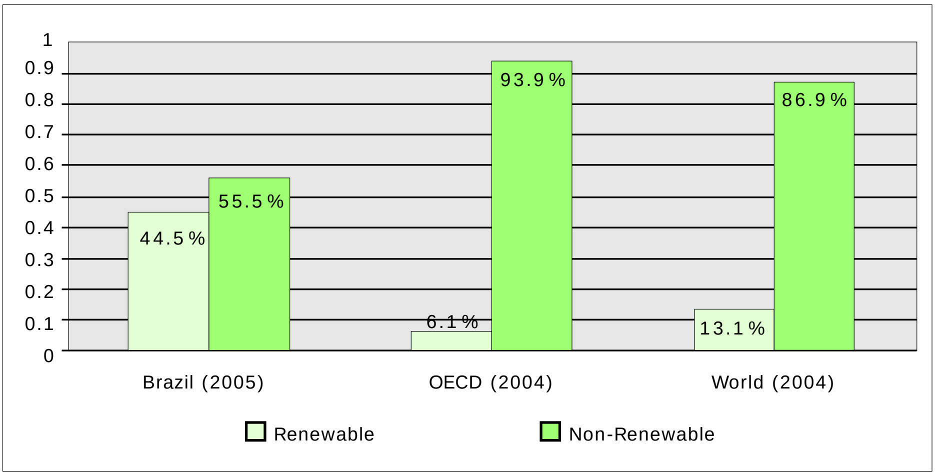
However, a significant portion of the Brazilian population is poverty-stricken, and there are also large regional disparities. In this light, Brazil's national priorities are to meet its pressing social and economic needs, such as eradicating poverty, improving health conditions, combating hunger, creating decent living conditions, among others. Despite these improved social indicators, especially in the last decade, the country still has a long way to go.

Energy

3 - ENERGY

Brazil's Energy Matrix is characterized by a high share of renewable energy, as shown in the chart below.

Profile of Domestic Energy Supply



Source: Brazilian Energy Balance 2006

In 2005, only 54% of the Domestic Energy Supply (DES) of 218.7 million toe (tonne oil equivalent) came from fossil fuels, thus only this fraction contributed to the increase in greenhouse gas concentration in the atmosphere. In the last 15 years, the annual increase in the DES was 2.9%, while GDP grew by 2.3% per annum and average annual population growth was 1.5%. The electricity supply in particular has grown significantly, providing access to electricity for an important share of the population, mainly in rural areas. The table below shows the evolution in the main energy and socioeconomic indicators for Brazil since 1970.

Main Energy and Socioeconomic Indicators

Indicators	Unit	1970	1980	1990	2000	2005
GDP per Capita	10^3US$/capita	2.2	3.9	3.8	4.2	4.3
Domestic Energy Supply per Capita	toe/capita	0.7	0.9	1.0	1.1	1.2
Domestic Energy Supply per GDP	toe/10^3US$	0.33	0.24	0.26	0.27	0.27
Final Energy Consumption per Capita	toe/capita	0.67	0.86	0.87	1.00	1.06
Final Energy Consumption per GDP	toe/10^3US$	0.30	0.22	0.23	0.24	0.25
Domestic Electricity Supply per Capita	kWh/capita	490.7	1144.6	1701.3	2295.7	2400.2
Domestic Electricity Supply per GDP	Wh/US$	222.3	295.8	453.3	550.3	555.2

US$ in constant 2005 dollars.
Source: Brazilian Energy Balance 2006

Some of the indicators have risen, as expected for a developing country, but if compared to other countries Brazilian indicators of CO_2 emissions per capita, per GDP, per energy supply or per territory area are on the lower ranges, as can be seen in the table below.

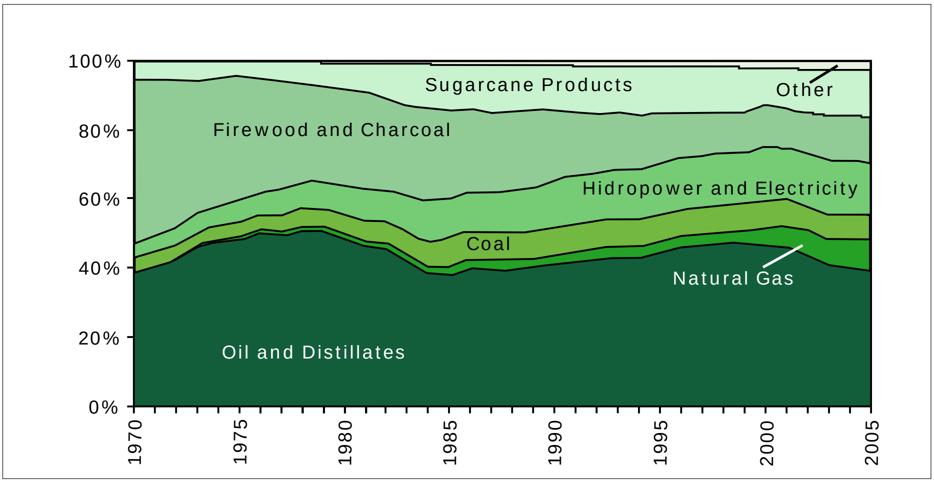
Main Indicators for CO_2 Emissions[1] from Energy

Indicators	Brazil	USA	Japan	Latin America	World[2]
tCO_2/capita	1.76	19.73	9.52	2.05	4.18
tCO_2/toe (Primary Energy Supply)	1.58	2.49	2.28	1.87	2.37
$tCO_2/10^3$ US\$ GDP[3]	0.49	0.54	0.25	0.59	0.76
tCO_2/km^2 land mass	38.0	631.0	3219.2	49.4	131.5

(1) Co_2 emissions from combustion
(2) CO_2 world emissions include international bunkers
(3) US$ in constant 2000 dollars
Source: IEA Key World Energy Statistics 2005

This low contribution to greenhouse gas emissions is due to several decisions to adopt renewable energy sources taken by the country over the past few decades. The chart below shows the evolution in the domestic energy supply since 1970. The primary energy sources that increased most significantly were hydroelectricity and sugarcane products (bagasse for thermal purposes and carburant ethanol, which rose by roughly ten fold in the period). During this period there was also an important decrease in wood consumption in the residential and industrial sectors and an increase in charcoal consumption in the industrial sector.

Domestic Energy Supply



Source: Brazilian Energy Balance 2006

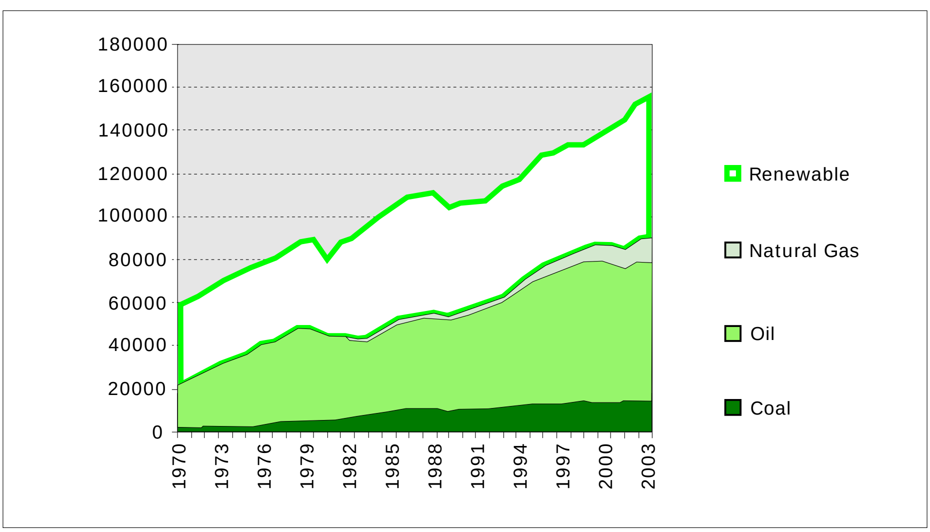
To quantify the contribution of these non-fossil primary sources in terms of avoided emissions, some hypotheses that are necessarily arbitrary must be formulated, given that the alternative scenario did not materialize.

3.1 - Renewable energy and its impact in avoiding greenhouse gas emissions

Biomass

One way to estimate the contribution of biomass is to quantify the CO_2 emissions avoided due to its use as a fuel, which in the figure below is represented by the empty area. CO_2 emitted into the atmosphere resulting from the combustion of biomass is not accounted because it does not contribute to the greenhouse effect, since it is absorbed during the process of photosynthesis in a plant's development.

Avoided carbon emissions in end use and energy transformation (Gg C)

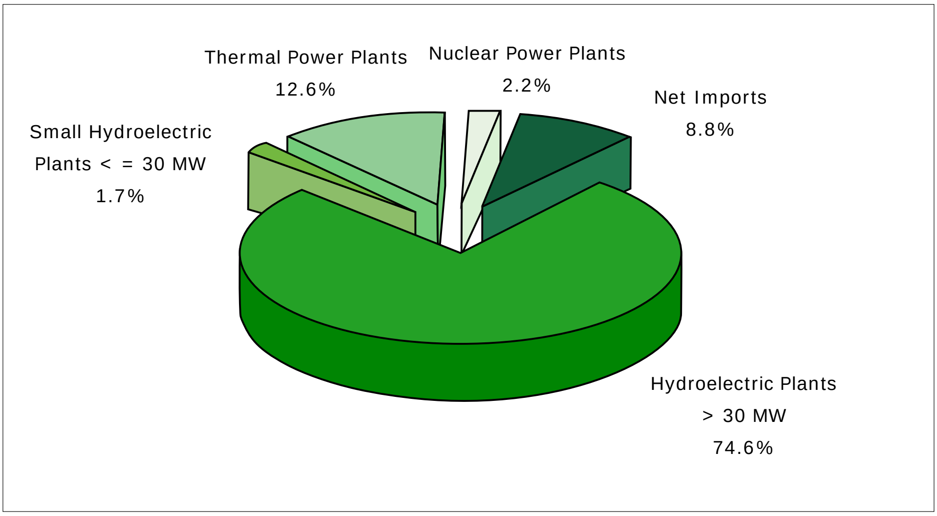


Source: *Economia e Energia n. 62*

Electricity

In the previous analysis, the contribution from hydroelectricity, nuclear energy, energy conservation and efficiency in the electricity sector was not considered. In most countries, thermal electricity production, together with heat production, is the main activity responsible for greenhouse gas emissions. In Brazil, the primary sources of electricity production are mainly renewable and do not contribute to GHG emissions, as shown in the figure below.

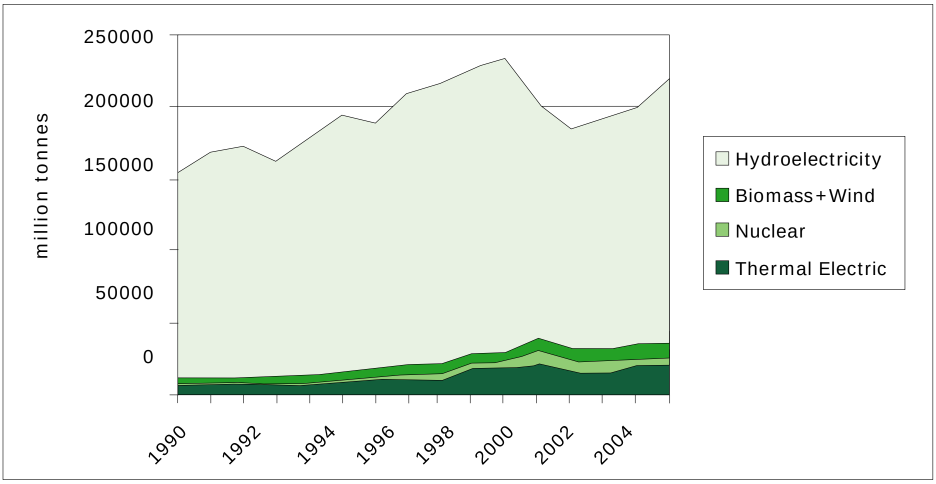
Domestic Electricity Supply - 2005



Source: Brazilian Energy Balance 2005

If the electricity produced from sources that do not emit CO_2 were produced from the mix of fossil sources, emissions from the electricity sector would be much higher, as shown in the chart below. The areas involving hydroelectricity, biomass, wind power and nuclear energy correspond to the avoided emissions. Only the emissions from the small area of conventional thermal power plants were in fact emitted into the atmosphere. This estimate does not include the impacts from energy conservation and energy efficiency.

