INTRODUCTION

The format of the Brazilian National Communication follows the guidelines contained in the position paper of the group of developing counties (G77 and China), prepared in a seminar held in Geneva, Switzerland, on February 25 and 26, 1996. The seminar was chaired by the Brazilian delegation and brought together experts from developing countries.

This document was officially presented on February 29, 1996, during the meeting of the Subsidiary Body for Scientific and Technical Advice - SBSTA, to be forwarded to the Second Conference of the Parties to the United Nations Framework Convention on Climate Change.

During the Second Conference of the Parties in Geneva, on July 8-19, 1996, the original document of the G77 and China was discussed by a group of countries co-chaired by the United States of America and by Brazil, and a modified version of the original document was approved as Decisão 10/CP.2, contida no documento FCCC/CP/1996/15/Add.1, on July 17, 1996 – Communications from Parties not included in Annex 1: Guidelines, Facilitation and Process for Consideration.

The structure of each chapter of the National Communication ? including the Description of Measures Planned and Taken for Implementation of the Convention ? was prepared based on this decision, adapting it, of course, to Brazilian circumstances and to the programs and activities carried out in Brazil.

According to the principal of common but differentiated responsibilities, Brazil has no reduction or limitations commitments for its anthropogenic emissions of greenhouse gases, as established in Article 3.1 of the U. N. Framework Convention on Climate Change and confirmed in the Kyoto Protocol. However, programs and activities are being carried out in Brazil that result in considerable reduction of these emissions. Some of these initiatives are responsible for the fact that Brazil has a relatively "clean" energy matrix, with lower greenhouse gas emissions per unit of energy produced or consumed. Several other initiatives being implemented, and others planned, also contribute or will contribute to reducing the growth of greenhouse gas emissions in Brazil.

This section will describe these initiatives, analyzing the wide range of sectors and drawing on the experience of the leading experts in Brazil in their respective areas.

Preparation of this report involved around 90 authors, representing a wide range of sectors, and whose reports were made available on the Internet in order to broaden the discussion of them. The results of the work of compiling and reorganizing these reports was subsequently submitted to 134 reviewers, including authors and others directly related to the programs and activities mentioned in this section.

The review process followed the example of reviews of the Intergovernmental Panel on Climate Change (IPCC). Reviewers were asked, in cases where they disagreed with the text, to propose an alternative wording, with the page and line indicated where it was suggested to delete/add/modify a particular phrase, presented in a table following the procedure used by the IPCC in their reviews. With the contributions in hand, a review committee worked to incorporate the suggestions and clarify any outstanding questions. After completing their work, the commission presented a consolidated version of the text, which was made available on the Internet so users could present their suggestions, which were included where relevant.

Thus, at the end of this extensive and participative process of drafting and review, the current section (OR document?) seeks to present the "state of the art" of implementation of the Convention in Brazil by the end of the year 2000. An attempt was also made to update certain information to 2002, which was done through footnotes.

Due to the deadline established for the “Description of Measures Planned and Taken”, in this First National Communication the issue of the electricity crisis in 2001 was not addressed, nor were the changes that the crisis provoked in Brazil’s energy sector.

Although the average aggregate electrical generating capacity of the electrical sector in the period of 1995 to 2001 was more than double that of the ten previous years, and the installed electrical generating capacity in 2001, in the order of 74,000 MW, exceeded by 32% the average electricity consumption in the interconnected grid during peak hours, the unfavorable hydrological conditions of the summer of 2001 compelled the National Electrical System Operator to demand, at the end of April of 2001, an emergency reduction in energy consumption in the order of 20%, because of the threat of putting the system’s supply capacity at risk.

As the supply of electricity in Brazil depends strongly on hydroelectric generation, the unfavorable hydrology in early 2001 ? rainfall in the first months of 2001 was 29% below the historical average in the Southeast and Center West, and 53% below the historical average in the Northeast ? brought on an electricity crisis. This crisis brought attention to the dysfunctional aspects and imperfections of the new model for the electrical sector that contributed to a disequilibria in the interconnected system, which was deprived of its multi-year characteristics and became dependent on the rainfall regime of a single year. These dysfunctions resulted from the process of transition to the new model, the lack of full implementation of the regulatory framework established, and some delays in the schedule of implementation of the thermoelectric projects, as outlined in the Thermoelectric Priority Program launched in 1999.

In response to the crisis, the government adopted two immediate measures. The Committee for Analysis of the Hydro-thermal Electrical Energy System was created to evaluate the electricity production policy, as well as to identify the structural and conjunctural causes of the imbalance between supply and demand of electricity. To ensure the Committee’s independency, members were appointed from outside of Government. In May 2001, the Committee for Management of the Electricity Crisis (GCE) was created, directly linked to the Presidency of the Republic, in order to administer the demand reduction programs and to coordinate efforts to increase the electricity supply.

The GCE’s work was based on an action plan with six elements:

- demand reduction program;
- structural program to increase energy supply;
- emergency program to temporarily increase electrical supply;
- revitalization of the electrical sector model;
- conservation and rationalization.

The extraordinary cooperation of Brazilian families and companies and of governments at all levels permitted achievement of the principal goal of the GCE in 2001: to maintain control of the interconnected electrical system and avoid blackouts. At the same time, at the end of 2001, all indications were that the goals for the next two years were well on their way to being met: in 2002, ensuring that the need for reduction of electricity consumption did not exceed 5%, even if the worst hydrological scenario were repeated; and in 2003, ensuring the complete normality of energy supply, with measures to be taken by the end of 2002.

The mobilization of Brazilian society around the Electricity Rationing Program, with the replacement of incandescent light bulbs by more economical fluorescent lamps, the replacement of domestic appliances by those with more efficient technologies, and behavioral changes, was fundamental to the demand reduction program reaching its target for 2001 of saving 20% of energy consumption compared to the May-July 2000 period, which meant much greater savings compared to the months immediately preceding the crisis. Initially restricted to the Southeast and Center West regions, the rationing later included the North region (Pará and Tocantins), which was fundamental to maintaining energy supply to the Northeast region, where the situation of reservoirs was more critical.

The energy crisis demonstrated the mobilization of the Brazilian people around the potential for energy conservation, an example which showed that the country, even without the commitment to reduce or limit its emissions, can take measures, such as those described in this section, to achieve the ultimate objective of the U. N. Framework Convention on Climate Change.

Brazil is a country of continental dimensions and of great complexity. Despite its socio-economic problems, and having the elimination of poverty as its priority, the country has countless programs and activities that demonstrate its commitment to sustainable development, a legacy of the United Nations Conference on Environment and Development, held in Brazil in 1992.

1 - PROGRAMS RELATED TO SUSTAINABLE DEVELOPMENT

The programs and activities related to sustainable development involve the use of renewable energies and energy conservation/efficiency, which are responsible for the fact that Brazil has a "clean" energy matrix, with very low greenhouse gas emissions in the energy sector. These programs contribute to the stabilization of greenhouse gas concentrations in the atmosphere, and at the same time contribute to sustainable development over the long term.

One of the programs related to sustainable development is the National Alcohol Program (PROALCOOL), developed to reduce the need for foreign currency during the oil price shocks. From 1975 to 2000, around 5,6 million vehicles running on hydrated alcohol were produced. In addition, the Program replaced a part (from 1.1% to 25%[1]) of all previously pure gasoline with anhydrous alcohol consumed by a fleet of more than 10 million gasoline-fueled vehicles, thereby avoided over this period, carbon dioxide emission in the order of 110 million tonnes of carbon (contained in CO_2), and this also offset imports of 550 million barrels of oil, as well as reduced the demand for foreign currency by around 115.5 billion[2].

Other important programs combat waste of energy, which indirectly contributes to avoiding further emissions from burning fossil fuels. These programs include the National Program to Combat Waste of Electrical Energy (PROCEL), a government program which, since 1985, has implemented a series of activities to reduce electricity waste, and the National Program for the Rational Use of Natural Gas and Petroleum Products (CONPET), created in 1991 with the goal of developing and integrating actions to encourage the rational use of petroleum derivatives and natural gas. The objective of these programs is to promote the reduction of losses and elimination of waste in the production and use of energy, as well as the adoption of more energy efficient technologies, and contribute to delaying the need for investments in new electrical stations and oil refineries.

It should be noted that the electrical generating capacity in the country emits almost no greenhouse gases. In 2000, the demand for electrical energy in Brazil was 322 TWh generating stations connected to the public grid. Around 93.5% of this production[3], or 301.4 TWh, was of hydroelectric origin. Because of this, the Brazilian electrical sector has special characteristics, not only as one of the world's largest producers of hydroelectric energy, but also because of the high share of hydroelectricity in meeting its demands for electrical energy.

Thus, CO_2 emissions from the Brazilian electrical sector are among the lowest in the world in terms of population and to GNP. However, emissions have been growing in recent years. But this trend can be modified and even reversed with the programs and actions related to sustainable development (new renewable energy sources, use of charcoal, etc.), addressed in this section.

[1] According to data from the National Energy Balance (BEN) from 1995 to 2000, the anhydrous alcohol content in the mixture (gasoline/anhydrous alcohol) over the period ranged from a minimum of 1.1% (in 1975) to a maximum of 25% (in 1999).
[2] Given the replacement of 1 liter of gasoline by 1 liter of anhydrous alcohol and by 1.25 liters of hydrated alcohol, 5% of the energy consumed in refining, the average prince of "Brent" petroleum (British Petroleum – BP) and the percentage of petroleum imports (BEN) for the period of 1975-2000, along with the importation of ethanol and methanol in the period 1990-99. Given also the average of avoided CO2 for the replacement of gasoline of 0.63 kg of C per liter of gasoline (IPCC).
[3] Or around 88.5% of the market of 347.7 TWh if electrical self-generators are included.

1.1 – THE NATIONAL ALCOHOL PROGRAM

1.1.1 – HISTORY OF THE SUGAR AND ALCOHOL INDUSTRY

Thus, in the 20th century, after the sugar cane agribusiness had already existed in Brazil for centuries, Brazil discovered in alcohol an attractive energy option. Between 1905 and the mid-1920s, there were several attempts by the sugar industry to promote alcohol as a fuel. In 1927, the Serro Grande Plant, in Alagoas launched in the Northeast the alcohol fuel blend called "USGA", which would soon be copied by producers from the principal sugar cane growing regions of the country at the time – (São Paulo, Rio de Janeiro, Pernambuco and in Alagoas itself). At the end of the 1920s, National Institute of Technology (INT), then called the Fuels and Ores Experimental Station, conducted experiments with alcohol fueled engines, tested in a four cylinder Ford. On February 20, 1931, the Brazilian government established decree # 19,717, requiring the mixture of 5% alcohol in imported gasoline consumed in the country. The creation of the Sugar and Alcohol Institute (IAA) in 1933 provided the basis for increasing Brazilian alcohol production by means of financing of distilleries connected to sugar plants. On September 23, 1938, Decree-law # 737 extended the mixture of 5% alcohol to gasoline produced in Brazil, with the implementation of the first Brazilian oil refinery.

Between 1942 and 1946, with the difficulties in supplies of oil and derivatives caused by World War 2, the proportion of alcohol blended with gasoline reached around 42%. In the 1950s and 1960s, however, alcohol as a fuel would became less attractive, both for governments and for companies from the sector. The percentage of alcohol in the blend was reduced, in the early 1970s reaching 2.9 % throughout the country and 7% in the city of São Paulo.