Avoided CO_2 emissions from electricity

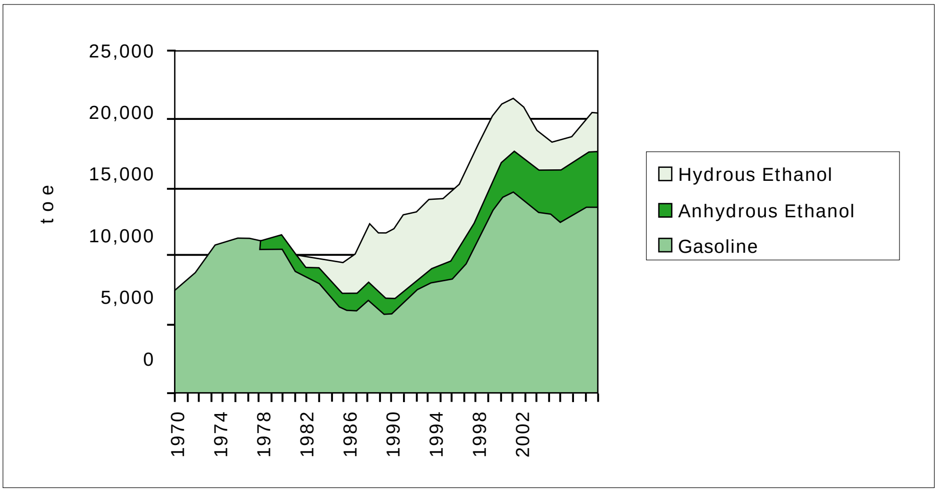


W H I T E P A P E R

Ethanol in the transport sector

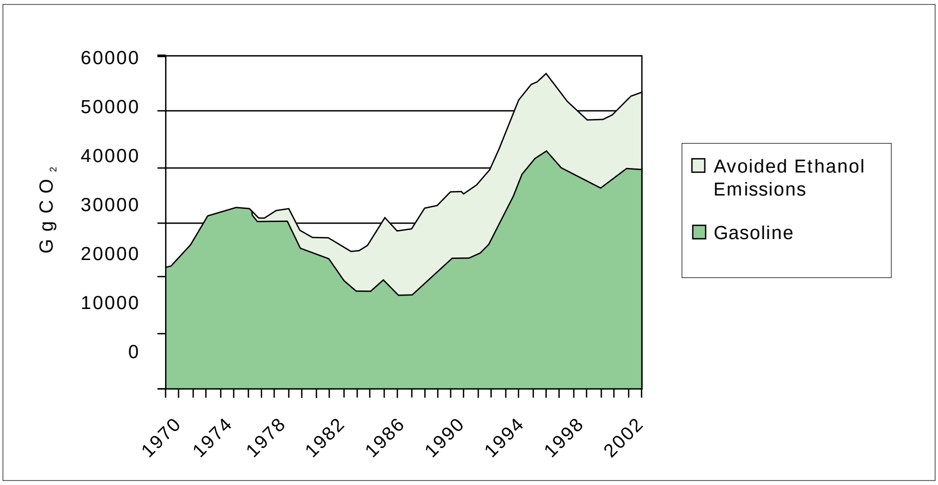
In response to the two oil crises in the 1970s, Brazil implemented a national plan known as ProAlcool to produce ethanol for substituting gasoline in light vehicles. The program was very successful and during the 1980s almost the entire fleet of light vehicles in Brazil ran on hydrous ethanol. In the 1990s, the low gasoline prices and high sugar prices led to deceleration in ethanol production, with the need for ethanol imports. In 2000, ethanol consumption began to recover, mainly driven by higher oil prices, environmental awareness and the massive improvement in ethanol productivity, as well as the development of flex-fuel vehicles, which can run on any proportion of ethanol and gasoline. This trend has already impacted the transport matrix, as depicted in the figure below, which shows the evolution of ethanol and gasoline consumption in highway transportation in Brazil since 1970.

Gasoline and ethanol consumption in highway transportation



Avoided CO_2 emissions from ethanol consumption were estimated by applying a factor of 0.7 to simulate the differences between ethanol and gasoline engine performance and the CO_2 emission factor for gasoline. The average annual contribution since 1990 was estimated at around 13 million tonnes of CO_2.

Avoided CO_2 emissions from the use of ethanol in highway transportation



The sugar and ethanol industry is also using sugarcane bagasse and straw for energy purposes. Many cogeneration projects are being proposed as CDM project activities. Since 2004, the Program for Alternative Electricity Production (Proinfa) has also encouraged the implementation of cogeneration projects based on sugarcane bagasse totaling 680 MW.

3.1.1 - Transportation

3.1.1.1 - National Ethanol Program

The "oil shocks" of the 1970s, especially the second shock in 1979, had a strong impact on Brazil's economy. To reduce distortions in Brazil's trade balance caused by the sharp rise in oil prices, the government decided to implement an energy policy aimed at reducing the deficit in the country's balance of payments. One of the key elements of this policy was the creation of the National Ethanol Program (ProAlcool).

The National Ethanol Program or ProAlcool was created on November 14, 1975 with the objective of replacing gasoline in passenger vehicles.

In the initial phase, from 1975 to 1979, the effort was directed mainly at the production of anhydrous ethanol for addition to the gasoline blend. Ethanol production grew from 600,000 liters per year (1975-76) to 3.4 million liters per year (1979-80). The first cars fueled solely by ethanol were produced in 1978.

From 1980 to 1986, the second oil shock (1979-80) tripled the price per barrel of oil, and oil imports came to represent 46% of all Brazilian imports in 1980. The government then decided to adopt measures for the full implementation of ProAlcool. Ethanol production reached a peak of 12.3 million m^3 in 1986-87, exceeding by 15% the government's initial goal of 10.7 million m^3/year for the end of this phase. The proportion of ethanol powered cars in Brazil's total fleet of manufactured light vehicles increased from 0.4% in 1979 to 21.8% in 1980, reaching the ceiling of 66.4% in 1985.

The year 1986 marked a new shift in the international oil market. The price per barrel of crude oil fell from US$30-40 to a low of US$12-20. This new period, which some observers called the "oil countershock", dealt a blow to efforts to replace fossil fuels and to promote energy efficiency around the world. In Brazil's energy policy, this wave began to have an effect in 1988, coinciding with a period of scarce public resources to subsidize programs to stimulate alternative energy sources, resulting in a significant decrease in investments in domestic energy production projects.

Ethanol supply, capped by production capacity, could not keep up with the growth in demand when sales of ethanol-powered cars reached 97% of all cars produced in 1986, generating a supply crisis in the period between harvests in 1989-1990. As a result, in following years there was a significant decline in the production of ethanol-powered vehicles.

The cost of ethanol production is directly linked to the productivity of sugarcane cultivation and to industrial yields in the ethanol production process. In the past two decades, the development and implementation of new techniques and technologies in the sugar and ethanol industry were largely responsible for the reduction in production costs. From 1976 to 1996, ethanol production costs fell from approximately 90 US$/boe to 45-50 US$/boe, which corresponds to an average annual cost reduction of 2%.

The improvement in the agricultural and industrial phases of sugarcane, sugar and ethanol production enabled Brazil to achieve the highest yields in the world in this sector. The efforts of universities and public and private research centers have led to remarkable scientific and technological advances in this area. From 1975 to 2005 in the Central-South region, sugarcane yields increased from 50-60 tonnes to 80-85 tonnes per hectare, sugar yields rose from 60 kg to 120 kg per tonne of sugarcane processed, and ethanol yields rose from 60 liters to 85 liters per tonne of sugarcane.

In terms of greenhouse gas emissions, the final balance is highly positive, due to the process of photosynthesis, through which sugarcane absorbs the same amount of carbon dioxide that is later released in the burning of ethanol and bagasse, since the carbon dioxide produced by combustion is absorbed from the atmosphere by plants during photosynthesis.

In Brazil, ethanol is used as a fuel basically in two ways: blended with gasoline, with the gasoline blend containing 20% to 22% of anhydrous ethanol, at 99.6 Gay-Lussac (GL) and 0.4% of water, to form a "gasohol" blend, with the objective of increasing the octane rating of the gasoline, which is used in regular vehicles; and as pure ethanol, in the form of hydrous ethanol, at 95.5 GL, used in vehicles with engines designed exclusively to burn hydrous ethanol, with parts protected against the corrosion caused by ethanol and higher capacity fuel tanks. Between 1995 and 2003, annual ethanol production fluctuated around 12 million cubic meters, with a gradual increase in anhydrous ethanol production while hydrous ethanol production declined. Since 2003, production has increased of flex-fuel engines on an industrial scale, which enable engines to run on a blend of ethanol or gasohol, with a mixture of these fuels in any proportion at any time. These engines have contributed to increasing ethanol supply and demand in Brazil, while also leading to higher volumes of avoided greenhouse gas emissions.

Ethanol production consumes much less energy than it produces. In crops in the State of São Paulo, the ratio of energy produced (ethanol and excess bagasse) to energy consumed (fossil fuels and electricity acquired) is 9.2 on average.

Thanks to the use of ethanol as a gasoline additive, Brazil was the first country in the world to completely eliminate tetraethyl lead from fuels in 1992, but starting in 1989 around 99% of oil refined in the country was lead-free. Because of its high octane rating, anhydrous ethanol gives gasoline anti-detonation characteristics, thus serving as an excellent substitute for tetraethyl lead, or MTBE, and eliminating this product's harmful effects on the environment.

In terms of employment, energy production operations involving sugarcane biomass are one of the biggest generators of jobs per toe produced. In 2005, the sugar and ethanol industry generated around 980,000 direct jobs.

Lastly, the use of the excess bagasse from ethanol production and possibly also sugarcane straw represents vast potential for renewable electricity cogeneration. A mill processing 3 million tonnes of sugarcane per year could provide 70 MW of electricity to Brazil’s electricity grid, with the use of bagasse in boilers with 80 to 100 kg of steam pressure. This is a remarkable result, especially considering Brazil’s current production of 400 million tonnes of sugarcane, which corresponds to cogeneration potential of 9,000 MW. Sugarcane tips and leaves could also become important sources of energy generation, in the near future increasing the availability of inputs for steam generation for electricity generation to meet the mill’s needs, enhancing even further the cogeneration capacity of the sugar and ethanol industry.

3.1.1.2 - The National Biodiesel Production and Use Program

Given biodiesel’s excellent potential to help resolve fundamental issues in Brazil – such as promoting the social inclusion of family farmers through job creation and income generation resulting from their engagement in the biodiesel value chain; reducing oil imports and consequently improving the balance of payments; strengthening renewable energy sources in the energy matrix; improving environmental conditions by promoting sustainable development – an Inter-ministerial Working Group (GTI) composed of representatives from 11 ministries and coordinated by the office of the President of the Republic was created by executive order in July 2003, with the purpose of analyzing the feasibility of biodiesel production and use in the country.

Given the social, economic, environmental and strategic benefits identified by the GTI, a new executive order was published in December 2003 creating the Biodiesel Inter-ministerial Executive Commission and its executive arm, the Biodiesel Management Group, seeking to promote and monitor the steps required for introducing this fuel into Brazil’s energy matrix.

After carrying out a series of studies and taking the necessary measures to establish a legal and regulatory framework in the country to incorporate biodiesel as a new viable fuel, the National Biodiesel Production and Use Program (PNPB) was launched on December 6, 2004. The program involves many issues, such as the creation of credit lines, including for family farmers; measures for promoting technological development in the agricultural and industrial stages, including testing engines and components with different proportions of a biodiesel/diesel blend; and support for the creation of a national biodiesel market based on purchase auctions held by the National Petroleum, Natural Gas and Biofuels Agency (ANP).

The main guiding principles of the PNPB are as follows:

Sustainable introduction of biodiesel in Brazil's energy matrix, promoting diversification of energy sources and a higher share of renewable sources, as well as enhancing energy security and reducing environmental impacts;

Promoting job creation and income generation for family farmers in the production of oilseed raw materials by implementing public policies aimed at the poorest regions and producers, offering financial and technical assistance, with a view to assuring economic, social and environmental sustainability;

Pursuing reductions in regional inequalities, seeking to develop the poorest regions of the country, such as the semi-arid region and the North;

Reduction of oil imports, improving Brazil's balance of payments;

Flexible regulations, with a view to allowing the use of different oilseed inputs and technologies (such as ethyl or methyl transesterification, cracking, etc.).

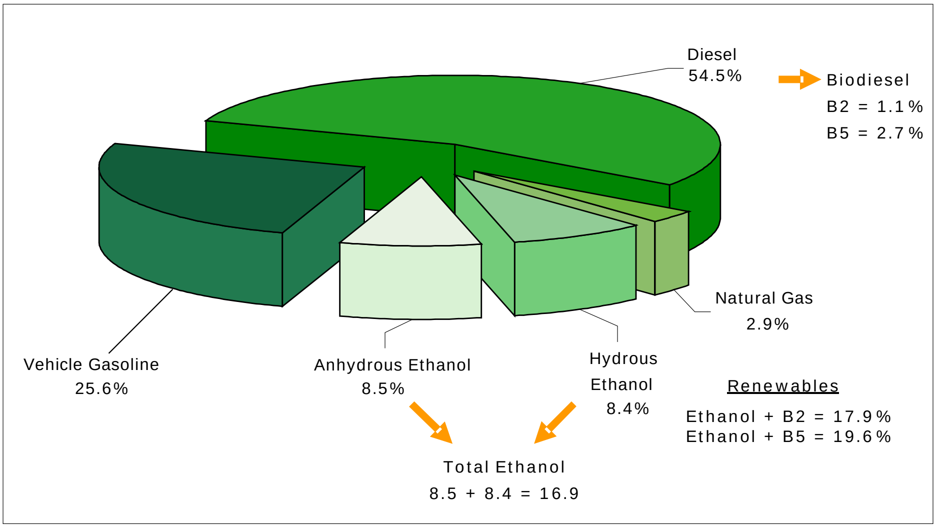
Given Brazil's favorable soil and climate conditions, as well as its large land mass, the country has many different options in terms of oilseed inputs, such as palm oil, castor, soybean, cotton, peanut, jatropha, sunflower, animal fats and oil byproducts, among others. Accordingly, the PNPB does not encourage the use of any specific raw material, leaving the choice to producers, who will base decisions on an analysis of production and opportunity costs.

As demonstrated by the guiding principles presented above, the purpose of the measures under the PNPB is to install biodiesel in the domestic fuel supply in a sustainable manner (socially, environmentally and economically), with a view to transforming biodiesel production into a development vector, with the creation of jobs and income, especially in Brazil's poorest regions.

On January 13, 2005, Law 11097 was published, defining biodiesel as a biofuel derived from renewable biomass for use in internal combustion engines with ignition by compression, or, pursuant to regulations, for the generation of other types of energy that either partially or totally replace fossil fuels, and allowed for the addition of 2% biodiesel to the mineral diesel blend (known as B2) as of that month, with this measure becoming mandatory nationwide as of 2008, and with the addition to the blend increasing to 5% as of 2013. The law also gave the ANP the power to regulate and supervise the sale of biofuels.

The share of renewable sources in Brazil's fuel market for highway transport stood at 16.9% in 2005, including the use of anhydrous and hydrous ethanol. The 2% (B2) and 5% (B5) biodiesel-diesel blend should increase the share of renewable fuels in the automotive matrix to 17.9% and 19.6% respectively, without considering the expected increase in ethanol use resulting from the growing popularity of flex-fuel engines.

Fuel Consumption in Highway Transportation - 2005



Source: Ministry of Mines and Energy

Diesel oil consumption in the Brazilian market is around 40 billion liters per year, of which 80.3% is used in the transport sector, 16.3% in the agriculture sector and 3.4% in the industrial and other sectors. Brazil imports 7% of the diesel it consumes. Thus, the addition of biodiesel to diesel in the proportion of 2% (B2) requires annual supply of 800 million liters per year, and of 2 billion liters when the proportion is increased to 5% (B5).

As of July 2007, the biodiesel production capacity authorized by the National Petroleum, Natural Gas and Biofuels Agency (ANP) in Brazil was 1.6 billion liters/year, produced by 35 plants and sold through more than 5,000 resellers. This volume is two times the amount needed to meet the demand generated by the mandatory B2 diesel blend as of January 2008. The foreign currency saved from the diesel imports avoided from the use of the mandatory B2 blend is approximately US$700 million, and in the case of B5 (at the same diesel price) this figure is US$1.8 billion.

From the point of view of demand, oil producers and importers are required to buy biodiesel at public auctions in accordance with their market share for meeting the B2 requirement. Biodiesel auctions held by the ANP establish a reference price and the winning companies are those that offer the fuel at the lowest cost, provided they meet the quality criteria required by the agency. It is worthy noting that the average fuel price dropped by around 9% between the first and the fourth auctions, which indicates that the producers are advancing in their learning curve and tend to offer biodiesel at increasingly competitive prices in relation to the diesel of fossil origin.

Therefore, within little more than four years, Brazil's biodiesel program went from the feasibility study phase to becoming a reality. As an energy policy and strategy, Brazil seeks to diversify its energy sources, strengthening the share of renewable sources in the domestic supply as a way to provide energy security in a sustainable manner.

3.1.1.3 - Flex-Fuel Vehicles

Brazilian flex-fuel vehicles allow their owners to select the fuel used each time they fill the tank, based on price, availability, performance and consumption. Accordingly, they can decide to use any addition of hydrous ethanol to gasoline in the blend, from 0 to 100%, with no need to change the vehicle's operation.

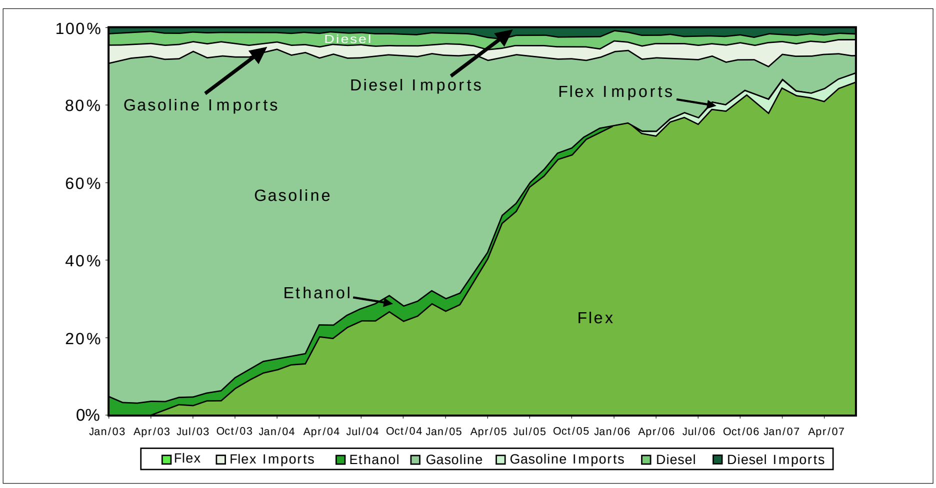
Flex-fuel vehicles represent the viability of an entire economic chain, which extends from the agricultural sugarcane production base to the production of ethanol, the mill equipment and production of flex-fuel vehicles for the consumer market, notwithstanding the environmental gains for the country.

The production and sale of flex-fuel vehicles (gasoline-ethanol) have been very successful since their launch in March 2003. At present, nine assemblers are manufacturing and selling flex-fuel vehicles in Brazil. The production of flex vehicles, according to the Brazilian Automotive Industry Yearbook published by the National Vehicle Manufacturers Association (Anfavea), has grown from 49,200 units in 2003 to 332,500 in 2004, 857,900 in 2005 and 1.4 million in 2006.

Sales of flex vehicles have increased from 48.2 thousand in 2003 to 328.3 thousand in 2004, 868.6 thousand in 2005 and 1.42 million in 2006. Sales of flex-fuel vehicles represented around 78% of the total of 1,824,276 cars sold in the country in 2006. The estimated fleet of flex vehicles in December 2006 was estimated at 2.6 million vehicles, representing 15% of light vehicles in Brazil.

In the period from January to August 2007, flex-fuel vehicle sales were equivalent to approximately 85% of all light vehicles sold in Brazil in 2006.

Sales of Light Vehicles in the Domestic Market,
by Fuel Type



The growth in flex-fuel vehicle sales has been driving increases in the production of hydrous ethanol (pure ethanol). According to the Ministry of Agriculture, production increased from 4.9 billion liters in the 2001/02 crop to 9.8 billion liters in the 2006/07 crop.

3.1.1.4 - Motor Vehicle Air Pollution Control Program (Proconve)

In Brazil, highway transportation accounts for 96.1% of passenger transportation. Highways are estimated to account for 96% of the distances traveled by people in the country, while railroads and subways account for 1.8%, and waterways and air transport the remaining 2.2%. In terms of cargo, highways account for 64% of freight transportation, railroads 21%, waterways 12%, and gas and oil pipelines and aviation the remaining 3%[1]. Growing urban pollution, deficiencies in public policies regarding mass transportation, and the recovery in economic growth have led to a dramatic increase in private transportation. The national fleet of automobiles and light duty vehicles increased from 10,325,000 in 1990 to 23,283,830 vehicles in 2005, resulting in increased pollutant emissions from motor vehicles[2].

On May 6, 1986, Resolution 18 of the National Environmental Council (Conama) created the Motor Vehicle Air Pollution Control Program (Proconve) with the aim of mitigating pollutant emission levels from motor vehicles, improving the technical characteristics of the liquid fuels used by the national fleet of motor vehicles. This resolution established the basic guidelines of the program and stipulated the first emission limits. On October 28, 1993, Law 8723 ratified the mandatory implementation of the steps required to cut vehicle pollution emission levels. Proconve is implemented in Brazil by the Ministry of Environment, through the Brazilian Environmental and Renewable Natural Resources Institute (Ibama).

The main objective of Proconve is to reduce atmospheric contamination by establishing maximum emission limits, inducing technological advances by manufacturers and requiring that both vehicles and engines comply with limits established. Compliance is measured by means of standard tests in dynamometers, using a reference fuel. Proconve also calls for certification of prototype and statistical monitoring of production vehicles; authorization from Ibama for the use of alternative fuels; the impounding or repair of vehicles and engines that do not comply with production standards or design; prohibition of the sale of vehicle models that have not been approved; and establishment of Inspection and Maintenance Programs (I/M).

Proconve is thus a national program that controls emissions in two distinct ways. First, through compliance with the legal emission limits established for the sale of new vehicles. And second, by making vehicle owners responsible, who will now play the important role of maintaining vehicles to preserve the environmental gains resulting from the technological innovations incorporated into the vehicles.

[1] Ibid.
[2] Including 18,627,576 automobiles, 3,205,013 light duty vehicles, 1,188,042 trucks and 263,199 buses. Study of the Brazilian operating fleet carried out by the Fleet Replacement Subgroup coordinated by Sven Dinklage. Sindipeças. March 2006. Available at: <http://www.sindipecas.org.br/paginas_NETCDM/modelo_detalhe_generico.asp?subtit=&ID_CANAL=514&id=34957>. Accessed on January 3, 2007.

Approval of prototypes is the foundation of Proconve's activities, inducing manufacturers to use design principles that ensure low potential pollution in new vehicles and a low deterioration rate of emissions throughout useful life. Note that emission limits and other Proconve requirements apply to both national and imported vehicles/engines.

To implement the program, vehicles were classified in three categories, each with a specific timetable: light passenger vehicles, with total mass of up to 3,856 kg; light commercial vehicles, which are divided into vehicles with a test mass of up to 1,700 kg and over 1,700 kg (pickups and vans); and heavy vehicles, with total mass of above 3,856 kg (buses and trucks).

When Proconve was first established, the need was identified to use catalytic converters in vehicle tailpipes exhaust systems and electronic fuel injection instead of carburetors in order to comply with the defined emission levels. Since the tetraethyl lead added to gasoline damaged catalysts over a short period of time, it became clear that this additive was incompatible with the new technologies used to reduce emissions. Thus, efforts by Petrobras resulted in the removal of tetraethyl lead from gasoline in 1989. Brazil was the first country in the world to completely eliminate that toxic substance from its fuel matrix. Anhydrous ethanol was used to replace tetraethyl lead, with significant advantages, especially environmental.

In the case of light passenger cars, emission control was divided into three phases, according to the provisions of Resolution 18/86. The first two phases have already been accomplished. Phase I, from 1988 to 1991, focused on the improvement of model designs that were already being produced when the program was established, as well as initiating the control of evaporative emissions. Phase II, based on the limits established in 1992, focused on emission reduction, with the application of new technologies, such as electronic injection, electronically-controlled carburetors and catalytic converters. Phase III, in process, is characterized by inducing manufacturers and importers to employ state-of-the-art technologies available for mixture formation and electronic engine control, setting emission limits equivalent to those currently in force in the United States (the program was based on the U.S. experience).

Heavy vehicles have been a constant concern, since they are the main emitters of particulate matter and nitrogen oxides in the main traffic corridors of large urban centers.

Similar to the Otto Cycle vehicles, in 1998, 80% of urban buses, and in 2000, 80% of other vehicles were required to comply with the limits established for Phase IV. By 2002, all vehicles were required to comply with these limits.

While the regulation of light vehicle emissions in Brazil was based on U.S. legislation, for heavy vehicles the model adopted was European. Brazil's Phase IV corresponds to Euro Phase II, which began in Europe in 1996 and is still in force.

Bear in mind that not only vehicles produced in Brazil must comply with the emission limits. Law 8723/93 also requires that all imported vehicles meet the same requirements as national vehicles.

With the advance of Proconve, the relative contribution of emissions from motorcycles and similar vehicles to air pollution began to grow. As a response, the Air Pollution Control Program for Motorcycles and Similar Vehicles (Promot) was created, with dates and targets previously established by Conama Resolution 297/2002. Following the example of Proconve, the program allows a period of time for technological improvement of motorcycles and similar vehicles, given the need to transfer the control systems used abroad to national vehicles.

Ibama Instruction 17/2002 and Conama Resolution 342/2005 were then established, setting EURO III limits for motorcycles in 2009. After establishing the regulatory infrastructure, motorcycle manufacturers and importers responded positively to Promot requirements already in 2003. According to Cetesb, this led to a reduction of 2/3 in carbon monoxide emission factors compared to previous models with no emission control.

Note that the timeframe established by the legislation is being strictly followed, at almost no cost to the government and with satisfactory achievement of targets. The program is one of the most successful environmental programs ever implemented in the country and was also adopted by Mercosur.

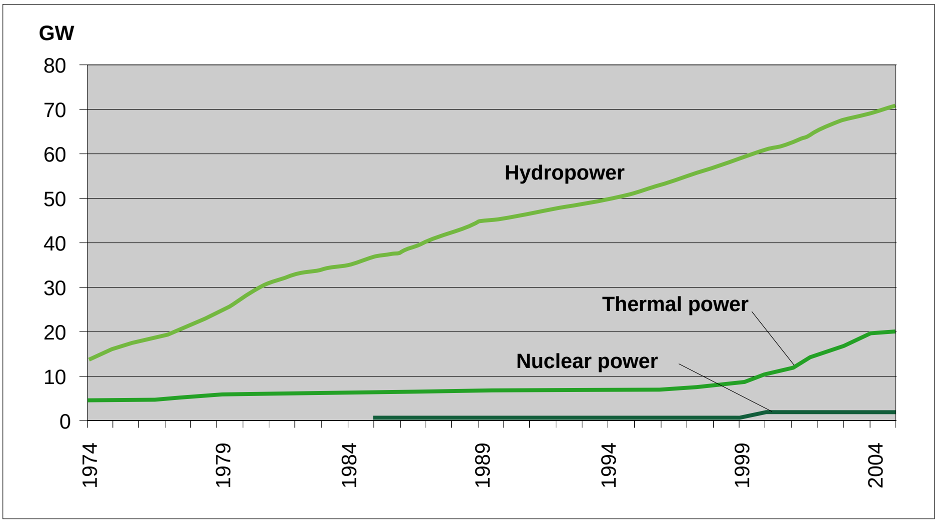
Lastly, the success of the program is demonstrated by an analysis of emission reductions in CO (from 54 g/km pre-80 to 0,35-0,82 g/km in 2004), HC (from 4.7 g/km pre-80 to 0,11-0,17 g/km in 2004), NO_x (from 1.2 g/km pre-80 to 0,08-0,09 g/km in 2004) e CHO (from 0.05 g/km pre-80 to 0,004-0,016 g/km in 2004), which shows that, thanks to Proconve, there was a dramatic reduction in average emission factors for light passenger vehicles from 1980 to 2004.

3.1.2 - Hydroelectric generation

Water production on Brazil's land mass, understood as the average annual flow of rivers emptying into the ocean, is 168,790 m^3/s. Including the flow produced in the Amazon Basin located on foreign territory, estimated at 89,000 m^3/s, total water availability rises to 257,790 m^3/s. With all of this potential water energy, it is only natural that this wealth is used to generate electricity.

Brazil's installed capacity in 2005 was 93.16 GW, of which 70.86 GW (76%) was from hydropower plants. The hydraulic potential (firm energy) of Brazil is currently assessed at 143.38 GW.

Electricity Generation Installed Capacity
(Brazil 1994-2005)



Domestic electricity supply in Brazil reached 403 TWh in 2005 (including net imports), of which 84% or 337.5 TWh was generated from hydro sources. These figures attest to the unique characteristics of Brazil's energy sector, not only because the country is one of the world's biggest hydroelectric producers, but also because of the very high share of hydroelectricity in electricity generation. Of the remaining 16% of the production mentioned above, other renewable sources account for 4.6 percentage points, natural gas for 4.7 p.p., oil products for 2.9 p.p., nuclear energy for 2.4 p.p., and coal products for 1.7 p.p.

3.1.3 - Renewable charcoal

In Brazil, around 85% of total national charcoal production is consumed by the steel and iron industry, while the remaining 15% is consumed by other sectors. Brazil is the only country that still has significant production of steel and iron that uses charcoal as a reducing agent for iron ore. In the rest of the world, as well as in most Brazilian steel and iron production, coal coke is used, given that since the mid-19th century in Europe, the mineral has represented an alternative for an expanding industry in a context of growing shortages of forest resources.