In the mid-1970s, a new inversion on the international economic situation, with the fall in international sugar prices and the increase in oil prices, created the basis for the return of fuel alcohol in the Brazilian energy matrix, including the introduction of pure ethanol as a fuel.

In 2000, in Brazil, alcohol is used as a fuel in two ways: blended with gasoline, as 22%[4] anhydrous alcohol (99.6 Gay Lussac (GL) and 0.4% water), forming a "gasohol"[5] mixture, with the objective of increasing the octane rating over that of pure gasoline used in common cars and reducing pollution emissions; and as pure alcohol, in the form of hydrated alcohol, with 95.5 GL, used in vehicles with engines designed for the exclusive use of hydrated alcohol as a fuel.

Alcohol has proven a good automotive fuel, with a higher octane rating than alcohol. Furthermore, it contains no sulfur, which avoids emissions of sulfur compounds and the contamination of catalytic converters, and has a lower vapor pressure than gasoline, which results in less emissions through evaporation.

Table 1 – Fuel properties and characteristics

	GASOLINE	ETHANOL
Specific heat (kJ/kg)	34900	26700
Octane number (RON/MON)	91/80	109/98
Latent heat from evaporation (kJ/kg)	376 ~ 502	903

[4] See footnote 1 and 8.
[5] In Brazil, what is usually called gasoline is a mixture of pure gasoline and anhydrous alcohol, known international as gasohol.

Ignition Temperature (ºC)	220	420
Air/Fuel Ratio	14,5	9

Source: Goldemberg and Macedo,1994.

The “oil shocks” of the 1970s, especially the second on in 1979, had a great impact on the economy of Brazil. To reduce distortions in the Brazilian trade balance caused by the sharp rise in oil prices, the Federal Government decided to implement an energy policy whose objective was to reduce the balance of payments deficit. One of the key elements of this policy was to support alternative energy sources to replace imported oil, as well as energy efficiency, principally through the following programs:

- Accelerated Oil Production Program;
- Thermal electric program;
- Efficiency in Energy Use Program - CONSERVE;
- National Alcohol Program - PROÁLCOOL.

Through these policies and measures, there was a significant change in Brazilian oil and natural gas production; annual end use energy consumption of ethyl alcohol rose from 580 million liters in 1975 to 10.6 billion liters in 2000, with the peak year for production being 1997, with 15.5 billion liters; there was a reduction of the relative demand for fuel oil and gasoline, at the same time as demand increased for other derivatives of a high social utility, such as liquefied petroleum gas - LPG, diesel, and petrochemical naphtha as a feedstock in the petrochemical sector, which meant a need for investments in refineries to adjust production to consumption.

1.1.2 – DEVELOPMENT OF THE NATIONAL ALCOHOL PROGRAM

The National Alcohol Program (Proálcool) was created on November 14th, 1975 by decree # 76,593, with the objective of stimulating alcohol production in order to meet the needs of domestic and international markets, as part of an automotive fuels policy. The decree states that production of alcohol from sugarcane, manioc or any other raw material should be encouraged through the expansion of supply of raw materials, with a special emphasis on increasing agricultural production, modernization and expansion of existing distilleries, and the installation of new production units, either annexed to plants or autonomous, and storage facilities.

Sugarcane has the highest return for farmers per hectare planted. The production cost for sugar in Brazil is low (less than US$ 200/tonne [6]), and thus competitive on the international market. However, this market is volatile and prices fluctuate widely. Global production of sugar in 2000 was 131 million tonnes, with around 13% coming from Brazil[7].

The production process for sugar and alcohol differ only from the point that the juice is obtained, which can then be fermented for alcohol production, or processed for sugar. If sugarcane production becomes less attractive because of reductions in international prices – which frequently occurs – it can be more advantageous to shift production to alcohol.

The decision to produce ethanol from sugarcane, aside from sugar prices, is political and economic, involving additional investments. This decision was taken in 1975, when the federal government decided to encourage production of alcohol to replace pure gasoline, in order to reduce oil imports, which were placing a heavy burden on the balance of payments. At this time, the price of sugar on the

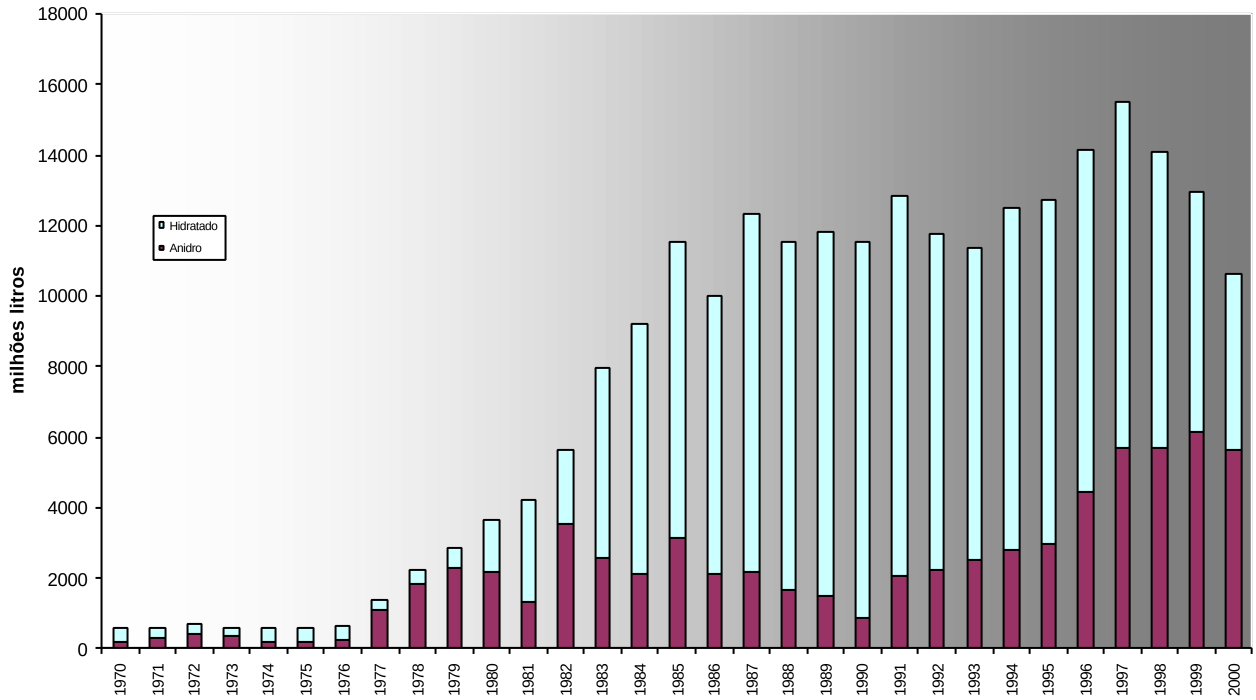
[6] Longo, 1996.
[7] Statistical database of the United Nations Food and Agriculture Organization (FAO): www.fao.org/waicent/portal/statistics_en.asp

international market had been falling rapidly, which made the shift from sugar to alcohol production more attractive.

The PROALCOOL program involved the following phases:

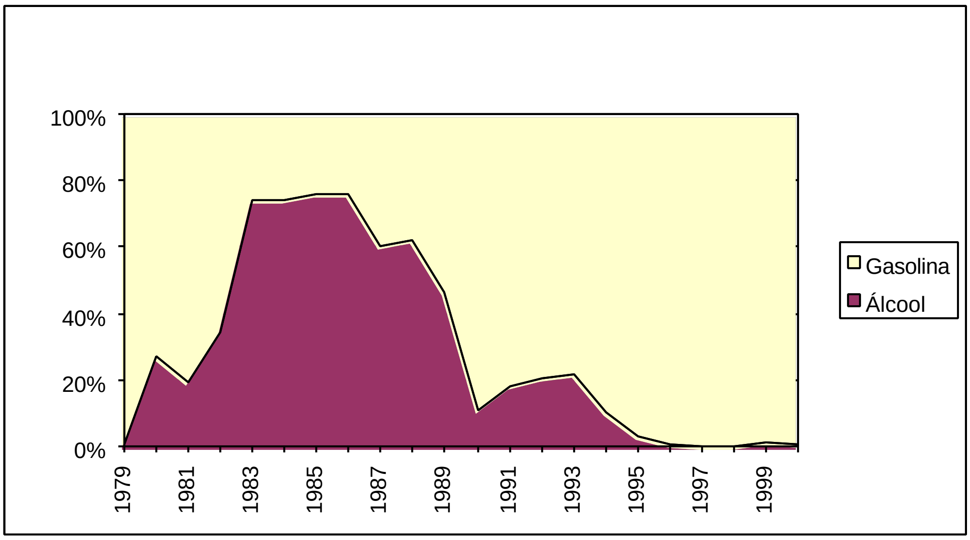
Phase 1: 1975 to the end of 1979 – Initial Phase – effort was directed principally at the production of anhydrous alcohol for mixture with gasoline. In this phase, the principal effort was made by the connected distilleries. Alcohol production grew from 600 million liters per year (1975/76) to 3.4 billion liters per year (1979/80) (Figure 1). The first cars powered by alcohol alone were produced in 1978.

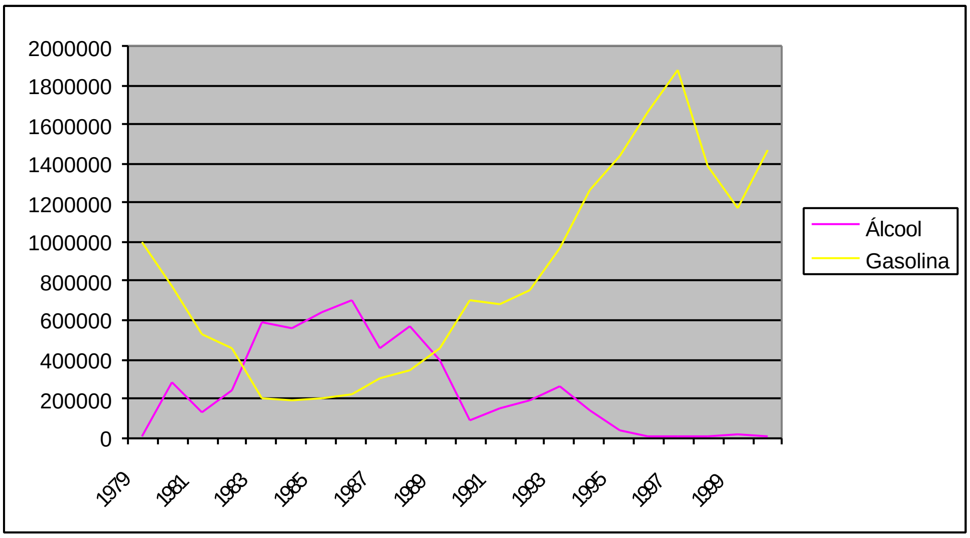
Figure 1- Production of Ethyl Alcohol – 1970-2000



Phase 2: 1980 to 1987 – Expansion Phase – 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 PROÁCOOL. Bodies such as the National Alcohol Council (CNAL) and the National Alcohol Commission (CENAL) were created to facilitate the program. Brazilian Alcohol production reached a peak of 12.3 billion liters in 1986-87 (Figure 1), surpassing by 15% the initial goal of the government of 10.7 billion liters per year for the end of the period. The proportion of alcohol powered Otto cycle cars in the total (passenger and mixed use) of cars manufactured in Brazil increased from 0.46% in 1979 to 26.8% in 1980, and reached the ceiling of 76.1% in 1985 (Chart 2).