Charcoal is obtained from wood and firewood[3] by means of a chemical process known as "pyrolysis", which consists in the thermal decomposition of biomass in the absence of oxygen[4]. The carbonization of wood allows for an increase in the calorific value of the original source, which is 3,300 kcal/kg in the case of wood and reaches 6,800 kcal/kg in the case of charcoal.

The great availability of natural resources in Brazil since its discovery favored the development of charcoal production from native forests, which, among other things, met the needs of the steel and iron industry until the 1940s, when the use of coal coke was introduced by the major integrated[5] steel and iron producers emerging at the time, in response to the government's encouragement to create a national industrial complex.

Over the years, however, growing concerns with the continuous degradation of native forests led to a search for ways to plant energy forests[6] capable of meeting the demand of the industry. In the 1960s, together with the creation of tax incentives to plant forests[7], there was also support for Brazil's steel industry and restrictions on imports, which increased the attractiveness of using charcoal as an alternative to the consolidated practice of using coal coke of the major steel and iron producers. Nevertheless, tax incentives to plant forest were removed in the late 1980s[8], decreasing and even stopping the establishment of new forests.

[3] By definition, "wood" is the woody part of tree trunks and branches. "Fuel wood" is the portion of tree branches, twigs or trunk fragments reserved to be used as fuel.
[4] VIANA, REZENDE, PINHEIRO, SAMPAIO, 2006.
[5] "Integrated" steel and iron industries are those that produce their own pig iron for subsequent use in iron manufacture. Most of integrated plants operate with coal coke furnaces.
[6] Usually fast-growing trees, such as eucalyptus and pinus.
[7] Law 5106 of September 2, 1966.
[8] Law 7714 of December 29, 1988.

Moreover, the trend of opening up domestic markets to imports led to higher coke production, encouraged by its immediate availability and cost-effectiveness, which was lower compared to the cost of installing and maintaining a forest. During the 1990s, the privatization of integrated steel and iron industries resulted in the shutdown or conversion of charcoal furnaces into coke furnaces. This scenario led many small and independent steel and iron producers to close because of difficulties finding enough charcoal to keep their blast furnaces working.

As a result, the production of charcoal from native forests increased. This activity is carried out mainly by low-income populations in precarious conditions in the country's rural areas with the use of very rudimentary carbonization methods. Therefore, in addition to leading to biodiversity losses and high greenhouse gas emissions, carbonization activities using native forests are in total conflict with labor laws, especially with regard to safety conditions or compliance with workers' rights. Through the middle of this decade, the production of charcoal from native forests was still relatively active given the use of the trees planted during the period of tax incentives. This activity generally follows a productivity cycle divided into seven-year rotations between harvest and regrowth[9].

Forest planting produces the wood needed for renewable charcoal production, meeting the demand of the industry and putting an end to the need to rely on wood from native forests for such a purpose. Thus new and additional planted forests add up to the carbon stocks of native areas, increasing carbon removal as a whole. In addition, forestry regulations require compliance with certain criteria, such as the creation of ecological corridors, protection of water springs and sources, soil protection, among others, ensuring the preservation of biodiversity, water resources and other sustainability indicators in the regions of the plantings. In addition, renewable charcoal production promotes quality jobs for the populations in the rural areas surrounding the plantings. Since it involves long-term planting rotations and investments, renewable charcoal production contributes to keeping families living in the countryside and ensures the compliance with labor laws, which means safety and dignity for rural workers.

The development of seedling production technology has virtually tripled production capacity per tree. Therefore, today only approximately 1/3 of the area is

[9] In the case of eucalyptus, which is the most used species for energy production.

needed to obtain the same output as when forest planting first began in Brazil. This very same technology applied to degraded areas or areas with exhausted coverage avoids the need to open new areas for planting to meet the energy needs of industry. Renewable charcoal production provides benefits in several stages of the production chain, from planting and maintaining the forest to improving the efficiency of the carbonization process, which leads to reductions in greenhouse gas emissions and consequent mitigation of emissions in product end uses.

Brazil's steel and iron production has expanded significantly, with growth in general iron demand and increased use of coke as a reducing agent, which in 2006 met 72% of the demand.

The relationship between the consumption of planted forests and native forests shows the potential of renewable charcoal, which in 2006 met only 51% of industrial demand. The product played an important role in the 1991-2006 period, enabling a reduction of 249 million tCO_2e, but this was not enough to combat the emissions in the sector, given that its consumption remained stable. Accordingly, the figures presented demonstrate renewable charcoal's importance as a resource in terms of both the environmental gain resulting from the mitigation of greenhouse gas emissions and as a factor for reducing pressure on native forests.

3.1.4 - Co-generation projects

In Brazil, 85% of electricity is generated from hydroelectric sources and approximately 30% of gross domestic energy consumption is derived from biomass.

The best hydroelectric sites in Brazil have already been exploited, especially in the country's Midwest, Southeast and South. However, there is still huge energy potential to be exploited in the North, principally in the Amazon Basin. However, energy projects in this area are limited by environmental and economic restrictions.

Given these restrictions, the use of biomass to generate electricity emerges as a very efficient and non-polluting alternative. Gasification of biomass, an important source of energy in many countries, reduces global warming because it is carbon neutral, considering the entire biomass growth and combustion cycle.

Estimates show that a considerable amount of energy can be obtained by planting trees, sugarcane and other biomass sources. Many studies have shown that energy generated by biomass gasification could be very attractive compared to energy generated by Brazil's water resources in terms of costs and potential energy. Furthermore, energy generated from biomass is seasonally complementary to that from hydroelectric generation and could also contribute substantially to the decentralization of electricity generation.

In Brazil, given the high level of sugarcane production and the experiences with ethanol use, the development of projects to use bagasse and sugarcane straw more efficiently for energy purposes has been encouraged. Since 2004, the Program to Foster Alternative Electricity Sources (Proinfa) has supported the implementation of around 680 MW in electricity generation projects based on cogeneration with sugarcane bagasse. The plants should all become operational by yearend 2008. The recent auctions of new energy, held in 2006 and 2007, have also made it possible to trade energy from biomass-based thermoelectric plants, attesting to this energy's true competitiveness in Brazil's electricity market. In addition, bagasse and sugarcane straw have also been studied for use as inputs in the production of cellulose-based ethanol.

Analyses of conventional electricity generation systems (steam) in Brazilian plants and distilleries suggest the possibility of increasing the current levels of conversion (bagasse to electricity – cogeneration) from 4% to 16% or more, including the possibility of cogeneration over the entire year using byproducts. Gasification/gas turbine (BIG/GT) technology, which is still under development, could raise conversion rates to above 27%. Furthermore, this electricity generation potential could come to represent a substantial share of total electricity production.

The hypothetical reductions in CO_2 emissions that could be achieved in Brazil with the implementation of BIG-GT technology, according to the scenarios adopted, could range from 25 million tonnes of CO_2 (sugarcane chopped – extractor connected, baled, 50% of straw transported to plant) to 41 million tonnes of CO_2 (whole sugarcane with straw, 100% transported to plant).

3.1.5 - New sources of renewable energy in Brazil

The energy sources universally recognized as renewable – solar, wind, biomass and small-scale hydro – have only recently been considered real alternatives for supplying market niches or complementing conventional sources.

In Brazil, the use of new forms of renewable energy received a major boost following the UN Conference on Environment and Development, known as Rio-92. The use of energy from small hydroelectric projects and sugarcane bagasse, along with other forms of biomass that are already established in the country, have been consolidating and expanding as a result of the restructuring of the electricity sector and the incentives offered for these sources and for electricity cogeneration.

In the area of solar energy for electricity generation, two technologies should be mentioned for their potential to contribute to improving the efficiency and security of Brazil's electricity supply. Photovoltaic systems transform light into electricity and can be isolated or integrated with the grid, and heliothermic systems use the heat from the sun to generate electricity in thermal generation plants.

Isolated photovoltaic systems have been widely introduced in Brazil through a number of programs, with more than 30,000 systems installed as of 2004. Targeting these market niches – isolated communities and loads – should continue in the coming years, since universal access to electricity services, especially in isolated regions, should in many cases adopt these systems as supply alternatives. This outlook could be further expanded, however, if photovoltaic generation increases in scale leading to a drop in installation and generation costs.

Photovoltaic solar energy integrated with the grid is seen as a good alternative for use in distributed generation. The technical issues for its use seem to have been resolved, although there is still a need to create standards and regulations for critical issues in distributed generation, in the areas of quality, security and protection. The main difficulty, however, for the effective use of photovoltaic systems in Brazil still lies in the cost of the photovoltaic cells.

Heliothermic generation is not yet competitive, but lower plant installation costs are expected. This technology is currently starting on the pilot scale, with the potential for moving to commercial scale over a 30-year timeframe. Several studies are currently being conducted in Brazil to identify potential sites for the installation of solar power generation plants. The studies seek to determine which of the two technologies is more appropriate for the environment and energy demand in Brazil's Northeast region, as well as the best installation configuration. One of the studies estimates the potential for 2.1 MWh/m^2 year of direct irradiance at soil level, a value very close to the solarimetric conditions in Spain, which is a reference country in the use of solar technology, with systems already operating commercially.

The development of wind energy in Brazil has been gradual and consistent and is aligned with federal government guidelines for diversifying the energy matrix, taking advantage of regional characteristics and potential when formulating and implementing energy policy.

Brazil's wind potential for energy use has been studied and inventoried since the 1970s, culminating in the publication in 2001 of the Brazilian Wind Potential Atlas. The Atlas pointed out the availability of areas with medium wind regimes suitable for the installation of wind parks, mainly in the Northeast (144 TWh/year), South and Southeast (96 TWh/year). The country's total potential amounts to 143 GW.

The main incentive for this energy source was created by Law 10438/2002, which represents a milestone in the regulatory framework for the power sector, since it created Proinfa (1st phase), the objective of which is to increase the share of electricity generation from wind, small hydro plants and biomass sources.

In the first phase of Proinfa, 54 contracts were signed for the installation of wind energy plants, for total capacity of 1,493 MW, with guaranteed purchase of all energy produced for 20 years.

Despite the drop in unit investment costs because of the rapid improvement in the learning curve, this technology still has average generation costs ranging from 70 to 95 US$/MWh, which is higher than conventional sources, even considering an installation cost of 1,200 US$/kW. The average annual capacity factor of wind plants ranges from 30% to 40%, depending on the equipment used and the geographic location of the park.

Brazil's wind potential and the incentives from Proinfa have attracted the interest of manufacturers and representatives from the main countries involved in this technology. There are currently around 5,000 MW in wind projects authorized by the

National Electricity Agency (ANEEL). In addition, several companies have measuring towers and carry out infrastructure studies for the installation and operation of wind parks. Installed capacity for this source in Brazil is conservatively estimated at 4,800 MW for the year 2030 (Sources: National Energy Plan - PNE 2030/MME).

Brazil also has very high potential in the area of small hydroelectric plants, boasting extensive technical knowledge, production capacity and natural resources. According to ANEEL, 285 small hydro plants are currently in operation, with total capacity of 1,728 MW. There are also 64 plants under construction (1,137 MW) and another 180 have been approved (2,700 MW). Brazil's installed capacity in 2030 is estimated at around 7,700 MW (PNE 2030).

Over a ten-year timeframe, an increase in installed capacity of around 1,800 MW is expected by the end of 2015 (Ten-Year Electricity Plan – PDEE 2006-2015), considering 700 MW in addition to 1,191 MW from small hydro plants contracted under Proinfa. The widespread engagement of Independent Power Producers (as defined by Law 10,438/02) has clearly shown how new stakeholders are entering the sector.

The potential of small hydro plants in Brazil is estimated at roughly 15,000 MW, composed of approximately 3,000 plants ranging from 1 to 30 MW (PDEE 2006-15).

Also, bear in mind that the small hydro plants in operation in Brazil have an average age of 60 years. The designs and operating regimes used at the time of construction were not based on the hydrological information available today, therefore these facilities have reasonable potential for optimization. In the short term, a relatively small investment would increase their capacity by 200 MW. Small hydro facilities that are now shut down could provide another 156 MW of capacity to the system. The situation of a further 328 MW known to be installed at some point is currently unknown. In all, there are 1466 small hydro units with 684 MW of power that could have their capacity increased. There are estimates that the remaining hydro potential that could be exploited by means of small hydro plants is in the order of 7000 MW.

In terms of biomass, because of the maturity of the technology and the extensive experience in the use of bagasse, black liquor, and more recently rice husks, the simple extension of benefits already conceded to small-scale hydro plants and the resolution of outstanding issues related to the demand for supplementary reserve capacity and the definition of backup tasks have further strengthened a segment that already has a history of success.

Introducing the incentives described above would reverse the history of wasting agricultural and forestry byproducts, through the incorporation of technologies for the efficient use of biomass energy that are either already developed or in various different stages of development. Agricultural byproducts, excluding those from sugarcane, represent energy potential of approximately 37.9 million toe annually, equivalent to 747,000 barrels of oil per day, and which is practically unused.

Sugarcane bagasse is one of the most important sources of energy in the sugar and ethanol industry. The 2006-2015 Ten-Year Growth Plan estimates the technical potential of cogeneration in this sector in 2009 at 5,750 MW, with commercial potential of slightly more than 2800 MW.

Today, the national sugarcane industry has 304 plants in operation, of which 227 are in the Central-South region and 77 in the North-Northeast region, as well as 80 projects in the implementation and development phases. The sugarcane industry is thriving because of the growth in domestic and foreign sugar and ethanol markets. Sugarcane production in the 2005-2006 harvest was 380 million tonnes, while around 520 million tonnes is expected for the 2010-2011 harvest and the 2015-2016 harvest should exceed 710 million tonnes, for average growth in the national industry of 6.4% per annum over a ten-year horizon.

In a nutshell, findings show that the country has supply potential of more than 500 MW per year of installed capacity in new biomass cogeneration projects, totaling more than 6,000 MW by the end of the ten-year period, potentially contributing some 3,300 MW of energy supply to the National Integrated System (SIN).

Note that this potential is not evenly distributed across the country, with 80% concentrated in the Southeast and Midwest regions, mainly in the states of São Paulo, Minas Gerais and Goiás, and 20% in the North and Northeast regions, mainly in the states of Alagoas and Pernambuco, with some potential in Maranhão by the end of the period. The 2006-2015 Ten-Year Plan conservatively estimates supply potential of 4,300 MW from sugarcane bagasse by 2015.

3.1.5.1 - Proinfa Program

The Program to Foster Alternative Electricity Sources (Proinfa), which is coordinated by the Ministry of Mining and Energy and implemented by Centrais Elétricas Brasileiras (Eletrobras), was regulated on March 30, 2004, when its implementation began. The program introduces a new strategy for the sustainable insertion of alternative renewable energies in Brazil's energy matrix and strengthens the country's policy of diversifying the matrix and encouraging the development of renewable energy sources.

In February 2005, the program contracted, through Eletrobras, 144 generation stations to benefit 19 states, with combined installed capacity of 3,299.40 MW, of which 1,422.92 MW came from wind plants, 1,191.24 MW from small hydroelectric power stations (PCHs) and 685.24 MW from biomass plants.

Proinfa receives investments, mainly from the private sector, of R$11 billion, and the main financing agents are the BNDES, BASA, CEF, BB and BNB. The power generated by all of the projects totals approximately 12,000 GWh/year, which is equal to twice the annual consumption of a medium-sized Brazilian state.

The program's implementation is expected to lead to carbon reduction of 2.8 million tCO_2e/year.

Today, of these 144 projects: 33 are already in operation (868 MW), 54 have started to be built (1,026 MW), and 21 are under the responsibility of contracted Engineering, Supply and Construction companies (EPCs) and have not yet started to be built (635 MW).

In other words, 76% of Proinfa has already been made viable, with the remaining 24% now basically depending on the wind turbine suppliers.

Furthermore, in June this year, the "1st Purchase Auction of Energy from Alternative Sources" was held, which will add total installed capacity of 638.64 MW in new plants to the National Interconnected System (SIN) as of 2010, of which 541.9 MW will be from biomass-fueled thermoelectric plants and 96.74 MW from small hydroelectric power plants.

Data on Brazil's potential in renewable energy sources

- Wind: 143 GW capacity (Atlas of Brazilian Wind Potential);
- Small Hydroelectric Power Plants: inventoried potential of approximately 15,000 MW; 1.700 MW in commercial operation;
- Biomass: sugarcane bagasse - 8,700 MW; rice husks and wood byproducts - 1,300 MW; urban solid waste - 600 MW.

3.1.5.2 - Light for All Program

In Brazil, approximately 12 million people did not have access to electricity, of which 10 million live in rural areas. With a view to accelerating the process of social inclusion of a large number of Brazilians, since 2004 the federal government, through the Ministry of Mining and Energy, has developed the National Universal Access to Electricity Program – Light for All Program. The objective of the program is to meet the needs of these electricity consumers by 2008, i.e., seven years earlier than projected in the government plans for universal access to supply, which without the Light for All Program would be expected to be implemented only by 2015.

The program calls for investments of R$12.7 billion. Of this total, R$9.1 billion will be provided by the federal government and the remaining funds provided by state governments, power utilities and rural electricity cooperatives.

As of September 2007, a total of 1,291,172 new connections had been made, which represents 6,455,860 people served and the creation of 193,000 jobs. To meet these targets, in addition to the conventional alternative of extending the grid, in isolated regions of the country, whenever possible the Light for All program adopts the use of individual generation or decentralized generation systems from renewable alternative sources.

More than just providing comfort, the program gives these Brazilians the opportunity to work and earn a living. The coordinated actions with other ministries involved with federal government social programs will increase the possibility of these regions further benefiting from other basic services that include water supply, health, education and communication.

3.2 - Policies and programs related to climate change mitigation

3.2.1 - Energy conservation and recycling

In modern economies, energy use is one of the principal causes of anthropogenic emissions of CO_2 into the atmosphere. To reduce these emissions without sacrificing economic development, the principal strategies are: 1) replacing fossil fuels with other non-emitting (or renewable) sources such as hydropower, solar power and sustainable biomass; and 2) conserving or using more efficiently all forms of energy used by society. This section analyzes the implementation of this second strategy in the Brazilian economy, although in the Brazilian context the two strategies are often strongly interlinked.

There is a huge potential for energy savings in Brazil among final consumers, whether by using more efficient technologies in vehicles, engines, home appliances, etc., or indirectly through actions such as improving transportation systems. There is also a significant potential for waste reduction among energy suppliers in the process of transforming primary energy into the forms more widely used by consumers.

The relationship between energy savings and emission reductions is not linear, in other words, a potential reduction in energy consumption does not necessarily lead to a proportional reduction in greenhouse gases. This is to a large extent due to the extensive use of renewable primary energy in Brazil, especially the dominance of hydro energy in electricity generation. However, the increased generation by thermal plants planned for the short term will mean that a small variation in energy savings will have a considerable impact on emissions.

Since the use of fossil fuels is unavoidable, its efficient use and a reduction in the byproducts produced are probably the most attractive way to reduce CO_2 emissions. This attractiveness is reinforced by the fact that to maintain or increase the use of renewable alternative energy sources, Brazil will depend in part on improving the efficiency of the transformation process.

3.2.1.1 - Procel

The National Electricity Conservation Program (Procel) was created by Inter-ministerial Act 1877 of December 30, 1985, through a joint initiative of the Ministry of Mining and Energy and the then Ministry of Industry and Commerce. The program was the first systematic initiative to promote efficient electricity use in Brazil by coordinating the many actions aimed at rationalizing electricity use throughout the country, seeking to maximize their results and promoting a broad spectrum of new initiatives, subjected to rigorous testing of opportunity, priority and economicity.

The program's objective was to combat waste in the production and use of electricity, providing the same product or service at a lower consumption, through greater energy efficiency, thereby ensuring an overall reduction in costs and investments in new installations in the electricity system.

On July 18, 1991, through an executive order, Procel was transformed from an industry-specific program into a government program with broader goals and greater responsibilities, with direct interaction with and effects on society as a whole. The program was no longer restricted to just the electricity sector, becoming involved in all sectors of society directly or indirectly linked to the production and use of electricity.

An effort was also made to revitalize the program through Law 8631 of March 4, 1993, which determined that resources from the Global Reversion Fund (RGR) must be allocated to electricity conservation.

The main projects and activities implemented by Procel thus far include:

Inclusion of a contractual clause that requires public utilities providing electricity services to invest 1% of their net operational income in energy efficiency measures. Law 9991/00 subsequently included research and development measures, among other provisions;

Promotion of Efficientia 98, the world's most important seminar on energy efficiency, with 2,300 participants, 150 of which from other countries;

Technical and institutional contribution to the drafting of the initial text of the bill that would became Law 10,295/01, known as the Energy Efficiency Law;

Support for the creation of conservation services companies (Escos);

Conferring of the Procel Energy Savings Seal and the Procel Award, the former to the most efficient equipment, in partnership with Inmetro’s Brazilian Labeling Program, and the latter to different consumer classes, as well as professionals who have distinguished themselves in the efficient and rational use of energy;

The inclusion of this issue at all levels of formal education in the country, including university extension courses;

Carrying out field research on the main consumer classes to guide the Program’s actions;

The creation of ReLuz and Sanear to improve energy efficiency in public lighting and in basic sanitation companies;

Successful media campaigns seeking in particular to reduce demand during the peak consumption hours of the electricity grid;

Preparing 22 laboratories and research centers to provide support for the Energy Efficiency Law and Procel’s actions;

Recent publication of a large technical collection focused on industrial processes;

Sponsoring of courses and training for agents, multipliers and technicians who work at industrial companies, service companies and public agencies;

Launching of the Brazilian Energy Efficiency Information Center (Procel Info), which aims to be recognized as a reference in quality information on energy efficiency.

Procel has incorporated new activities, especially in the areas of:

Marketing: strengthen the Procel brand and disseminating the concepts of combating electricity waste to the market and the general public. The main instruments used are: promotion of the “Energy Savings Seal” and the “National Award for Combating Energy Waste”;

Technology: encouraging technological advances in the home appliances and consumer electronics sold in the country, by conferring the Procel Seal and building the capacity of universities and research institutions to carry out the tests required by Inmetro’s Brazilian Labeling Program (PBE);

Information: the main tool of the Brazilian Energy Efficiency Information Center (Procel Info) is a website (www.procelinfo.com.br) that aims to gather and make available qualified information on the rational and efficient use of energy in Brazil and the world;

Education: implemented in primary and secondary schools as well as in universities, the program has already benefited 17 million students through the environmental education program “The Nature of the Landscape - Energy” developed for basic education schools, and the “Energy Conservation” course developed for post-secondary students;

Government buildings: optimization of energy use in government buildings by promoting efficient lighting and cooling and orientation for managers and staff on rational use of resources;

Municipal Energy Management: seeks to collaborate with municipal governments on efficient management and use of electricity in the local government's power consumption centers;

Public Lighting: the National Program for Efficient Public Lighting (Reluz) provides for investments of some R$2 billion financed by Eletrobras, with resources from the Global Reversion Fund (RGR) to improve the efficiency of 5 million public lighting points and install 1 million new points in the country by 2010;

Industry: provides support for a range of industrial segments to improve the energy performance of their facilities, drawing on the participation of a variety of agents in the sector;

Sanitation: promotes not only electricity conservation but also water conservation issues;

Buildings: energy conservation in buildings in the residential, commercial and services sectors.

The quantitative results achieved by PROCEL have been estimated in terms of energy savings, expressed in GWh/year, as well as in demand reduction during peak hours of the system, expressed in MW removed or diverted from the peak.

These values for energy savings and demand reduction can also be interpreted as equivalent to the electricity produced by a typical hydroelectric plant (equivalent plant), the construction of which was avoided through the implementation of energy conservation measures. Also considered is the avoided investment in construction of this plant and expansion in the electricity system, taking into account generation, transmission and distribution of energy to final consumers.

In the period 1986-2005, Procel enabled electricity savings of around 22,000 GWh, at a cost of less than R$860 million, compared with an avoided investment of R$14.9 billion in the construction of a plant with installed capacity of 5,100 MW. In other words, for each R$1.00 used in combating waste, R$17.00 was saved.

Of the overall results in energy savings (2158 GWh/year in 2005) and demand reduction (585 MW in 2005), the sectors in which Procel obtained the greatest returns in 2005 were the promotion of more efficient lighting, with the replacement of lamps in public lighting and in the commercial and residential sectors, and the increased efficiency of domestic appliances (refrigerators, freezers and air conditioners) and motors, through labeling and the granting of the Procel Seal.

3.2.1.2 - Conpet

Conpet was created by an executive order on July 18, 1991, with the goal of integrating actions that seek to optimize the use of oil and natural gas products by reducing losses and eliminating waste, using energy in a more rational and efficient manner, and developing more energy efficient technologies. The program was implemented through the Ministry of Mining and Energy.

The program, with the support of Petrobras, establishes technical cooperation agreements and partnerships with governmental and non-governmental bodies and with representatives from entities involved in the issue, and also organizes and sponsors projects. The program's actions to rationalize the use of oil and natural gas products help to better coordinate the economic, environmental and institutional strategies.

Conpet develops specific and strategic actions to achieve its main objectives: to reduce diesel oil consumption and black smoke emissions, promote the use of natural gas as a fuel, encourage new technologies in the home appliances sector, encourage companies in the sector to rationalize energy use, and educate new generations about the concepts of rationalization, sustainable economy and quality of life.

Conpet's initial goal was to obtain a gain in energy efficiency of 25% in the use of oil and natural gas products within the first 20 years, without affecting the level of economic activity in the many sectors of the national economy. Conpet has been carrying out projects in the transport, industrial, residential, commercial, agriculture and thermoelectric generation sectors.

In the area of highway transportation, Conpet developed a methodology to assess energy efficiency in bus and truck fleets and develop demonstration and dissemination projects, through monitoring of fuel consumption, vehicle maintenance, driver training, and new fuel saving technologies.

Also in the highway transport sector and including freight and passenger transportation, the Economizar (literally "savings" in Portuguese) project was created in 1996, seeking to rationalize the consumption of diesel oil and improve air quality, reducing black smoke emissions from buses and trucks. The program's objectives include reducing by roughly 13% and within a timeframe of two to five years the consumption of diesel oil, achieving a reduction of some 50,000 barrels/day and minimizing vehicle emissions, and consequently improving air quality and making a positive contribution to the sector's image.

The Economizar project has already achieved positive results, which have generated demand from the private sector for its expansion. With the engagement of other entities and an increase in the fleet, the project has now been implemented in 22 states of Brazil and has 45 mobile units. The number of participating companies has grown to 5,000.

Results of the Program

Number of States	21
Entities (15 passenger entities, 13 freight entities and 5 freight and passenger entities)	33
Mobile units	48
Participating companies	1,750
Fleet	98,000
Assessments made	120,000
Total fuel saved (l/year)	252,000,000
CO_2 not released to the atmosphere (t/year)	700,000
Particulate not released to the atmosphere (t/year)	19,000

Note: Consolidated data up to 2005.

In the case of urban passenger transport, Conpet developed a methodology for managing the use of diesel oil in bus companies. This involves implementing demonstration projects to validate the methodology and providing incentives for bus companies to adopt management practices and technologies aimed at reducing fuel consumption.

In this context, CONPET developed the Gas Bus project to encourage the use of natural gas in urban and metropolitan public transportation. The idea of using natural gas in the public transport sector is based on the fact that Brazil's transportation sector accounts for around half of domestic consumption of oil products. Highway transport accounts for most consumption: 95% of passenger transport and 62% of freight transport uses diesel-fueled vehicles. Because of vehicular emissions, especially in major urban centers, the transport segment suffers pressure from environmental authorities and the public to improve diesel oil use and possibly replace it with another fuel in the near term.

As a result, vehicular natural gas (VNG) is the fuel that offers the best conditions for large scale use, with guaranteed supply and distribution, vehicle manufacturing technology and significant environmental benefits.