Figure 2 – Production of Light Vehicles



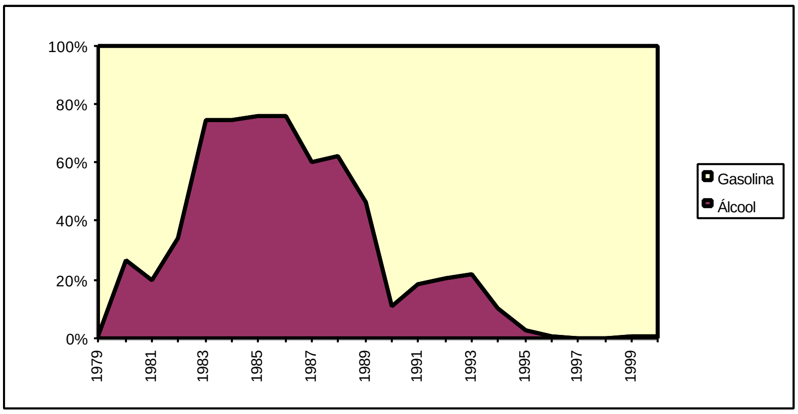


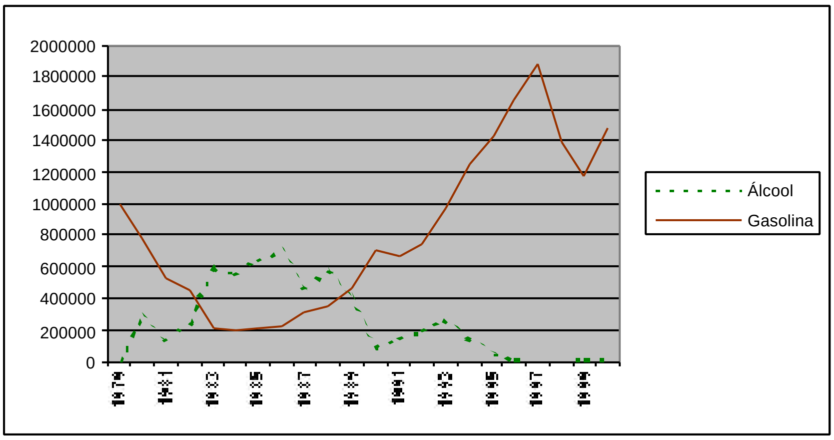
Phase 3: 1986 to 1995 – Stagnation Phase – Starting in 1986, the situation of the international oil market changed again. The price of a barrel of crude oil dropped from US$ 30-40 to a low of US$ 12-20. This new period, which some observers called the "oil countershock", dealt a blow to efforts to replace fossil fuels and to promote energy efficiency around the world. In Brazilian 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.

The supply of alcohol could not keep with the growth in demand, with sales of alcohol-fueled cars exceeding 95.8% of total sales of Otto cycle vehicles for the domestic market in 1985. The low prices paid to alcohol producers with the sudden drop in international oil prices (starting at the end of 1985) brought an end to the increase in domestic alcohol production. However, the consumer demand for ethanol continued to be encouraged through maintaining low prices relative to gasoline, and through lower taxes in alcohol fueled vehicles. This combination of discouraging alcohol production and encouraging demand, through market factors and government intervention, generated a supply crisis in the period between harvests in 1989-1990. In the period prior to the supply crisis both production of alcohol and production and export of sugar, whose prices at the time were set by government, were discouraged. Alcohol production remained practically constant, reaching 11.8 billion liters in the 1985-86 harvest; 10.5 billion in 1986-87; 11.5 billion in 1987-88; 11.7 billion in 1988-89 and 11.9 billion in 1989-90. Brazilian sugar production in this period was 7.8 million tonnes in the 1985-86 harvest; 8.2 million in 1986-87; 7.9 million in 1987-88; 8.1 million in 1988-89 and 7.3 million tonnes in 1989-90. Sugar exports in this period dropped from 1.9 million tonnes in the 1985-86 harvest to 1.1 million tonnes in the 1989-90 harvest.

Despite its temporary nature, the crisis of alcohol supply at the end of the 1980s damaged the credibility of PROALCOOL, and together with the reduction of incentives, caused in the coming years a significant drop in demand, and thus in sales of alcohol fueld automobiles (Figure 3).

Figure 3 – Sales of Light Vehicles





Other reasons can be given for the reduction in production of alcohol fueled vehicles. At the end of the 1980s and the beginning of the 1990s, the international context of oil prices fluctuated strongly, with the price per barrel declining significantly. This situation, which persisted for the next ten years, combined with the increasing trend on the part of the automobile industry to standardize production of models and engines (using gasoline) globally. In the early 1990s, Brazil also liberalized imports of automotive vehicles (produced in the country of origin with exclusively gasoline or diesel engines) as well as the introduction of a policy of incentives for the "popular car" – with a maximum one liter engine – developed to use gasoline.

The crisis in supply of alcohol was only overcome with the introduction in the market of what became called the MEG mixture, which would replace hydrated alcohol with the same performance. This mixture (60% hydrated alcohol, 34% methanol and 6% gasoline) would oblige the country to import ethanol and methanol (which between 1989 and 1995 surpassed one billion liters) to ensure supply over the 1990s. The mixture met the requirements of the market, and no serious problems were observed regarding contamination and public health.

Phase 4: Current situation – Redefinition phase – The markets for fuel alcohol, both anhydrous and hydrated, are now free in all phases – production, distribution and resale – with the prices set by supply and demand. From the around 1.1 million tonnes of sugar that the country exported in 1990, exports grew to around 10 million tonnes per year (dominating the international market and lowering international prices). Currently, the question is how Brazil, without the role of government in the sector, will find mechanisms to regulate its (highly competitive) products: sugar for the domestic market, sugar for the international market, and ethanol for the domestic and international markets. Given the positive externalities of alcohol, and with a view to directing policies for the sugar and alcohol sector, the Interministerial Sugar and Alcohol Council (CIMA) was created by decree on August 21, 1997.

According to the National Association of Automotive Vehicle Manufacturers (ANFAVEA), between 1998 and 2000 production of alcohol fueled vehicles remained at the 1% level. The creation of the "green fleet" – the encouragement and requirement of the use of hydrated alcohol in some classes of light vehicles, such as official cars and taxis, has led to a debate between experts in the economic area, opposed to incentives, and from the environmental areas, favorable to ethanol incentives. On May 28, 1998, Provisional Measure # 1662 gave the Executive the power to raise the percentage of ethyl alcohol added to gasoline fuel, from the required 22% throughout Brazil to 24%[8]. The producers and research centers have tested a mixture of alcohol and diesel fuel.

To implement the PROALCOOL program, first a process was established to transfer the resources obtained from part of the prices of gasoline, diesel and lubricants to offset the costs of alcohol production, in order to make it viable as a fuel. Thus a relationship of parity was established between the prices of alcohol and sugar for the producer, and financing incentives were offered for the agriculture and industrial stages of alcohol production. With the advent of the hydrated alcohol fuel in 1979, relative pricing policies were adopted between hydrated alcohol fuel and gasoline, in gas stations, in order to stimulated the use of the renewable fuel.

There is currently no incentive for alcohol. There is a regional incentive that compensates the higher production costs in the Northeast region in the agricultural stage[9], relative to the more efficient states, and a freight compensation for producers located in the states of Mato Grosso and Mato Grosso do Sul, which are located farther from the consumption centers[10]. This subsidy, however, has a termination date set of January 31, 2004, because it sought only to provide a period of adjustment for those producers that faced a natural market disadvantage. All the government measures involving products from the sugar and alcohol sector are compatible with the commitments assumed by Brazil under the World Trade Organization.

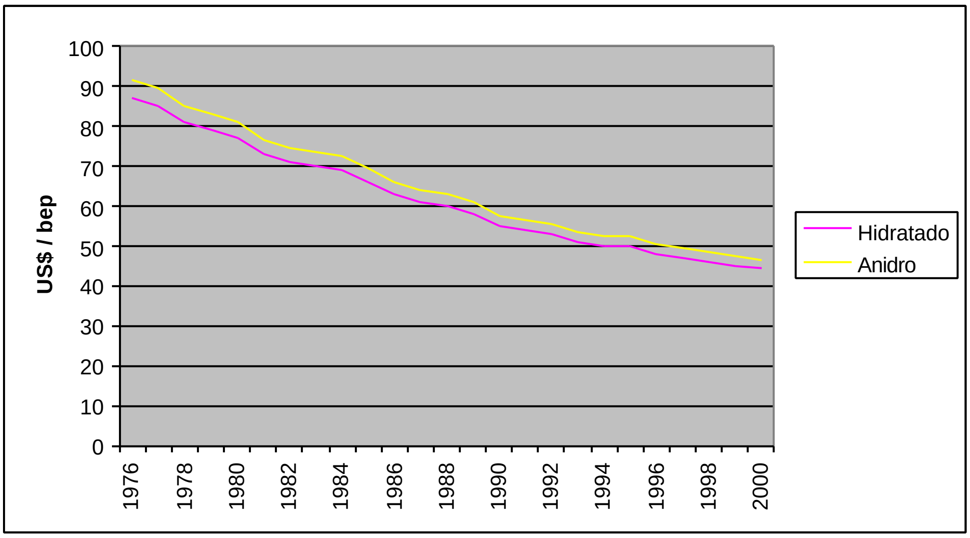
1.1.3 - ECONOMIC ASPECTS OF PROÁLCOOL

[8] This provisional measure was regulated by Law # 10,203, of February 26, 2001.
[9] Portaria (administrative decree) of the Ministry of Finance # 275/98 and CIMA resolution # 5, from September 10, 1998.
[10] Portaria of the National Petroleum Agency (ANP) # 138/98.

Costs of Alcohol Production

The production costs for alcohol are directly linked to the productivity of sugar cane cultivation and to the industrial yield of the process of ethanol production. In the last few decades, the development and implementation of new techniques and technologies in the sugar and alcohol sector were largely responsible for the reduction in costs of production. From 1976 to 1996, the costs of production of fuel alcohol fell from approximately 90 US$/BOE to approximately 45 US$/BOE, for an average rate of cost reduction of 2% a 3% p.a. (Chart 4).

Figure 4 - Brazil – Production Costs of Fuel Alcohol at Constant Prices - 1976-2000



The gains in productivity in the sugar and alcohol sector came from three distinct phases:

- starting in 1975, search for greater industrial productivity;
- from 1981-82, search for greater efficiency in conversion of sucrose to the final product, as well as by cost reductions;
- from 1985, ***integrated management of agricultural and industrial production***, including planning and control of sugar cane production, integrated with industrial production.

In order to achieve a greater effectiveness of technological development programs, the greatest emphasis of the sector has been in the agricultural sector, because this stage includes around 61% of the costs of ethanol production.

Stages of Production

In sugar cane production (agricultural phase)

The average productivity of Brazilian sugar cane increased from 50-60 tonnes per hectare in 1975 to 75-85 t /ha in 1996, because of various factors:

- varieties of sugar cane selected - the Cooperative of Producers of Sugar Cane, Sugar and Alcohol of the State of São Paulo Ltd. - COPERSUCAR[11] has the largest program in the world of research on genetic improvement of sugarcane, involving approximately 60% of Brazil's sugarcane crop;
- agriculture technology – leading developments are the principal of management of agricultural production with the use of soil maps, use of satellite images for identifying varieties, and general improvement of management;
- reduction of fuel consumption in collection - in 1996, consumption was 50% lower than 1991, and there should be a further reduction of more than 50% in the next three years, thanks to evolution in the mechanization of collection and transport of greater quantities per trip;
- collection of crude sugarcane - sales of equipment for collection of crude sugarcane;
- management of agricultural residues - utilization of the waste product "vinhoto", and dry cleaning of sugarcane, without the need for washing, thereby avoiding losses of 1 to 2% of sugar which is carried off by the water during washing of the cane;
- reduction of demand for artificial fertilizers - use of vinhoto as an organic manure, rich in phosphorus and potassium.

In ethanol production (industrial phase)

In recent years there have been significant technological advances, resulting in an increase in average productivity in the conversion of sugarcane into ethanol from 75 l /t in 1985 to around 85 l /t in 1996, because of various factors:

- extraction of sugarcane juice – the extraction rate of juice from sugarcane grinding has risen from 92% at the beginning of the PROALCOOL program in 1975 to 97%. Also, with small changes in equipment and the operational system, it was possible to raise grinding capacity by 45%;
- treatment and fermentation of juice - first, biological control and then continuous fermentation (an increase in productivity of more than 230% since 1975);
- distillation - increased capacity according to the alcoholic content of the mixture, because of improvements in equipment;
- improvements in the area of energy - in the production of sugar and alcohol, from 1980 to 1995, the percentage of plants self-sufficient in electricity rose from 60% to 95%. Some plants already sell their surplus electricity to the grid. In São Paulo, there is already 300 MW available for the electrical system.

Alcohol prices in Brazil are set by the free market. Given the importance of the sector, and its characteristics, which are often at odds with the standards of perfect competition, the activities of production, distribution and sales of fuels are regulated by the National Petroleum Agency (ANP).

The percentage difference between the values attributed to ethanol and gasohol (gasoline mixed with anhydrous alcohol) between 1980 and 1997 indicated that there were distinct phases of government interest in ethanol:

- 1980 to 1983 - strong stimulus to fuel alcohol - pressured by a crisis in the balance of payments and the high prices for imported oil, prices of ethanol in this period were around 40-45% lower than that of gasoline.

11 Copersucar is a private cooperative made up of more than 100 members, including rural producers, agricultural units and sugar plants and alcohol distilleries. In the 2001-02 harvest it was responsible for a production of 54 million tonnes of sugarcane; 3.5 million tonnes of sugar, and 2.4 billion liters of alcohol, for a 25-30% share of Brazil's sugarcane industry. In this production 90,000 workers are employed directly and another 40,000 indirect jobs are provided by sugarcane suppliers.

- 1984 to 1988 - moderate stimulus to fuel alcohol - domestic interest in controlling inflation and reducing prices of imported petroleum, starting in 1985, meant that ethanol prices in this period were on average 35% lower than gasoline.
- 1989 to 1996 - weak government stimulus to the program due to the crisis of alcohol supply at the end of the 1980s and low international oil prices. In this period, the price difference for consumers between hydrated alcohol and gasoline fell to less than 20%, taking the price of gasoline as a reference.
- 1997 to present day – in more recent years, with the rise in international oil prices, the price difference for consumers between hydrated alcohol and gasoline again increased[12]. The has been no policy set for hydrated alcohol fuel, although several authorities have come out in support of the resumption of this option. The return to incentives for alcohol cars has been debated[13] and rising international oil prices, as well as the exchange rate, tends to favor the use of alcohol.

During the 1980s, ethanol, along with allowing the reduction of use of oil and derivatives, was also an important product in terms of Brazilian exports. But after 1989, there was a period of net imports of ethanol, because of the domestic supply crisis. In recent years, the pendulum swung back to net exports, and there is a clear trend towards Brazil becoming a significant exporter of this product, due to the comparative advantages of production in the country and the adoption of programs for use of fuel alcohol in several countries as a strategy to achieve environmental improvements and emissions reductions.

1.1.4 - EXTERNALITIES OF PROÁLCOOL

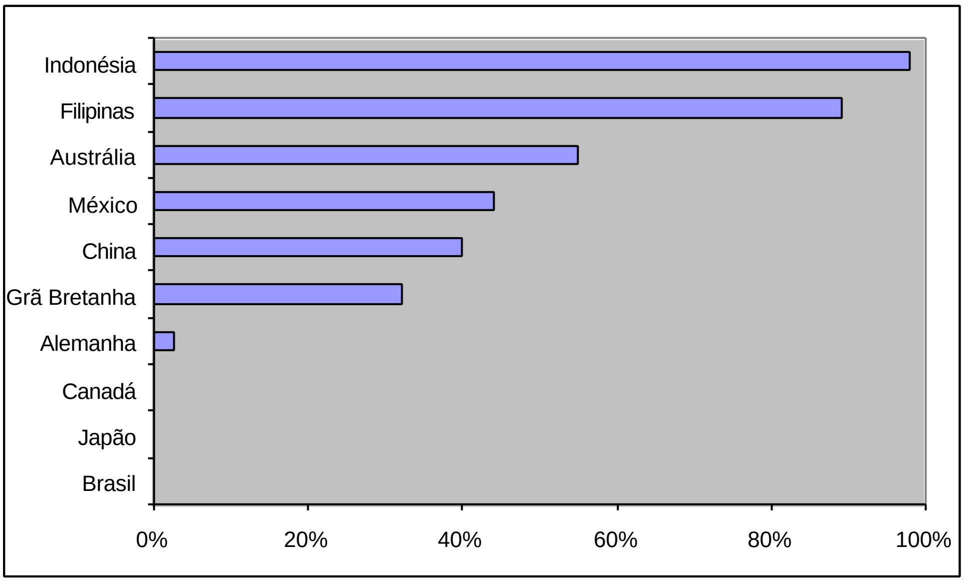
PROALCOOL is a governmental program that goes beyond specific issues to include policies related to energy, industrial, agriculture, transport, international trade, social welfare, labour and the environment. Therefore, for a more rigorous evaluation of the Program, specialists have identified the need to take into account externalities in the agricultural, industrial and energy phases of production, in order to distinguish more clearly the socio-economic and environmental impacts of production and consumption of sugar cane and ethanol.

Environmental

Elimination of tetraethyl lead from gasoline – Brazil was the first country in the world to completely eliminate tetraethyl lead from its fuel matrix in 1992, but starting in 1989 around 99% of oil refined in the country was lead-free. This achievement was possible thanks to the use of alcohol as a gasoline additive. Added to gasoline, anhydrous alcohol gives anti-knock characteristics, because of its high octane rating. Thus, it is a good substitute for tetraethyl lead, allowing the elimination of the harmful effects this causes to the environment (Chart 5).

Figure 5 – Percentage of gasoline sold containing tetraethyl lead

[12] In the 2000-02 period, the difference was between 35% and 50%, being 50% in 2002.
[13] Law # 10,336, of December 19, 2001, created the tax “Contribution for Intervening in the Economic Domain” (CIDE), which falls on imports and sales of petroleum and derivatives, natural gas and its derivatives, and ethyl alcohol fuel. The revenue collected from the CIDE will be allocated, in the form of budgetary law, to payment of subsidies to the prices or transport of fuel alcohol, natural gas and its derivatives, and oil derivatives; to financing of environmental projects related to the oil and gas industry; and to financing of transportation infrastructure programs.



Very few countries have completely eliminated tetraethyl lead from its fuel. The Declaration of Principals approved by the Summit of the Americas, in a meeting held in Miami from December 9-11, 1994, committed governments participants to the "preparation and implementation of national action plans for the general elimination of lead added to gasoline". The successful Brazilian experience with the use of anhydrous alcohol as a substitute for tetraethyl lead has, since 1989, been an example that other countries could copy (see table 3, elimination of tetraethyl lead).

Reduction of atmospheric pollution in urban centers - according to the Environmental Sanitation Technology Company (CETESB), if Brazil's entire fleet of cars was fueled by alcohol, air pollution in the large centers would be reduced by 20-40%. Carbon Monoxide (CO) emissions were significantly reduced: before 1980, when gasoline was the only fuel in use, CO emissions were above 50g/km, and were reduced to less than 1g/km by 2000, because of the technological changes introduced in the period, which has also resulted in significant reductions of emissions of other gases (see Table 34). Similarly, improvements in emission controls for light vehicles using gasohol (gasoline with around 22%[14] anhydrous alcohol), have also contributed to reducing their emissions, so that for cars currently manufactured there are no significant differences between emissions from motors using hydrated alcohol and gasohol (for example in 2000, emissions of 0.73g/km in gasohol vehicles and 0.63 g/km in alcohol fueled vehicles) (see item 7.5 – Motor Vehicle Air Pollution Control Program - PROCONVE).

Another factor of concern in the large urban centers relates to the significant emissions of SO_x, as a result of burning of gasoline and diesel, which despite having dropped from, respectively, 0.22 g/km and 2.72 g/km in 1992 to, respectively, 0.16 g/km and 0.43 g/km in 2000, as the result of reductions of sulfur content in these fuels, although this is still a concern with the increase in fleet size[15]. The sulfur oxides (SO_x) emitted react chemically with water vapor in the atmosphere, resulting in H_2SO_x, which causes acid rain. However, the burning of alcohol do not emit SO_x, which is one more environmental advantage of this fuel. However, burning of alcohol produces a slightly greater amount of aldehydes than gasoline.

[14] See footnote 1.
[15] CETESB, 1992 and 2002.

Reduction of greenhouse gases - in terms of the risks of global climatic change, the final balance is highly positive, as a function of the process of photosynthesis in which sugar cane absorbs a volume of carbon dioxide proportional to that released in the burning of alcohol and bagasse, because the carbon dioxide released in combustion is absorbed from the atmosphere by plants during photosynthesis. However, there are emissions of greenhouse gases in agricultural production (due to the use of fertilizers and burning for harvest) and in transport of sugarcane from the field to the plant. As a result, the net reduction in CO_2 emissions is in the order of 2.46 t CO_2 equivalent per m^3 of ethanol consumed.

The CO_2 avoided with substitution of gasoline corresponds to an average reduction of 4 M t C in the 1980s and 6.2 M t C/year in the 1990s. The CO_2 avoided with substitution of gasoline in the period of 1975-2000 was around 110 M t C/year[16].