Another project under Conpet, the Transportar project, provides specialized technical support to the fleets of tanker trucks that supply Petrobras, taking advantage of the environmental aspects, as well as the lower fuel consumption and fuel transport safety aspects. The project aims to reduce black smoke emissions, improve air quality, save diesel fuel, contribute to fuel transport safety, and disseminate a culture of social responsibility.

As of December 2005, the Transportar project had carried out more than 4,600 assessments of almost 2,300 vehicles. Around 300 companies have participated in the tests. The efforts and work of project participants have avoided 57,279 tonnes/year of CO_2 emissions.

Conpet also develops a project involving a review of technical standards for testing the energy performance of domestic gas stoves and water heaters. A labeling program for domestic gas stoves and water heaters was created to provide consumers with information and guidance on the energy performance of equipment available on the market. Considering only the residential sector, LPG consumption is around 10 million m^3/year, or 5.2 million t/year. Estimates indicate that the program has the potential to save around 1.4 million m^3 or 780,000 tonnes of LPG per year, decreasing the share of the imported LPG gas needed to supply the domestic market.

The Conpet Seal and the Gas Stove and Heater Labeling Program, combined with awareness-raising measures targeting the general public, such as tips on gas savings provided by Conpet and booklets on Inmetro's Labeling Program (PBE), have the potential to generate savings of up to 20% in gas consumption.

The Conpet energy efficiency Seal, in use since August 2005, seeks to encourage the manufacturing and sales of more efficient Brazilian-made equipment, showing consumers which units have the best levels of energy efficiency within each specific category. The seal is awarded to consumer equipment that burns oil and natural gas and has achieved the lowest fuel consumption rates. The purpose of the seal is to serve as an incentive for domestic manufacturers of gas appliances.

Conpet also develops educational projects with a view to presenting the importance of rational energy use and raising the awareness of future generations related to the preservation of natural resources and the environment, encouraging students and teachers to advocate the rational use of such resources, particularly oil and natural gas products. The program has been implemented in more than 350 municipalities with the participation of more than 3,500 schools, including more than 4,900 teachers and 2.3 million students as of 2003.

3.2.1.3 - Recycling

Given its economic, social and environmental advantages, recycling in Brazil has been expanding steadily. Previously, recycling occurred only through a few isolated programs by municipalities, communities and business entities involved in the selective collection of waste materials. Today, these initiatives are fostered by the federal government.

In recent years, with the substantial advances in Brazil in terms of recycling, several materials have recycling rates close to those of developed countries.

Recycling in Brazil

Material		Recycling rate (%)
Aluminum cans		96.2
Glass containers		46
Paper	Office	49.5
	Corrugated	77.4
	Film	20
Plastic	Rigid	20
	PET	47
Steel cans		29

Source: CEMPRE 2005

A large number of materials are currently recycled in Brazil. Some waste markets involve recycling of industrial wastes, but this is still limited, and does not exploit all the commercial possibilities. And only materials where the process has been proven to be economically viable (aluminum, paper, glass, plastic, etc.) have attracted interest in their recycling. The materials that are most used for recycling in Brazil are office paper; corrugated paperboard; plastic film; aluminum cans; steel cans; glass; rigid plastic; tires; PET containers; long-life cartons; used lubricating oil; urban compost.

Of special note are the figures for the recycling of aluminum cans in Brazil, for which the recycling rate increased from 37% in 1991 to 96.2% in 2005. These figures exceed those of industrialized countries such as Japan and the USA. In 2004, the United States recycled 51% of its cans, Argentina 78%, Europe 48%, and Japan 86%.

Recycling involves reusing materials and wastes generally considered garbage. Thus it is of crucial importance to implement curbside recycling programs to collect recyclable materials.

In a pioneering initiative, CEMPRE collected information about the selective collection programs implemented by 327 municipalities throughout Brazil, with the highest concentration located in the Southeast and South of the country. Studies were completed in 17 municipalities (Belo Horizonte/MG, Brasília/DF, Campinas/SP, Curitiba/PR, Florianópolis/SC, Itabira/MG, Londrina/PR, Porto Alegre/RS, Recife/PE, Ribeirão Preto/SP, Rio de Janeiro/RJ, Salvador/BA, Santo André/SP, Santos/SP, São Bernardo do Campo/SP, São José dos Campos/SP, São Paulo/SP). Some 25 million Brazilians have access to recycling collection programs, with 43.5% of these programs directly related to scavenger cooperatives.

Despite the unquestionable advantages of recycling, this research shows that the price of curbside recycling programs is very high, on average US$151/tonne, more than five times the cost of conventional collection. There is a clear need, therefore, to seek cheaper and more efficient collection means.

Deforestation Emission Reduction in the Brazilian Amazon

4 - DEFORESTATION EMISSION REDUCTION IN THE BRAZILIAN AMAZON

Brazil has a different anthropic greenhouse gas emission profile from developed countries where CO_2 emissions from burning fossil fuels represent the largest part of their total greenhouse gas emissions. The fact the country has invested heavily in renewable energy sources, underscored by its electricity production as well as its use of renewable biomass fuels in transportation, can be seen in the National Greenhouse Gas Inventory for 1990-1994. It shows that together the Energy, Industrial Processes, Solvents and Waste Treatment sectors contributed only 25% of total carbon dioxide (CO_2) emissions in 1994, estimated at 1.030 Tg (approximately 1 billion tons). The rest of Brazilian CO_2 emissions was tied to the Change in Land and Forest Use sector, and of that total, 90% corresponded to the conversion of forests to other uses, especially agriculture and ranching.

Brazil is comprised of six large biomes, two of which are particularly important for national greenhouse gas emissions: the Amazon and the Cerrado, which together cover more than 70% of national territory (see figure below).

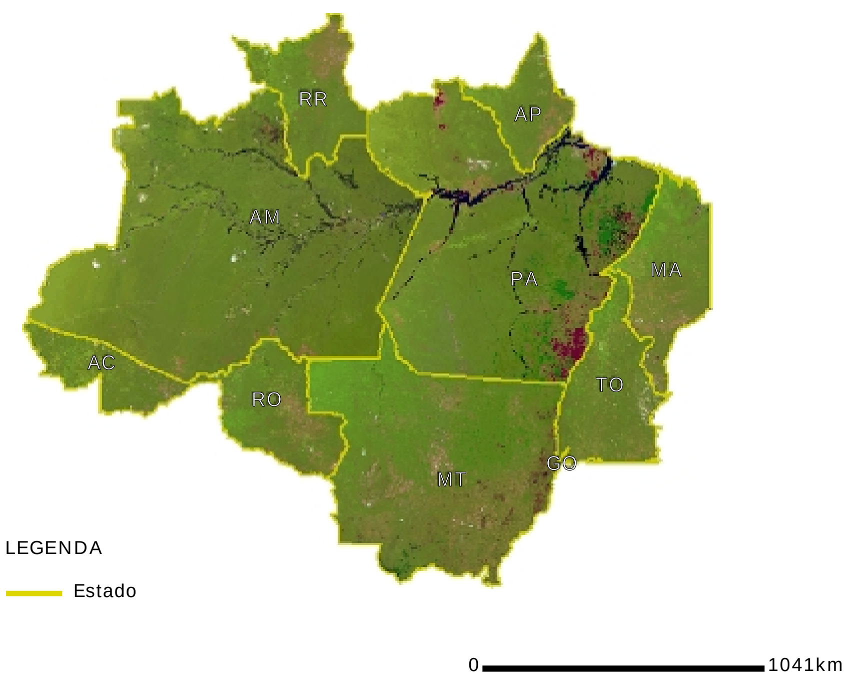
Distribution of Brazilian biomes in national territory

Source: MMA (Ministry of Environment)

Although the Amazon deserves most of the international attention, the Cerrado is also an extremely important biome with high levels of biodiversity and a carbon stock mainly concentrated in the below-ground and above-ground biomass. Of the gross annual average CO_2 emissions associated with the Change in Land and Forest Use sector from 1988 to 1994 (902.28 Tg CO_2/year), 62% and 27% referred to the Amazon and Cerrado biomes, respectively. The four remaining biomes made marginal contributions to total Brazilian emissions.

Brazilian Amazon is comprised of nine states: Acre (AC), Amapá (AP), Amazonas (AM), Maranhão (MA), Mato Grosso (MT), Pará (PA), Rondônia (RO), Roraima (RR) and Tocantins (TO) (see figure below), each with different patterns of occupation and forest cover.

States of the Brazilian Amazon



Source: IBGE 2006

Brazil has invested in space technology since the mid-1970s, through the creation of the National Institute for Space Research (INPE) and the training of a team that was involved in the first pre-launch studies for the American satellite, ERS-1, later called Landsat-1. This investment also involved installation of a reception antenna located in Cuiabá, which has captured images of the entire national territory since the 1970s, thus representing a huge and unique collection of data on our country.

At the end of the 1980s, the National Institute for Space Research - INPE began to generate annual estimates of gross deforestation of the Legal Amazon based on the visual interpretation of colored imagery on a scale of 1:250.000. This permitted the visualization of any deforestation greater than 6.25 hectares (0.0625 km^2). A methodology was also developed to estimate possible deforested areas under cloud cover. It was thus possible to develop a consistent historical series of gross deforestation. Additionally, the methodology used by INPE in the so-called PRODES (Program to Calculate Amazon Deforestation) applies, whenever necessary, a correction factor to each image to ensure the analyses cover a 12-month period, thus avoiding any under or overestimation of the annual rate of gross deforestation.

The Pilot Program for the Protection of Brazilian Rain Forests (PPG-7), then financed by the G-7, was announced during the Earth Summit in Rio de Janeiro in 1992. In 2000, the federal government began a study to understand the causes and dynamics of Amazon deforestation with the objective of guiding public policy and the use of existing management instruments, confronting the problem in an integrated manner. Despite the advances obtained with the Program, the average annual rates of gross deforestation remained high.

The PPG-7 based itself on a set of sub-programs and projects focused on five large lines of action, which were very important for gaining knowledge on deforestation in the Amazon region: (a) protection and management of protected areas and indigenous lands; (b) demonstrative projects in sustainable production and resource management; (c) institutional strengthening of governments at the state and municipal levels and civil society organization networks; (d) support for applied research in science and technology; and (e) identification and dissemination of strategic experiences.

In the first semester of 2003, the INPE gave the Ministry of Environment the estimated annual rate of gross deforestation for the Legal Amazon, which indicated a 40% increase in the estimated rate for the previous period, from July 2001 to August

[3] Here, deforestation is understood as the conversion, through anthropic actions, of areas with primary forest physiognomy to develop agrosilvopastoral activities detected from orbital platforms. The term gross deforestation indicates that areas in the process of secondary succession or forest recomposition were not deducted from the extension and rate calculation

2002. The estimate represented the second highest annual rate for gross deforestation recorded since 1988, which made the federal government form a Work Group comprised of 12 Ministries to carry out a careful assessment of the causes for this increase in deforestation and to present an integrated action plan to confront the problem. The Civil House for the Presidency of the Republic was given the job to coordinate the work, indicating the action's strategic nature.

The Action Plan for the Prevention and Control of Amazon Deforestation was announced in March 2004. Its priority focus was the deforestation arch, in Legal Amazon, where the highest annual rates of gross deforestation and the highest heat foci recorded in the country were concentrated.

The Action Plan introduced several important changes in relation to other initiatives carried out in the past. Rather than being treated in an isolated manner by the Ministry of Environment, the Plan involved more than a dozen Ministries, allowing deforestation to be treated in an integrated manner and projecting actions directed towards:

Improving the monitoring of the deforestation process, from a regional to a local scale, in order to provide more agility to public authority action against degraders;

Promoting the presence of public authorities in critical zones, a long-time request from the most vulnerable sectors of regional society;

Confronting the land speculation problem involving public lands, which is at the origin of the economic frontier's advance on the forest;

Planning territorial occupation in critical areas through the appropriate distribution of public lands according to social and ecological peculiarities;

Containing predatory wood exploration while also promoting production activities that valorize the forest, such as sustainable forest management.

The actions projected in the Action Plan began to be implemented during the first semester of 2004. Over the next two years, the annual rate of gross deforestation in the Legal Amazon presented a systematic drop until reaching 1,403,900 hectares, the lowest on record since 1997. More details on the deforestation rate reduction process are shown in "Deforestation emission reductions over the past two years".

Preliminary estimates generated from data from the MODIS sensor, which is on board the American Acqua and Terra satellites, indicate an even more accentuated reduction for the period from August 2006 to July 2007. The estimated gross deforestation rate for this period, using better spatial resolution data (Landsat and CBERS) shall be provided by the end of this year.

The main actions implemented since 2004 were:

4.1 - Improvement in remote sensing systems to control deforestation and the selective cutting of wood

The Ministry of Environment has invested in the INPE since 2003, expanding its technical team and the infrastructure needed to promote the analysis of imagery as well as the acquisition of a larger number of TM-Landsat images per year. Images from the Chinese-Brazilian Earth Resources Satellite (CBERS) also began to be used in the PRODES to minimize the cloud cover effect on areas of the Brazilian Amazon forest, thus permitting more reliable estimates of the annual rate of gross deforestation. The work, which once took eight months, now takes approximately five months. This allows the data (aggregated as well as discriminated at the state and municipal levels) to be distributed to the country with greater agility.

Although PRODES is carried out in order to ensure the consistency of the historical series of data since 1988, several advances have been achieved over recent years in the Project, and they include:

Making images, interpretation and analysis of data available on the Internet, providing transparency to the estimated annual rates of gross deforestation in the Brazilian Amazon;

Improving the cartographic quality of the analyses;

Increasing the number of sensors used to generate the estimated annual rate of gross deforestation, minimizing the total area of forests affected by cloud cover;

Expanding the technical team and infrastructure needed to reduce the time required to generate annual estimates;

Assembling a consolidated database (TerraAmazon System) containing the digital PRODES data.

At the same time, investments were made to develop a new system, called DETER (Detection of Deforested Areas in Real Time System), which operates as an early warning system concerning deforestation in the Legal Amazon. Georeferenced information is generated every 15 days on changes in the Brazilian Amazon forest cover. This permits implementation of faster inspection and fine notification actions involving illegal deforestations.