Table 2 – Flow of CO_2 equivalent in Production and Consumption of Ethanol in Brazil***

Gases	Flow (t CO_2/m^3 ethanol)
CO_2 avoided* (substitution of gasoline) (substitution of fuel oil)	-2.71 -2.44 -0.27
CO_2 liberated** (sugarcane/ethanol prod.)	0.25
Total Net	-2.46

Source: Macedo, 1997.
Notes:
* Average avoided CO_2 from substitution of gasoline both by anhydrous or hydrated alcohol and replacement of fuel oil by sugarcane Bagasse.
** CO_2 equivalent from agricultural and industrial stages of production of sugarcane and ethanol[17].
*** It is worth mentioning here the case of ethanol in the United States, produced from grains (especially corn). In contrast with Brazilian ethanol, produced from sugarcane and using sugarcane Bagasse as a source of energy in its industrial production process, production of alcohol in the U. S. uses large energy inputs from fossil fuels. This results in reductions of only 30 to 36% in CO_2 emission in U. S. vehicles running on E85 fuel (85% ethanol and 15% gasoline) and of only 2.4 to 2.9% in vehicles with E10 fuel (10% ethanol and 90% gasoline). These reductions are very modest compared to the negligible net emissions for alcohol produced in Brazil. The calculations of the energy balance for alcohol from corn produced in the United States also has discrepancies, and CO_2 emissions reductions can be identified ranging from 0 to 30% (Wang *et al*, 1997).

However, in the burning of sugarcane leaves for harvest[18] CO_2 is liberated, but experts do not consider this to be a net emission, because the carbon emitted was previously sequestered by the plant during its growth. However, during the combustion process, other gases besides CO_2 are produced. According to a recent study by the Ministry of Science and Technology (MCT) and the Brazilian Agricultural Research Corporation (EMBRAPA), in the phase of combustion with flames, the gases N_2O and NO_x are generated, and the gases CO and CH_4 are formed under burning where smoke is predominant. In Brazil, legislation exists calling for the gradual elimination of burning of sugarcane for harvest, which results in a greater harvest of raw sugarcane and an effort to development technology for mechanical cutting of this raw sugarcane. Also, the replacement of burned sugarcane by raw sugarcane in the harvest (see 7.9.3 – Prohibition of Burning in Sugarcane Harvest in the State of São Paulo) could be driven by the increase in the economic value of the tips and straw for production of electrical energy.

[16] See footnote 2.
[17] During the industrial and agricultural phases of ethanol production, greenhouse gases are emitted such as CO_2, CH_4 and N_2O, in the order of 250 kg of CO_2 equivalent per m^3 of ethanol produced.
[18] Sugarcane has abundant foliage with cutting edges and is planted with such close spacing that at harvest time it is very difficult to penetrate the plantation.

Water and soil pollution – discharge of vinhoto into rivers, waterways, soils and water tables was extremely critical at the beginning of the PROALCOOL program. Today, this waste product from ethanol production (11 to 17 liters of vinhoto per liter of alcohol) has become an economic and environmental asset for sugarcane producers, because it is now returned to the soil as fertilizer, in controlled amounts (up to 150 m^3 of vinhoto per hectare) to avoid contamination of the water table.

Energy

Extremely positive energy balance - one of the great advantages of PROALCOOL is the fact that ethanol production produces much more energy than it uses. Research shows that 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) ranges between 9.2:1 and 11.2:1.

Enormous potential for co-generation with use of ethanol by-products - the use of excess bagasse in production of ethanol and eventually of sugarcane straw represents a vast potential for renewable co-generation of electrical energy (see item 1.4.3.2). Currently around 93% of bagasse is consumed as a fuel to provide all the electrical, mechanical and thermal energy required for sugarcane processing.With the use of high pressure boilers and turbines, using only bagasse during the harvest (cogeneration), it is possible to generate up to 50 kWh in surplus electricity per tonne of sugarcane. Currently, the leaf straw and tips are not used, since around 85% of sugarcane is still burned before harvest. With the trend towards harvesting without burning (which could reach 55 to 60%) and with the use of 50 to 80% of the available straw, the plant could generate surpluses of more than 100 kWh/tonne of sugarcane with conventional technology (high pressure boilers and turbines) or more than 250 kWh/tonne of sugarcane with more advanced technologies such as biomass gasification and gas turbines. In these two cases, the energy would be generated year around, with a hybrid of cogeneration and pure thermal generation.

A plant processing 3 million tonnes of sugarcane per year could provide 70 MW of electricity to the Brazilian electrical system, with the use of bagasse in boilers of 80 to 100 kg of steam. Given that current Brazilian production of sugarcane is 300 million tonnes, there is a co-generation potential of 7,600 MW, or half the installed capacity of the Itaipu generating station (12,600 MW).

Economic

Important fiscal contribution – in the 1996-97 harvest, the sugar and alcohol sector was responsible for the circulation of US$ 10.5 billion per year, which corresponds to around US$ 2.8 billion/year in state, federal and municipal taxes from this sector alone.

Use of ethanol in large cities reduces public health expenses for problems related to air pollution - the municipality of São Paulo, with more than 10 million residents, is the principal city in a metropolitan area with a population of around 15 million. The estimated vehicle fleet for the city of São Paulo is around 4 to 4.8 million, approximately 1 vehicle for each 2 individuals. It is estimated that 2.5 to 2.8 million vehicles use the city's road system every day. Vehicle traffic is the principal source of air pollution in São Paulo, being responsible for 98% of CO emissions and 90% of breathable particulate material (PM_{10}). A study by the University of São Paulo[19] has shown a significant link between air pollution and mortality from respiratory diseases among the elderly in São Paulo between January of 1991 and December of 1994. Although data about the fleet's fuel consumption have been collected over different time periods, which doesn't allow establishment a direct association with daily mortality, the results of this study suggest an indirect relationship between greater levels of ethanol and lower levels both of PM_{10} and mortality from respiratory diseases in the elderly.

[19] Miraglia et al. *Analysis of the impact of fuel consumption on mortality rates in São Paulo*, 1997.

Declining costs of production of sugarcane products – the constant values for costs of ethanol production dropped by an average 2.85% annually between 1976 and 1996. It is estimated that the cost has dropped by an average of 2% per year between 1996 and 2000[20] (see Figure 4). Currently, under conditions of maximum efficiency and minimum cost, currently achieved by a very small number of plants, the costs of production are around US$ 0.18 per liter of ethanol[21] in the most efficient region of the country (Center-South). At the international level, the costs of production of Brazilian alcohol are much lower than in the United States (US$ 0.33/liter) and in Europe (US$ 0.53/liter), which attests to its competitiveness. The financial conditions to make ethanol viable were favorable interest rates for financing of the agricultural and industrial stages of production, and the application of a surcharge on gasoline[22] to lower to price of alcohol at the pumps, thereby ensuring the competitiveness between these fuels and compensating the differences in costs of regional production.

Sugar from Brazil, for its part, has one of the lowest costs of production in the world, lower than US$ 200.00 per tonne in the Center South region of Brazil, compared to between US$ 250.00 and 850.00 in other producing countries[23].

Social

Job creation and wages – the sugar and alcohol industry is one of largest creators of employment in the Brazilian economy – although it has often been characterized by a range of social problems – and is responsible for around one million jobs, half of which can be attributed to alcohol and the other half to sugar. The investment by unit of work generated is low compared to other activities, which could be considered a benefit in a country with capital scarcity like Brazil. The average investment per fob in Brazil's sugar and alcohol sector is US$ 23,000, compared for example to US$ 274,000 in the chemical and petrochemicals sector and US$ 99,000 in the engineering industry and the automobile and autoparts sector. The average salary in the sugarcane fields in the state of São Paulo (considered the best in the Brazilian agricultural sector) which is responsible for 60% of Brazilian sugar and alcohol production, is above the average salary for other agricultural fieldwork in the state, and the workers are registered and have health services. However, the average salary in the sugar and alcohol sector is lower than the petroleum sector and other industrial sectors, because of the low investment per job created. There is thus a potential conflict in the sector between meeting environmental requirements (eliminating burning off of leaves) and maintenance of jobs, given that each harvesting machine eliminates from 80 to 100 temporary jobs.

Maintenance of workers in the rural environment – along with the high employment levels in the sugarcane agroindustry, these jobs are in rural areas, which reduces rural-urban migration and controls the growth of the large Brazilian cities. It should be noted, however, that labour in the sugarcane industry is low-skilled, which is not necessarily a negative factor, given the abundance of such labour in Brazil, with few employment alternatives, and which could be thrown out of work in the absence of this activity.

[20] Moura Campos, 2002.
[21] For anhydrous alcohol, US$ 29/BEG.
[22] Starting in 1964, the government created clauses for specific destinations in the structure of fuel prices and authorized the National Petroleum Council (CNP) to account for its allocations in specific accounts. Thus emerged the "petroleum account" and the "alcohol account". In the "petroleum account" were included the revenues of FUP (Price Equalization Charge – the amount of the fuel price structure, the purpose of which was to allow a single price for each fuel throughout Brazilian territory), normally coming from part of the price of diesel, and the expenses of imports of petroleum and derivatives, along with subsidies to freight charges for derivatives and movements of transport of derivatives carried out by Petrobras. In the "alcohol account" were appropriated the revenue of the FUP, normally coming from part of the price of gasoline, and the expenses related to subsidies to alcohol and the sugar and alcohol industry (Quijano, 1988). FUP was replaced by the Specific Price Component, which in turn was replaced by CIDE (see footnote 13).
[23] Costs of sugar production in the world: US$ 250.00 for South Africa, US$ 300.00 for Australia, US$ 480.00 for the European Union, US$ 525.00 for the United States and US$ 850.00 for Japan (Longo, 1996).

Strategic

Alternatives to oil – the growing consumption of oil in the world, along with the concentration of oil reserves in the countries of the Persian Gulf, suggest a growing trend towards instability in future hydrocarbon prices. In 2000, Brazil produced domestically 78% of the gross domestic oil supply. Based on current production levels, ethanol from sugarcane cannot replace all consumption of oil in Brazil, but should be part of the energy options for facing situations of instability in oil supply.

Technological

Development of technology for alcohol fueled cars - Brazilian automotive engineering has made a significant technological effort to adapt vehicles using the Otto cycle, for the use of ethanol in the diverse climatic conditions of the country. In addition, new materials and coatings were used to avoid corrosion caused by alcohol.

Technical progress in sugar and alcohol production - the efforts of universities and public and private research centers led to a marked advance in Brazilian science and technology in this area. Since 1975, the productivity of sugarcane increased from 50-60 tonnes to 75-85 tonnes per hectare, sugar production increased from 90-100 kg to 120-140 kg per tonne of sugarcane, and ethanol production rose from 60 l to 80 l per tonne of sugarcane. The improvements in sugarcane production are due to the intensification of the use of biotechnologies, soil conservation techniques, of systems of production and improvements of production environments.

Soil Quality - in principal, sugarcane cultivated year after year in the same land could be expected to result in declining productivity over time. However, the reverse proved to be the case: after decades of harvests the productivity of Brazilian sugar cane has increased continuously. Much of the increased productivity could be attributed to better preparation of the soil, to development of superior varieties of sugarcane and to recycling of nutrients (liquid waste from distillation).

1.1.5 – The Current Debate about the Viability of Proálcool

The energy sector is currently undergoing a range of changes, such as the attempt to resume projects that take into account the environment and the labour market. In the context of the Framework Convention on Climate Change, there is an interest on the part of the Brazilian government to maintain and reactivate the National Alcohol Program (PROALCOOL), given that fuel alcohol plays an important role in the energy strategy for sustained development.

The Federal Government showed clear signs that it wants to restructure the alcohol policy in the country, as presented in this report. The emergence throughout the world of new types of vehicles and engine technologies (such as fuel cells and “flexfuel” vehicles, which can run on more than one type of fuel) have brought about significant changes in the traditional posture of the automobile industry and other agents active in the market. In this context, consideration has been given to incentives to alcohol-fueled cars (see item 7.12.4 - IPI).

Box 1 - New technologies and ethanol

“Flexfuel” automobiles – “Flexfuel” automobiles, which can burn either alcohol or gasoline, are expected to go on sale at the end of 2003.. These vehicles have a software in the injection and ignition systems. A sensor in the exhaust pipe analyzes the burning of the fuel [OR fuel feed system] and informs the electronic system and combustion sensors whether the engine is burning alcohol, gasoline or a mixture of the two, in any proportion. The fuel system must be similar to alcohol fueled cars, which have more protection against oxidation, with the ideal engine compression around 12:1.

Ethanol powered fuel cells – Several projects are being carried out (LACTEC), contracted (FIPAI/USP) or being studied (FUJB, FUNCAMP and FUNCATE/INT) by FINEP (Financing Agency for Studies and Projects) for the production of hydrogen by reforming ethanol and production of electricity in fuel cells under CT-Energy. The goal is to develop technology for the catalyzer, polymeric membranes, optimized and prototype electrodes (up to 1 kW), for using ethanol in electricity production.

1.2 - ENERGY CONSERVATION

1.2.1 - ENERGY CONSERVATION IN BRAZIL

In modern economies, energy use is one of the principal causes of anthropogenic emissions of CO_2[24] to the atmosphere. To reduce these emissions without sacrificing economic development, the principal strategies are: *replace* the fossil fuels by other non-emitting (or renewable) sources such as hydro power, solar and sustainable biomass; and *Conserve* or use more efficiently all forms of energy used by society. The objective of this section is to analyze the implementation of the second strategy in the Brazilian economy, although in the Brazilian context the two strategies are often strongly linked.

There is a great potential for energy savings in Brazil among the final consumers, whether by using more efficient technologies in cars, motors, domestic appliances, etc., or indirectly, with actions such improving transport systems. There is also a significant potential for waste reduction among energy suppliers, in the process of transformation of primary energy into the forms more widely used by consumers.

The relation between energy savings and reduction of emissions is not linear, that is, a possible reduction of energy consumption does not necessarily lead to a proportional reduction in greenhouse gases. This results to a great extent from the extensive use of renewable primary energy in Brazil, especially the dominance of hydro energy in electrical generation. However, increased generation in thermal plants planned for the short term will mean that a small variation in energy savings will have a considerable effect on emissions, since the thermal generation will complement hydroelectricity.

Since the use of fossil fuels is unavoidable, its efficient use and waste reduction are probably the most attractive way to reduce CO_2 emissions. The rational use of energy is the principal example of “no regrets” actions, which means that its economic and social benefits are so important that it is justified even if CO_2 emissions are discovered in the future to not be a problem. This attractiveness is reinforced by the fact that, to maintain or increase the use of non-emitting sources of biomass, Brazil will depend in part of improving its transformation efficiency.

1.2.2 – GOVERNMENT PROGRAMS FOR ENERGY CONSERVATION

[24]Leaving aside the emissions of other greenhouse gases resulting from energy use, such as methane produced by organic decomposition of trees submersed in hydroelectric reservoirs, leaking of natural gas, etc. The conservation of energy will reduce emissions, *ceteris paribus*, to the extent that it reduces demand for primary energy.

The most common measure of energy intensity is the ratio of energy per unit of GDP. In Brazil[25], in 1994, this index was 0.27 toe[26]/US$ 1000, less than that of the USA (0.34), but greater than that of many developed countries such as the England (0.22), France (0.19) and Japan (0.15).

Conservation measures in Brazil were carried out by the federal government as a way to avoid crises caused externally, particularly from oil price increases and an increase in interest rates that affected generation, bringing risks of rationing.

In response to the oil shocks of 1973 e 1979, when imported oil supplied approximately 70% of Brazil's primary energy consumption, a strategy was formulated centered on the reformulation of energy supply policy: intensification of oil exploration, increasing hydroelectric capacity, use of domestic coal, and replacement of gasoline by alcohol for the transport sector.

In the early 1980s, the program Conserve was implemented, administered by the Brazilian Development Bank (BNDES). This program financed projects for rationalization of energy use in industries, mobilizing a broad government effort, and generated significant results.

In the mid-1980s, the National Electrical Energy Program (PROCEL) was created, and in the 1990s, the National Program for the Rational Use of Natural Gas and Petroleum Products (CONPET), which has achieved impressive results.

Annual investments in research and development, on the part of those holding concessions, permissions and authorizations from the electrical sector are currently regulated by Law # 9991, of July 24, 2000, which obliges holders of concessions and permissions for public services of electricity distribution to allocate annually at least 0.75% of their net operational revenue in research and development in the electrical sector, and at least 0.25% in end use efficiency programs. Until December 31, 2005, the minimum investment will be 0.5%, both for research and development and for energy efficiency programs in the area of energy supply and end use.

Companies holding concessions for generation and those authorized for independent production, as well as concession-holders for public services of transmission of electricity are required to invest annually at least 1% of their net operational revenue in research and development in the electrical sector[27].

Other measures for conservation and rational use of energy[28], as well as for energy efficiency, are being studied.

1.2.2.1 - Conserve

The program Conserve, created under the Ministry of Industry and Commerce - MIC (currently the Ministry of Development, Industry and Commerce - MDIC) in 1981, was the first significant effort in

[25] According to the BEN, 1998
[26]Given that 1 MWh = 0.086 TOE (tonnes of oil equivalent) and 1 TOE = 10,000 Mcal, in accordance with the methodology adopted by the IEA/OCDE.
[27] As provided for in Law # 9991, some resolutions and procedures manuals were already published by ANEEL. The most recent resolutions are # 502, of November 27, 2001, for R&D and resolution # 394, of September 18, 2001, for energy efficiency. It is estimated that the resources invested in the period of 2000-01 in energy efficiency resulted in a reduction in consumption of around 4.1 GWh/year and an avoided demand of around 154 MW.
[28] On October 17, 2001, Law # 10,295 was sanctioned, creating the National Policy for Conservation and Rational use of Energy, seeking the efficient allocation of energy resources and environmental preservation. According to this law, the Executive Branch of government will establish maximum levels of specific consumption of energy, or minimum energy efficiencies, for energy consuming machines and appliances manufactured or sold in Brazil, based on relevant technical indicators, which the manufacturers and importers of these machines and appliances are required to obey. The Law also requires the Executive to develop mechanisms to promote energy efficiency in buildings constructed in Brazil.

terms of energy conservation in Brazil, and aimed at meeting the objectives of Portaria (Administrative Directive) MIC/GM46, which addressed the promotion of energy conservation in industry, in the development of more energy efficient products and processes, and encouraging the replacement of imported energy sources by domestic sources. The program Conserve is represented here only as a record of accumulated experience in terms of energy efficiency measures in Brazil over the last two decades.

The reduction of oil imports, which jumped to the top of governmental priorities after the consecutive oil price shocks, also affected the fuel oil provided to industries. Along with a policy of price increases starting in the 1980s, the National Petroleum Council (CNP) imposed linear cuts of 10% and 5%, respectively, on the supply of fuel oil and diesel to industry and implanted a system of supply controls through fuel quotas until 1983. The unpopularity generated in the business community with the adoption of these measures led the federal government to offer support to conservation and the replacement of fuel oil used in industry, through the program Conserve.

Operational Guidelines

Conserve offered the possibility of carrying out energy diagnostics in industrial facilities, without cost to the industries, in order to identify the energy conservation potential in each case. Thus, the diagnostics sponsored by Conserve were carried out by state technological institutes, certified by the Secretariat of Industrial Policy of MIC. These institutes functions as state agents of Conserve, acquiring equipment from the United Nations Industrial Development Organization (UNIDO) to assemble the mobile units in each state for carrying out the energy diagnostics.

The structure of Conserve was complemented by a fund to support transfers, in the form of very favorable loans to nationally owned companies to support the energy conservation efforts identified through the diagnostic.

Positive Results

The most positive results of Conserve, along with promoting energy conservation in industry, involve the consolidation of a national capacity for surveying industrial energy conservation opportunities. The program served as a catalyst and channel for the competence built up by the state research and technological centers in prior efforts financed by FINEP (Financing Agency for Studies and Projects) and by the Energy Mobilization Program (PME) for joint action with the private sector.

In terms of energy savings, it was noted that in the period 1981-85, there was a reduction from 9.5 million TOE to 5.3 million TOE in consumption of fuel oil in the industrial sector, for a reduction of 44%. These results, while significant, were not obtained only through the Conserve program. It is estimated that around 18% of the reductions resulted from these actions. Much of the reduction in consumption of this derivative resulted from the slowdown in industrial activity at the beginning of the 1980s, because of the economic recession in Brazil. However, the outcome of Conserve is very satisfactory for a program for conservation of oil petroleum derivatives.

Negative Results

A critical analysis of the program should address two questions: the underutilization of the resources allocated and the predominance of a focus on replacement of energy sources, to the detriment of the basic purpose of energy conservation.

In terms of the first question, approximately half the resources at the disposition of Conserve went unused. Less than 200 companies submitted applications for these resources, while around 80 made effective use of them.

It is clear that this underutilization of resources was not only a result of delays in bureaucratic procedures involved in handling the proposals during Conserve's approval process. Other external factors should also be considered, such as the climate of recession the Brazilian economy was going through in the period 1981-85, which reduced the level of industrial activity and investments in the sector, moving energy conservation to the back burner, as well as the absence of clear signals on the part of the authorities as to the directions economic policy, and especially energy policy.

In terms of the second question raised, table 3 shows that most of the operations approved under Conserve, through the BNDES system, between 1981 and 1985, were for energy switching (79%), with energy saving through conservation accounting for only the other 21%.

Table 3 - Total Savings of Petroleum Derivatives in the period 1981-85 (10^3 Toe)

Sectors	Conservation	Replacement	Total
Pulp and Paper	155.1	165.8	320.9
Steel	146.7	486.8	633.5
Cement	0.4	498.6	499.0
Petrochemicals	26.6	93.3	119.9
Energy	42.0	7.4	49.4
Metallurgy	2.1	13.9	16.0
Mining	-	8.6	8.6
Agroindustry	1.0	88.8	89.8
Construction Material	-	18.0	18.0
Total	373.9	1381.2	1755.1

Source: PICCININI, M. "Conservação de energia na indústria; as políticas adotadas na época da crise energética". Rio de Janeiro, Revista do BNDES, 1994.

Thus, the basic purpose of Conserve was subverted, since in practice what happened was a set of efforts and measures oriented to the replacement of petroleum derivatives, including with probable losses in efficiency, and ignoring the core of the energy conservation program.