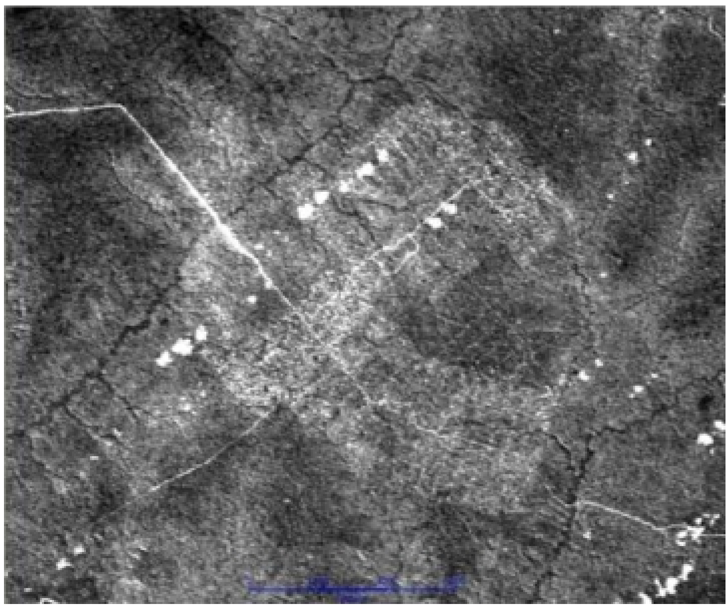
Although the information is generated from coarser spatial resolution satellite images (250 meters), DETER has proved to be useful to speed up the combating of illegal deforestation, since it provides data with greater temporal frequency (15 days). DETER images are also available on the Internet (www.obt.inpe.br/deter), through INPE, and can be downloaded and used without restriction by all interested parties.

DETER data have also been used to point out significant differences in the altered forest cover areas in the corresponding months, from one year to the next, promoting an intensification of inspection actions for the more critical areas detected by the System. In 2007, for example, an increase was detected in the deforested area in July, August and September, when compared to the same months of 2006. But that does not necessarily imply that the gross deforestation rate for the period from August 2007 to August 2008 will increase. It is necessary to assess deforestation over the entire period in consideration, and not only in the indicated months. Regardless, at the end of October 2007, the Ministry of Environment called a meeting with the operating bodies of the Action Plan for the Prevention and Control of Deforestation in the Amazon, with the objective of discussing strategies to continue the intensification of command and control actions to combat deforestation in the region. The 40 townships with the highest rates of deforestation, located in the state of Pará, in Rondônia and Mato Grosso, will be the targets for new operations.

Additionally, a new system, called DETEX (Selective Logging Detection System), is being tested to monitor public forest areas set aside for the sustainable management of production through concessions. This process is managed by the Ministry of

Environment's Brazilian Forest Service using Landsat images. The DETEX System aims at monitoring the impact of logging activities in the middle of the forest, such as trail openings, log storage yards and the removal of trees, the so-called selective logging, shown in the figure below.

Selective logging pattern in a Landsat image



Source: INPE 2007

As part of the efforts to reduce the pressure in public forests areas in the Brazilian Amazon, the government began a program to promote logging in public forest areas in Brazil, adopting precautions to avoid conflicts while also ensuring total transparency to the process to grant forest concessions. The first area to receive a forest concession through a public tender and payment for the use of forest resources was announced in September of that year, and it is located in the Jamari National Forest, a region with intense illegal deforestation. Of the 220 thousand hectares of protected area, nearly 40% (90 thousand hectares) are set aside for sustainable management. The projects can consider the management of logging and non-logging products and even include activities like ecological tourism.

Monitoring areas under concession will be fundamental to ensure the success of this pioneer initiative in the country. Thus, instruments like DETEX will play a fundamental role in accompanying activities carried out in public forest areas, as well as *in situ*.

This remote sensing technology (orbital and Geographic Information System – GIS images) is also being used in a system that has been installed in the state of Mato Grosso since 2000 (Environmental Licensing System in Rural Properties - SLAPR). Besides its inspection and licensing activities, it also monitors agriculture and ranching activity on rural properties in Legal Amazon.

SLAPR consists of georeferenced registration on a digital cartographic basis, on a scale of 1:100,000, of the perimeter of the rural property in which the areas protected by law are delimited, as are the zones set aside for economic use. Deforestation of these areas is authorized by the issuance of a license by a state environmental body. After that, property use is monitored annually by satellite images. If irregular deforestation is detected, inspection is activated and the rural property is fined and notified it must sign a commitment to recover any damage it caused. The system is being applied to 25% of the state's area.

After one year of operation, a reduction in the pace of deforestation was ascertained on properties registered in SLAPR, whereas the other areas saw an increase. However, in following years, deforestation began to increase in regions monitored by the system. A study contracted by the Pilot Program in 2004 concluded that although it is an innovative tool to control deforestation on private properties, problems such as the lack of transparency and ineptitude in managing and operating SLAPR compromised its results. Furthermore, the percentage of punished violators was low. That same year, a Federal Police operation uncovered a gang that defrauded deforestation authorizations with ramifications in the environmental body responsible for the system.

Despite this drawback, SLAPR is considered an essential instrument by governmental and non-governmental sectors to expand control of deforestation in the Legal Amazon. That is why the system is being implemented, with adaptations, in other Legal Amazon states since 2004, as part of the objectives of the Action Plan for the Prevention and Control of Deforestation in the Amazon. Implementation will permit the federal environmental body (IBAMA) to integrate state databases on environmental licensing in rural properties with other computer systems used to monitor and control human activities in the Amazon, administered in Brasília. With that, public authorities will have the means to monitor deforestation from a regional and state scale to a rural property scale, facilitating the identification of violators and the application of laws.

4.2 - Permanent inspection and control actions for environmental crime in the Legal Amazon

Insufficient presence of government bodies responsible for inspection and for enforcement is understood as one of the reasons for illegal deforestation activities in the Brazilian Amazon. Without appropriate means, the bodies in charge of repressing environmental crime and violence against local populations depended on an extraordinary allocation of resources to form task forces that eventually and periodically carry out operations to uncover gangs comprised of land speculators, loggers, hired guns, and not rarely, civil servants. At the end of operations, the illegal activity resumed.

One of the great advances brought by the Action Plan for the Prevention and Control of Deforestation in the Amazon was to tie remote sensing monitoring actions to inspection actions and early, no longer occasional, warning control, thus contributing to the creation of an environmental inspection culture integrated to federal public authority. Construction of this new policy required investments in IBAMA, the federal environmental body, to create new structures, improve technical and human resources and implement planning and execution methods that resulted in the body's increased presence in critical areas and greater effectiveness of inspection actions.

Below we describe how this has been done.

- *New inspection action planning model:* first, from the selection of inspection operation targets based on deforestation's dynamics and spatial tendencies (when PRODES data are fundamental) and field information provided by IBAMA inspectors. This selection can be dynamic, whenever new data point to the need for adjustments; second, an estimate of the number of necessary operations, their duration and necessary human and financial resources, which permits better planning; third, a partnership with federal and state police and state environmental bodies, and in more complex operations, the Brazilian Army.

- *Expansion and restructuring of operation bases in critical zones:* at present, there are 13 operational bases that operate in a radius of approximately 300 km. They are integrated to IBAMA's command and monitoring centers, headquartered in Brasília, and constituted based on information from the most critical deforestation areas. These bases are dynamic and can be moved elsewhere as necessary. Investments in equipment, especially vehicles equipped with radios and GPS, were made at all the operational bases, totaling nearly US$ 15 million from 2004 to 2007.

■ *Creation of the Environmental Monitoring Center:* the Center was created in 2004 and it is responsible for the interface between the Amazon's monitoring systems and the operational bases responsible for inspection. After receiving DETER images, the Center distributes a digital file to the operational bases in the Amazon, activating inspection. Between the beginning of 2005 and September 2007, 17,412 map guides were sent to the bases indicating changes in forest cover recorded by DETER.

Data from the ALOS radar satellite, which belongs to the Japanese space agency (Jaxa), have been made available to the Center, since September 2007, with the support of the Japan International Cooperation Agency - JICA. Use of these images will increase inspection capacity in areas persistently covered by clouds, especially during the cloudiest period from October to March, since radar data are not affected by their presence.

■ *Creation of the Coordination for the Production of Information on Environmental Crimes:* the creation of this Coordination in 2006 was necessary to combat the level of organization of those groups that commit environmental crimes in the Amazon, the ramifications of which involve public authorities. The Coordination acts together with the investigation services of the Federal Police, a Ministry of Justice entity, and the Brazilian Intelligence Agency, aimed at providing useful information for planning inspection operations and repressing crime associated with deforestation.

■ *Renewal and training of inspection staff:* the holding of two civil servant exams in five years improved the professional profile of those responsible for inspection since new hirings increased the number of civil servants with college degrees, with more diversified capacities and able to operate new technologies incorporated into the system. Specific courses were offered for inspectors, operation coordinators and entities operating in the region, aimed at improving operations of the diverse agents in identifying environmental crime and other types of crime associated with deforestation.

■ *Improved enforcement:* one of the reasons understood as a stimulus for illegal deforestation activities in the Amazon was associated with the low value of fines - a maximum of US$ 500 for every 1.5 thousand illegally deforested hectares. In 2005, this value was increased to US$ 2.5 thousand per illegally deforested hectare, which led to an increase in the sum of applied fines, from US$ 250 million to approximately US$ 1 billion per year.

- *Integrated action:* illegal deforestation in the Amazon is associated with other criminal practices such as illegal appropriation of public lands, invasion of protected areas, corruption, narcotraffic and violence against local populations. Since IBAMA's police power is limited to environmental crimes, inspection operations carried out in the Amazon demand the participation of agents from other federal and state government bodies. This integration between different bodies has been pointed out as one of the main reasons for the good inspection action results in the Amazon. Between 2005 and 2007, an average of 70 large inspection operations were planned and carried out per year in the Amazon.

Other results achieved by inspection operations in the Legal Amazon include:

Between 2005 and 2006: sharp reductions in gross deforestation rates in 18 of the 20 townships with the highest rates; in 15 of these townships the reduction in deforested area was greater than 50% and in 10 the reduction exceeded 70%;

Between 2005 and 2006: accentuated reduction in the gross deforestation rate in protected areas under state jurisdiction;

Between 2003 and August 2007: 364 loggers and 96 civil servants arrested in 12 operations to combat corruption. The operations had the support of the Federal Police;

Between 2005 and 2006: 54% reduction in gross deforestation rate in indigenous lands in the Legal Amazon.

- *Land regularization and combating the illegal appropriation of public lands:* decades of fragile policies to plan land occupation and use in the vast territory that comprises the Brazilian Amazon contributed towards the expansion of conflicts involving access to land and to natural resources. One of its products is precisely deforestation, since during the process of illegal appropriation of public lands, land-use change for other uses is one of the mechanisms used to characterize possession or ownership of land by private landowners for subsequent regularization.

■ *Registration of lands and land regularization:* the National Registry of Rural Properties (CNIR) was created in 2001. It was re-energized in 2004 with the injection of US$ 5 million into the system aimed at combating fraud involving public lands. The CNIR concentrates information on the registration of rural properties spread about different public bodies in a single registry. This permits identifying contradictions regarding the person's land assets and thus points out fraud.

■ *Revision of public land use policies:* when Law # 11.196 of November 2005 took effect it promoted the regularization of federal public land occupation in areas ranging between 100 and 500 hectares. Before that, this regularization was limited to occupations of up to 100 hectares. Regularization requires proof of residence and productive use of the occupied area before December 1, 2004. Regularization of the right to land reduces illegality and encourages producers to adopt more sustainable means of land and natural resource use. At the same time, it contributes to a reduction in tension in the field and permits producer access to credit and infrastructure programs for production.

■ *Combats corruption:* the participation of civil servants in illegal land appropriation schemes is at the core of the issue in the Brazilian Amazon. After a Federal Police operation in 2004, a gang was uncovered with ramifications in the public sector. It used to falsify documents to legalize the occupation of large federal and state areas. Eighteen people were arrested, including civil servants. This had a positive effect through the acknowledgement of positive actions on the part of federal bodies.

■ *Territorial planning – the role of protected areas:* the creation of protected areas is one of the Action Plan for the Prevention and Control of Deforestation's instruments to solve conflicts involving access to land and natural resources, and as a consequence, contain deforestation in critical areas of the Brazilian Amazon.

Between 2004 and 2006, 40,800 mil km^2 of protected areas were created on public lands endangered by the advancing economic frontier in the Legal Amazon. At present, nearly 17% of Legal Amazon encompasses parks and reserves set aside for conservation and the sustainable use of biodiversity. Additionally, about 21% of the region's surface is set aside for indigenous lands. These two forms of land use total nearly 38% of the Amazon territory at this time.

- *New legal framework for the exploration of public forests:* throughout the 1990s, the debate regarding the appropriate development model for the Brazilian Amazon strengthened the idea that only command and control actions were insufficient to contain deforestation. Together with norms, inspection and monitoring, it would be fundamental to implement economic valorization policies for the forest that would increase regional development and keep it standing on a long-term basis. The great challenge of this forest policy would be to eliminate the economic advantage enjoyed by predatory and illegal logging that was spreading about the region and replacing it with sustainable management.

The Public Forest Management Law was created in March 2006 with the objective of strengthening public authority's control over public forests so they could be set aside and explored according to the principles and guidelines that promote sustainable development. The new law was conceived to support the structuring of production chains based on sustainable forest production in order to generate a local and regional economy tied to the good management and conservation of forests. With the new legal framework, exploration of public forests can only occur through concession and with the application of sustainable management techniques. The exploration or deforestation of public lands has been a crime ever since.

4.3 - The future of the Action Plan for the Prevention and Control of Deforestation

Implementation of the Action Plan for the Prevention and Control of Deforestation from 2004-2007 played an important role in reducing gross deforestation in the Legal Amazon, and the consequent reduction in greenhouse gas emissions into the atmosphere. The application of command and control instruments were especially important to prevent illegal deforestation activities, however these instruments are viewed as insufficient to ensure the legal use of land over the long term. The growing domestic and foreign market demand for agriculture products has been putting great pressure on the forest or its frontier, directly influencing deforestation dynamics.