In 1981, with the economic recession of that time and the resulting reduction in demand for electricity, there was excess generating capacity in the country. Thus, in order to reduce the idle generating capacity in the electrical sector, the Guaranteed Energy for a Specified Time - EGTD[29] was created, targeting the industrial sector, pressured by high oil prices. This rate was provided to companies willing to replace oil products with electricity, at prices 30% lower than normal.

Thus the penetration of electrical energy in the industrial sector, which was motivated by Conserve, was reinforced through the application of the EGTD rate. This exercised a strong influence on the performance of Conserve, to the extent that it increased the distortion of the fundamental purpose of the program, allowing the alternative of replacement of derivatives (in this case by electricity) at the expense of the original focus of the program.

In addition, the EGTD raised the level of underutilization of the resources of Conserve, to the extent that it constituted an alternative to this program, with reduced bureaucracy and faster implementation,

[29] "Guaranteed Energy for a Specified Time" (EGTD), according to MME Portaria # 1169, from August 20, 1982, is understood as active energy, supplementary to firm energy from the interconnected grid, put at the disposal of specific industrial consumers, with a guaranteed minimum of supply for 3000 (three thousand) or for 6000 (six thousand) hours annually.

thus showing a more efficient "service" to the "public" (industrial sector), resulting in the withdrawal of several applications already presented to the Conserve program.

With the growing use of electricity for thermal uses in the industrial sector as a result of Conserve and EGDT, there was actually a transference of responsibility for energy conservation to the electrical sector, since the growth in electrical demand for thermal purposes in industry began to put pressure on the electrical supply capacity.

Therefore, the strategic option in the face of the existing situation was to implement a policy of conservation of the use of electrical energy, which culminated in the creation of PROCEL, in 1985, under the coordination of ELETROBRAS (Centrais Elétricas do Brasil S.A.).

1.2.2.2 - PROCEL

History of the Creation of PROCEL

The Program to Fight Waste of Electrical Energy - PROCEL was created by the interministerial "Portaria" (Administrative Directive) nº 1877 of December 30, 1985, by a joint initiative of the Ministry of Mines and Energy - MME and of the then Ministry of Industry and Commerce - MIC. It was the first systematic initiative in the promotion of the efficient use of electrical energy in the country, through the coordination of actions to rationalize use of electrical energy throughout the country, seeking to maximize their results and promote a broad spectrum of new initiatives, subject to rigorous tests of opportunity, priority and economic viability.

The objective of the program was to combat waste in the production and use of electrical energy, 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 electrical system.

On July 18, 1991, through a presidential decree, PROCEL stopped being a sectoral program and was transformed into a governmental program, with more wide-ranging goals and greater responsibilities, with direct interactions and effects in society as a whole. The program was no longer restricted to just the electrical sector, but came to be involved in all sectors of society directly or indirectly linked to the production and use of electrical energy.

From the time PROCEL was created until 1989, there was a more generalist focus on the issues addressed, with incentives for research and promotion of new technologies. Wherever, in 1989 the operational structure of PROCEL underwent reforms, so as to give more agility in taking actions that would result in real energy savings, that is, measurable in kWh.

However, in the 1990-91 period PROCEL entered into a stagnation because of the weak performance of its coordination, and especially because of the discontinuity of the investments in the program. Only in 1994 was the program revitalized, in order to expand its capacity for articulation and coordination, as well as to decentralize its executive activities through a better structuring of the conservation areas of the electrical energy concessionaires, encouraging capacity-building with multipliers and strengthening the program with private enterprise.

A reactivation of PROCEL was motivated by the establishment of international contracts starting in 1993, for the purposes of learning from international experience, along with cooperation with United

Nations Development Program (UNDP) and the European Commission. The objective the project agreed upon between PROCEL, UNDP and Brazilian Cooperation Agency of the Ministry of Foreign Relations ABC/MRE is to created the conditions so that when the project is completed, PROCEL will be able to act as the "agent" of conservation of electrical energy, in an autonomous and independent manner.

Other efforts towards the revitalization of the program included the promulgation of law # 8631, of March 4th, 1993, which determined that the resources from the Global Reversion Fund - RGR[30] must be allocated to the conservation of electrical energy; the development of ELETROBRAS's Priority Actions Plan, which established a set of measures to stimulate conservation under the National Campaign against Waste of the Ministry of Mines and Energy, and the creation of the Committee for the Conservation and Rational Use of Electrical Energy of the Companies of the ELETROBRAS System (CONSEL).

With this revitalization, there was space for the attempt at restructuring for, among other goals, the establishment of an appropriate management for the size of the program, improvement of the methodology for forecasting the gains in energy conservation; a new focus on PROCEL, which came to act also in the reduction of losses from systems for generation, transmission and distribution of electrical energy; and especially the objective definition of potential and priorities for electrical energy conservation in the short term, in order to achieve the long term objectives of the program.

PROCEL Lines of Action

Between 1986 and 1992, several initiatives were identified, but only five lines of action had corresponding concrete programs implemented over this period:

- Consumption labeling: the objective is to inform consumers of the level of electrical energy consumption of domestic appliances available on the market, to influence purchasing decisions and induce manufacturers to increase the energy efficiency of their equipment.

- Energy diagnostics, self-assessment and energy optimization: energy diagnostics consists of an assessment of energy use and the conditions of the facilities of the consuming unit, allowing the identification of critical points and indicating the need for action in regards to specific equipment.

- Research and technological development: account for the investment of around one third of the resources of PROCEL, with the goal of enabling the entrance into the market of a growing range of more efficient end use equipment.

- Public lighting: through a joint effort of distribution concessionaires and PROCEL, incandescent lamps were replaced by mercury vapor and high-pressure sodium vapor lamps, consuming around 75% less energy than the incandescent lamps.

- Information, Education and Promotion programs: the objective is to enable a range of sectors of Brazilian society to have access to information regarding conservation of electrical energy. These programs included PROCEL in Schools (see item 4.2.1), energy fairs in homes and in the field, seminars on electricity conservation techniques, a synopsis of socio-economic and electricity information and manuals and pamphlets giving advice on energy consumption.

Since 1994, PROCEL has been undertaking new activities, along with upgrading those mentioned, including in the areas of:

[30] The RGR is a federal fund created with resources from concession-holders, proportional to their investments in installations and services. This fund is allocated to investments in electrical energy, with part going to energy efficiency projects.

- Marketing: seeking to strengthen the trademark PROCEL and disseminate the concepts of combating waste of electrical energy to the market and the public. The main instruments used are the "Seal of Energy Savings" and the "National Award for Combating Energy Waste".

- Residential Sector: normally carried out in partnership with the concession-holders, activities in this area are aimed at combating waste with the use of efficient lighting and domestic appliances.

- Government buildings: seeks the optimization of energy spending in buildings used for public administration, by the use of efficient lighting and refrigeration and through orientation of staff in the rational use of resources.

- Municipal energy management: development through an agreement with municipalities, the goal is to optimize municipal expenses on electrical energy.

- Leading edge management: this program involves a range of actions to reduce electricity demands in peak hours.

- Reduction of losses in the electrical system: carried out be concessionaires to make their facilities more efficient. These actions could involve plants, substations, transmission lines and distribution networks.

- Training: adequately preparing the human resources necessary for the objectives of combating energy waste in the long term. Accordingly, many courses have been offered to industrial and commercial consumers, Energy Service Companies for Energy Conservation (ESCO's), concessionaire staff, public organizations, etc., covering a range of issues and involving universities, international specialists and others.

- Technology research and development: PROCEL has carried out research to support their programs to eliminate energy waste, in terms of databases and methodological tools.

- System for information, management and assessment of results: PROCEL has been improving its methods for analysis, implementation and evaluation of results of energy conservation programs.

- Seminars and conferences: the program has organized or supported several seminars and conferences, for the purposes of dissemination and exchange of experiences in the area of techniques to combat waste of electrical energy.

Results

The quantitative results achieved by PROCEL have been estimated in terms of energy savings, expressed in GWh/year, and 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 being equivalent to electricity produced by a typical hydroelectric plant (equivalent plant), whose construction was avoided through implementation of energy conservation measures. Also considered is the avoided investment in construction of this plant and expansion of the electrical system, taking into account generation, transmission and distribution of energy to final consumers.

The indicators in Table 4 show the accumulated results of actions of PROCEL in the periods of 1986-95 and 1996-98:

Table 4 - Quantitative Results of PROCEL

Indicators	1986-95	1996	1997	1998
Investments Approved (R$ millions)	63.5	50	122	159
Investments already made (R$ millions)	47.3	19.6	40.6	50.4
Energy Saved and Additional Generation (GWh/year)	1,846	1,970	1,758	1,977
Equivalent plant (MW)	435	430	415	460
Reduction of Peak Load (MW)	322	293	976	532
Avoided Investment (R$ billions)	870	860	830	920

Source: ELETROBRAS/PROCEL "Results do PROCEL 1997 – Energy Savings and Peak Reduction". 1998.
OBS: In April of 2000, the exchange rate was 1.77 reais/dollar.

In the period 1986-97, PROCEL enabled energy savings of around 4,900 GWh, at a cost of less than R$ 236 million, compared with an avoided investment of R$ 2.3 billion in the construction of a plant with an installed capacity of 1,133 MW. In other words, for each R$ 1.00 used in combating waste, R$9.64 was saved.

From among the overall results in energy savings and demand reduction, Table 5 presents the contributions of the sectors where PROCEL obtained the greatest returns in 1997.

Table 5 - Results from PROCEL by sector - 1997

Sector	Energy Savings (GWh/year)	Demand Reduction (MW)
Refrigerators and Freezers	333.2	47.5
Motors	216.0	37.9
Air Conditioners	49.4	10.8
Lighting	592.7	135.2
Diagnostics and Studies	19.0	2.3
Public Buildings	6.3	1.9
Education	26.6	7.6
Improved Efficiency in Industry	19.9	0.3
Demand Management	-	0.2
Installation of Meters	228.1	83.3
Generation and Distribution	194.3	30.8
PROCEL Award in Concessionaires	72.3	17.8
Media Publicity Campaign	-	600
Total	1757.8	975.6

Source: ELETROBRAS/PROCEL "Results of PROCEL 1997 – Energy Savings and Peak Reduction". 1998.

The areas where PROCEL had the most dramatic results were promotion of more efficient lighting, with the replacement of lamps in public lighting and commercial and residential sectors, increased efficiency of domestic appliances (refrigerators and freezers) and motors, through labeling, installation of meters, reductions in commercial losses and elimination of waste of electrical energy by concessionaires, and reduction of losses in generation, transmission and distribution systems

RELUZ

In the year 2000 the program RELUZ was launched, with the goal of encouraging the installation of efficient public lighting systems and providing improvement in public safety throughout the country. the Federal Government, under the coordination of the Ministry of Mines and Energy - MME, with technical, financial and administrative support of ELETROBRAS, and in partnership with National Electrical Energy Agency - ANEEL[31] intends to improve the efficiency of 9 million points of public lighting, reducing peak load by 580 MW and saving 2550 GWh per year of electrical energy.

Energy savings will reduce municipal expenses on lighting, reducing electrical bills and other costs, including for maintenance and stocks, with the payback period estimated at 3.3 years.