In face of this scenario, the Brazilian government is concluding the elaboration of a second phase of the Plan for the Prevention and Control of Deforestation in the Amazon, with a focus on structuring short-term actions aimed at reversing the verified trend, between June and September of this year, of increased deforestation, and the formulation of long-term actions. Besides expanding and improving the implementation of command and control instruments and territorial planning in areas with high annual rates of deforestation, the intention is for the sustainable economic use of forests to be able to compete on equal footing with activities that force them to be cut, especially ranching, whose valorization follows the pace of other agriculture commodities.

The main pillars for the actions in this new phase of the plan were conceived with the objective of reversing the pressure for opening new production areas and they are:

Increase productivity in active or underutilized areas and at the same time make degraded or abandoned areas productive. Of the estimated 700 thousand km^2 of deforested area in the region, it is estimated that at least 14%, or 98 thousand km^2, is in this situation;

Directly encourage reforestation activities and the sustainable exploration of forests;

Strengthen and articulate federal government actions with state governments through the elaboration of state plans for the prevention and control of deforestation.

The strategic articulation with state governments will be fundamental for improving the following actions:

Monitoring with the implementation of new instruments geared towards the control of logging activities and occupation of agrarian reform settlements;

Control and inspection of irregular activities with a new strategic focus that also addresses production chains, as well as direct production and primary extraction activities; and

Creation of new protected areas and the implementation of recently created units.

This new phase of the Action Plan shall consider, in a complementary manner, preventive measures for deforestation in the area of influence for infrastructure works and inspection and enforcement actions directed towards the most serious cases of deforestation, which will also require an improvement in accountability instruments (criminal, administrative and civil) for those who violate forest legislation. In order to achieve the intended result, it will be crucial to have greater involvement of other government areas in the effort to prevent and combat deforestation. Other mid and long-term actions will be incorporated into the plan after the result of the assessment being carried out at this moment by the Ministry of Environment and which shall be debated with Brazilian society between February and April 2008.

In this new context of policies for the Brazilian Amazon, the federal government is working to substantially increase the federal budget for the actions stipulated in the Plan for the Prevention and Control of Deforestation, and in 2008 it will conclude the final design for the Amazon Program, an initiative that will succeed the Pilot Program to Conserve the Brazilian Rain Forests - PPG7 and which will count on projects geared towards sustainable development in the Amazon.

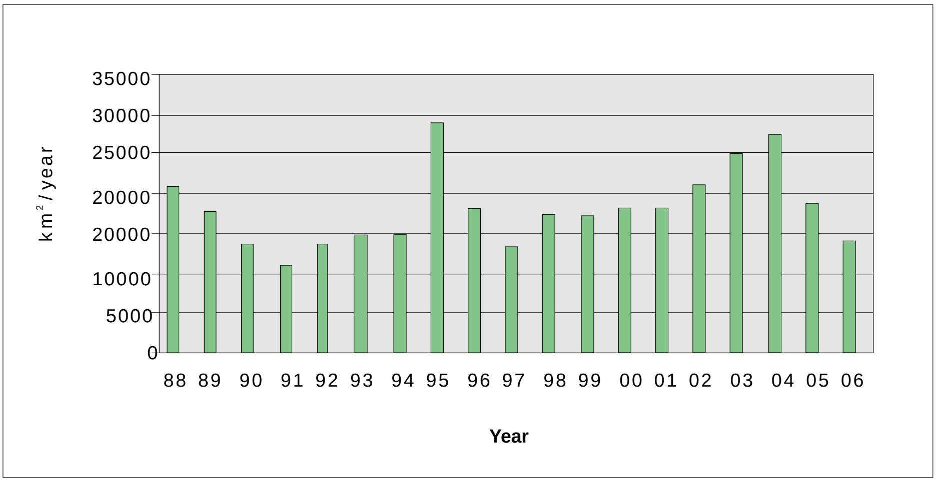
4.4 - Deforestation emission reductions over the past two years

Since 2004, implementation of the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon has had a significant effect on reducing the annual rate of gross deforestation in the Amazon, as can be seen in the table below and graphically represented in the figure below, indicating the evolution of the referred to rate since 1988.

Annual rate of gross deforestation in the Legal Amazon from 1988 to 2006
(in hectares/year)

1988	1989	1990	1991	1992	1993	1994
2,105,000	1,777,000	1,373,000	1,103,000	1,378,600	1,489,600	1,489,600
1995	1996	1997	1998	1999	2000	2001
2,905,900	1,816,100	1,322,700	1,738,300	1,725,900	1,822,600	1,816,500
2002	2003	2004	2005	2006		
2,123,700	2,528,200	2,727,900	1,875,900	1,403,900		

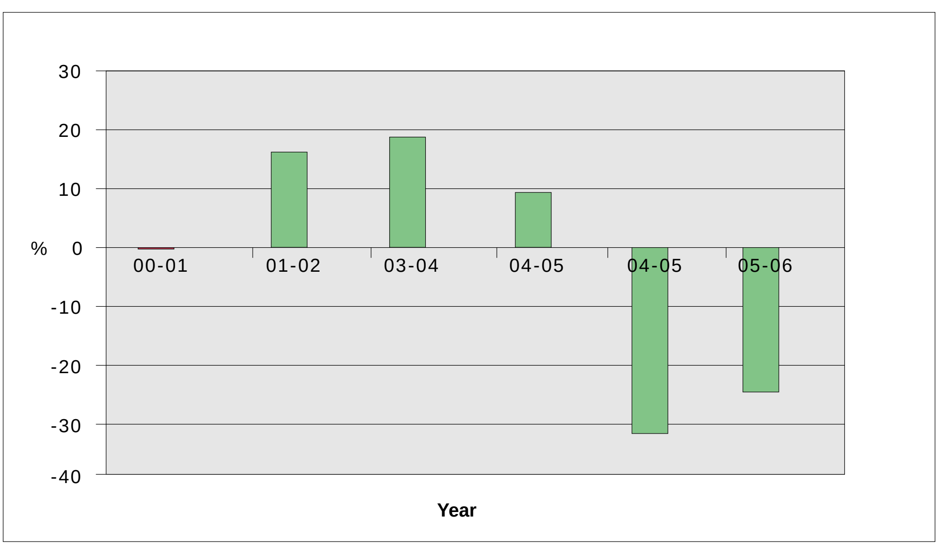
Graphic representation over time of the annual rate of gross deforestation in the Legal Amazon from 1988 to 2006



Source: INPE 2007

The percent variation of the annual rate of gross deforestation is shown in the figure below, where we see a reduction of more than 30% in the period from 2004-2005, compared to 2003-2004, and another 20% in 2005-2006, compared to 2004-2005. Projections for 2006-2007 still indicate a reduction in the rate compared to 2005-2006.

Percent variation in gross deforestation rate of the Amazon from 2000 to 2006



Source: INPE 2007

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If we assume the average rate of gross deforestation, calculated using the estimates generated for 1996 to 2004 (inclusive), which equal 1,959,100 hectares/year, as a reference for annual deforestation emissions, from 2004 to 2006 there was a reduction in the gross deforestation rate of about 210 million tons of CO_2, considering a 90-ton stock of above-ground biomass of carbon per hectare. If we use the average rate generated from estimates for 2002 to 2004, which equals 2,463,300 hectares, as an estimate for the emission reference rate, then the reduction in deforestation emissions totals more than 500 million tons of CO_2.

Clean Development Mechanism

5 - CLEAN DEVELOPMENT MECHANISM

The Clean Development Mechanism (CDM) is one of the three compensation mechanisms[11] of greenhouse gas emission reductions introduced by the Kyoto Protocol[12]. Its importance is due to the fact that it is the only one of these mechanisms to allow the participation of countries not included in Annex B to the Kyoto Protocol in the global effort to reduce greenhouse gas emissions.

The mechanism allows for the implementation of projects involving measures to reduce greenhouse gas emissions. The CDM must also contribute to local sustainable development.

Brazil has established itself in the international scenario as an important actor in the sphere of the CDM. The idea for the CDM was initially proposed within the context of the international negotiations of the Kyoto Protocol by the Brazilian delegation in 1997, during COP 3, in the form of a Clean Development Fund. Later, Brazil was one of the first countries to establish locally the legal basis needed for the development of projects under the CDM through the creation of its Designated National Authority (DNA)[13] through the executive order dated July 7, 1999, and was the first nation to formally designate its national authority to the CDM Executive Board.

The work carried out by the Brazilian government to ensure an environment with clearly defined rules for the development of CDM projects helped foster the response from civil society. The first methodology approved under the scope of the CDM by the Executive Board was Brazilian (Landfills – Salvador, Bahia state); and later, the first project effectively registered under the CDM was also Brazilian: the Nova Gerar project.

Today, the CDM has gained truly global dimensions, with the participation of 59 nations[14], estimated emission reductions of the order of 4 billion tonnes of CO_2e, and

[11] The Kyoto Protocol has made three arrangements to assist Parties included in Annex I to meet their greenhouse gas emission reductions, namely: (a) Joint Implementation; (b) Emissions Trading; and (c) Clean Development Mechanism. The first two involve exclusively Annex I countries while the third allows for the participation of non-Annex I countries.

[12] Legally binding instrument of the United Nations Framework Convention on Climate Change (UNFCCC) that establishes specific greenhouse gas reduction targets for Annex I countries.

[13] The Brazilian DNA is a collegiate body composed of 11 ministries, chaired by the Minister of Science and Technology and vice-chaired by the Minister of Environment, called the Inter-ministerial Commission on Global Climate Change. The commission is responsible for analyzing project activities proposed under the CDM, issuing letters of approval for those meeting the national sustainable development and voluntary participation criteria, as well as establishing specific local rules and criteria.

[14] Data compiled by the Ministry of Science and Technology based on documents made available by the CDM Executive Board (http://cdm.unfccc.int) on 1 August 2007.

more than 2,300 projects participating. Brazil is one of the leading nations in this process, accounting for estimated reductions of roughly 200 million tonnes of CO_2e through 234 projects.

In terms of the greenhouse gas emission reductions projected for the first commitment period, Brazil ranks third, accounting for annual reductions of 27,149,937 t CO_2e, which represents 6% of the world total. This figure corresponds to approximately 2% of Brazilian emissions in 1994, or around 1.4 billion CO_2e. The amount of emission reductions expected for the first crediting period of Brazilian projects is 206,246,381 t CO_2e, which corresponds to 5% of the world total; in this scenario, Brazil also ranks third, after China (51%) and India (24%). In these two countries the energy matrix is highly dependent on fossil fuel consumption, especially coal, unlike Brazil, where the energy matrix is largely based on renewable sources (hydroelectricity). Nevertheless, the data presented below show that Brazil has been successful in developing CDM projects in many sectors.

Distribution of project activities in Brazil by type of project

CDM projects in Brazil		
Number of projects	234	
Country position - number of projects	3rd in the world	
Amount of tCO_2e to be reduced	annual	27,149,937
	1st crediting period	206,246,381
	starting date through 31 Dec 2012	182,018,488
Country position - tCO_2e to be reduced	annual	3rd in the world
	1st crediting period	3rd in the world
Gases	CO_2	150
	CH_4	80
	N_2O	3
	PFC	1
Sector Scope	Energy generation	141
	Landfill	26
	Swine	38
	Energy efficiency	9
	Waste handling and disposal	4
	Manufacturing industry	11
	N_2O	3
	Metal production	1
	Chemical industry	1

The composition of Brazilian CDM projects involves a high component of carbon dioxide (CO_2) reduction, which represents 65% of Brazilian projects, followed by methane (CH_4), with 34% of projects, and nitrous oxide (N_2O), with only 1% of Brazilian projects.

In Brazil, the most important sector in terms of CDM project development is electricity generation, accounting for 63% of projects developed, followed by pig farming, with 16% of projects, and the landfill sector, with 11%.

In the electricity generation sector, the contribution of CDM projects to the total installed capacity of electricity generation plants is 2656.02 MW, broken down as follows: biomass cogeneration with 1389.3 MW, small hydro plants with 407.2 MW, wind energy with 334.2 MW, hydroelectric power plants with 310.0 MW, and biogas with 115.3 MW.

A careful analysis of the contribution of each sector to greenhouse gas emission reductions shows that despite the importance of the energy generation sector in absolute terms, projects involving landfills and nitrous oxide (N_2O) destruction are more significant in terms of greenhouse gas emission reductions, as shown in the table below. Methane emission reductions in the landfill and pork production sectors represent 39% of Brazilian emission reductions, followed by the energy generation sector, which represents 29% of emission reductions.

Note the importance of the sector of nitrous oxide destruction in Brazil, composed of only three project activities, which combined achieve annual reductions of 6,205,612 t CO_2e and represent 23% of Brazilian greenhouse gas emission reductions, as shown in the table below.

Relative and absolute importance of the contribution of Brazil's industrial sectors to greenhouse gas emission reductions

Projects under Validation/Approval Process	Number of projects	Annual emission reduction	Emission reductions in the 1st crediting period	Number of projects	Annual emission reduction	Emission reductions in the 1st crediting period
Energy generation	141	7.916.560	59.717.067	60%	29%	29%
Swine	38	1.964.633	19.152.149	16%	7%	9%
Landfill	26	8.723.035	65.584.704	11%	32%	32%
Manufacturing industry	11	1.853.002	14.119.206	5%	7%	7%
Energy efficiency	9	48.440	406.496	4%	0%	0%
Waste handling and disposal (other)	4	315.112	2.904.653	2%	1%	1%
N_2O	3	6.205.612	43.439.284	1%	23%	21%
Chemical industry	1	17.137	119.960	0%	0%	0%
Metal production	1	80.286	802.862	0%	0%	0%

Brazil's effort to reduce greenhouse gas emissions by implementing CDM projects is underscored by the fact that 65% of projects are unilateral, in other words, developed without the participation of Annex I countries.

In terms of investments, the Brazilian Development Bank (BNDES) has approved the Clean Development Program, which was created to leverage investment in CDM projects. The BNDES Clean Development Program seeks to select Investment Fund Managers, and targets companies/projects with the potential to generate Certified Emission Reduction (CERs) under the Clean Development Mechanism. The Funds will be constituted as Private Equity Funds (FIPs), regulated by CVM Instruction 391 dated July 16, 2003 and later amendments. The Funds will have an Investment Committee with the power to deliberate on all of the Fund's investment proposals. The BNDES has recently selected the Investment Fund Managers, and the Funds are expected to be fully operational by early 2008.