1.2.2.3 - CONPET

The National Program for the Rational Use of Natural Gas and Petroleum Products (CONPET) was created through a presidential decree on July 18, 1991, with the goal of integrating actions related to the rationalization of the use of oil derivatives and natural gas through reducing of losses and elimination of waste, using energy in a more rational and efficient manner, and developing more energy efficient technologies. All these measures are in accordance with the directives of the National Program for Rationalization of Energy Production and Use, created through decree nº 99,250 of May 11th, 1990.

CONPET's goal is to obtain a gain in energy efficiency of 25% in the use of oil derivatives and natural gas in the next 20 years, without affecting the level of activities of the diverse sectors of the national economy. CONPET has been carrying out projects in the Transport, Industrial, Residential, Commercial, Agricultural and Thermoelectric Generation Sectors.

Transport Sector

Setting energy efficiency indexes - a project developed under the Brazil - European Union - EU agreement, with participation from the private sector and government bodies linked to highway transport. The purpose is to develop a methodology to assess energy efficiency in bus and truck fleets, compare energy efficiency in this sector between Brazil and Western European countries, and develop demonstration and dissemination projects, through monitoring fuel consumption, vehicle maintenance, driver training, and new fuel saving technologies.

Urban passenger transport - development of a methodology for managing the use of diesel oil in bus companies. Carried out in partnership with the Federation of Urban Passenger Transport of the State of Rio de Janeiro – FETRANSPOR (around 35 companies in the state of Rio de Janeiro are formally involved in the project).This involves demonstration projects to validate the methodology and incentives to bus companies to adopt management practices and technologies oriented to reducing fuel consumption.

Highway Freight Transport (Project SlGA BEM) - pilot project with BR Distribuidora, first established in June 1994 at a Petrobras (Petróleo Brasileiro S.A.) service station on the Fernão Dias Highway in Betim/MG, which in 200 had 75 roadside service stations. The objective is to motivate truck drivers to save fuel, as well as monitor and analyze consumption in their vehicles. This involves

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[31] According to Art. 2 of Law # 9427, from December 26, 1996, which created ANEEL, the objective of the Agency is to regulate and inspect the production, transmission, distribution and sale of electrical energy, in accordance with the policies and guidelines of the federal government. Art. 3 holds that it is the responsibility of ANEEL to: V – "resolve, at the administrative level, the divergences between holders of concessions, permissions and authorizations, independent producers and self-producers, as well as between these agents and their consumers.

dissemination of instructional material and adjustment and maintenance of vehicles to reduce fuel consumption, offered free of charge at the service sites.

Project Economize – created in 1996 as an instrument for rational energy use, the priority objective of MME's energy policy, coordinates government efforts with the private sector, through supporting freight and passenger transport companies in the implementation of measures to improve the use of diesel oil and professional training for drivers and mechanics. The project operates in 21 states, with the participation of 14 regional entities (federations and unions), through which 111,000 assessments of 67,000 vehicles were conducted, resulting in reductions of up to 14% in the specific consumption of diesel oil in the fleets participating in the project. This resulting in fuel savings of around 144,360,578 liters/year and 401,695 tonnes/year of CO_2 not emitted to the atmosphere. This project should, by 2003, allow Brazil to reduce the specific consumption of diesel fuel and enable savings of 50,000 barrels/day.

Energy Efficiency Seal - created through a presidential decree on December 8, 1993, the objective is to give prominence to the light vehicle that, already labeled, has the best energy performance in its class.

Residential and Commercial Sector

Review of technical standards - project involving review of technical standards for domestic gas stoves and water heaters.

Green seal of energy efficiency - created by a presidential decree to distinguish equipment with the best energy performance in their category.

Industrial Sector

Establishment of energy efficiency indexes - Brazil-EU Cooperation Project for the development of indexes for assessment of industrial energy efficiency and comparison with energy efficiency of industries of Western Europe.

Energy conservation in Professional Courses - training and dissemination of information about energy conservation and the rational use of fuel in the professional courses of National Industrial Learning Service (SENAI) (development of teaching material for students and professors).

Co-generation - energy integration in industrial plants of Petrobras based on the use of energy co-generation systems.

1.2.2.4. Energy Application Agency - AAE[32] and other activities by state concession-holders

Energy conservation activities have been implemented in the State of São Paulo since 1985, through the Energy Application Agency - AAE and by the concessionaires Centrais Elétricas de São Paulo (CESP), Eletropaulo Metropolitana Eletricidade de São Paulo S.A. (Eletropaulo), Companhia Paulista de Força e Luz (CPFL) and Companhia de Gás de São Paulo (Comgas).

AAE received funding and personnel from the three concession-holders in the state[33] and coordinates the energy efficiency program in the state of São Paulo. The concession-holders participate in the

[32] Currently Energy Rationalization Group.

programs implemented by AAE, but also carry out their own actions, generally through their distribution departments. Several activities were implemented, but a quantification of the results obtained from energy conservation efforts is not available.

State program for the rational use of energy - its purpose is to measure and monitor energy consumption in all public buildings and provide recommendations for controlling consumption.

Education of students in elementary and high schools about energy efficiency - program established at the end of the 1980s, to educate students and train professors to avoid the excessive use of energy.

Train of professionals in various areas in the efficient use of energy - several courses and meetings took place annually to train specialists in marketing and personnel in industrial and commercial activities involved with energy management.

Stimulus to activity of Energy Saving Companies (ESCOs) - it is widely accepted that ESCOs are important partners for dissemination of energy efficient technologies.

Centrais Elétricas de Minas Gerais (CEMIG) is a public utility of the state of Minas Gerais which in recent years has taken an increased interest in energy efficiency. Most activities took place in a poor rural area where the installation of transmission lines is very expensive (Vale de Jequitinhonha). In this area, CEMIG subsidized the use of compact fluorescent lamps (LFC) and the installation of current limiters to avoid high residential consumption during peak hours. CEMIG was also a pioneer in the installation of seasonal meters in residences, to discourage consumption during peak hours through a surcharge on electricity consumed in these hours. This program - Yellow Tariff - is now being implemented by other concessionaires.

In the last two years the Companhia Elétrica do Ceará (COELCE) has shown an interest in energy conservation activities and is involved in a large program to stimulate the use of compact fluorescent lamps. Centrais Eletricas do Norte do Brasil S.A. (Eletronorte) became interested in energy efficiency because of the difficulty in providing electricity to the growing market in the city of Manaus. In the last years, the Companhia Elétrica da Bahia (COELBA) and a Companhia Elétrica do Paraná (COPEL) have been active in demonstration projects in the residential sector and in public lighting.

1.3 - CONTRIBUTION OF HYDROELECTRIC GENERATION TO REDUCTION OF ATMOSPHERIC EMISSIONS

1.3.1 – TRENDS IN ELECTRICITY GENERATION

Brazil is a country of continental dimensions, with eight large drainage basins: the Amazon river; the Tocantins river; the North and Northeast basins of the South Atlantic; the São Francisco river; the east basins of the South Atlantic, the Paraná river; the Paraguay river; and the Southeast basins of the South Atlantic.

[33] Currently with privatization of companies, new levels of cooperation are being negotiated in the state in accordance with the new proposals of ANEEL.

The water production on Brazilian territory, understood as the average flow of rivers emptying into the ocean, is 168,790 m³/s. Taking into consideration the flow produced in the area of the Amazon basin located on foreign territory, estimated at 89,000 m³/s, total water availability reaches 257,790 m³/s.

With all this hydro potential, it is natural that this wealth would be used for the generation of electricity. The hydroelectric potential of Brazil is currently assessed at 1,268 TWh/year (including 50% of the capacity of bi-national potential), of which only around 24% is now exploited.

In 2000, the Brazilian electricity market demanded the production of 322 TWh. Of this production, 93.5%, or 301.4 TWh[34], was generated from hydro power. As a result of these values, the Brazilian electricity sector has special characteristics, not only as one of the greatest hydroelectric producers in the world, but also because of the exceptional share of hydroelectricity in meeting its electricity needs. Of the remainder, a significant amount was produced with nuclear energy (around 1.5%) and biomass (around 3%).

The preference for the hydroelectric option predates the decade of the 1960s, in which integrated planning and expansion of supply was begun at the regional, and later national, level. Although production statistics antes de 1950, the data on installed generating capacity are sufficiently indicative of a historic predominance of hydroelectricity in Brazil, as follows:

Table 6 - Brazil - Installed Generating Capacity

Year	Hydro* MW	Total MW	H / T %
1900	5	10	50
1910	124	157	79
1920	301	367	82
1930	630	779	81
1940	1,009	1,244	81
1950	1,536	1,883	82
1960	3,642	4,800	76
1970	8,985	11,239	80
1980	27,651	33,474	83
1990	45,558	53,050	86
1997	53,889	62,97	87
1998	56.759	65.209	87
1999	58.997	69.153	85
2000	61.324	74.903	82

Source: Estatística Brasileira de Energia nº 14 e 42, CBCME and SIESE/MME. BEN, 2001 for data from 1999-2000.
*Includes 50% of Itaipu

In the 1950s, large-scale state activities in the area of hydroelectric generation began, with the construction of plants on the São Francisco and Grande rivers. Activities on the São Francisco river began with the Paulo Alfonso I plant (180 MW) in Bahia, followed by Três Marias (306 MW) in Minas Gerais. The Grande river projects included the Furnas plant (1,312 MW), important because of its installed capacity and the capacity of other facilities downstream. Also significant was the construction of the Jupiá (1,414 MW) and Ilha Solteira (3,444 MW) plants on the Paraná river, begun in the 1960s, when exploitation of the Paranapanema and Iguaçu basins also began. The 1970s saw, along with the expansion in the São Francisco and Paraná basins (in Brazilian territory), the beginning

[34] Or around 88.5% of the market of 347.7 TWh if electrical self-generators are included.

of construction of Itaipu (12,600 MW), in its international stretch, as well as the exploitation of the Amazon potential, with the Tucuruí plant (4,200 MW) on the Tocantins river.

Planning studies for expansion of electrical systems at a regional level, geared to the coordinated operation of interconnected plants, was begun in 1962, with the hiring of a consortium of Canadian, U. S. and Brazilian consultants, called CANAMBRA, with funding from the United Nations Development Program (UNDP) and the Federal Government. Technical supervision of the work was conducted by the World Bank, for UNDP. This consortium concluded its studies of the Center-South region (states of Rio de Janeiro, São Paulo, Espírito Santo, Minas Gerais and part of Goiás and Mato Grosso, including the Federal District) in 1967. It's expansion to the three states of the Southern region was completed in 1969.

The data obtained from this research confirmed that the preference of the electrical sector for hydroelectricity resulted, even before 1973 (the first oil crisis), from the competitive costs of this source of electrical energy, provided by natural conditions favorable to a wide range of projects, their relative proximity to markets, discount rates which were not very high (in the order of 10% per year) and at the business level, access to credit at interest rates not exceeding 6% per year. These relative advantages presented by a range of projects prevailed even in the 1960s, when oil prices reached their lowest levels, accompanied by reduction of international transport costs. The impact of importing fuel and equipment (higher for thermal and especially coal plants) on the balance of payments was also relevant to the choice of options.

Beginning in the 1970s, there was a significant growth in hydroelectricity production in the total supply of electricity in Brazil, coming to represent more than 93.5% in 2000[35]. Various factors contributed to this:

- rising fuel prices, with the renewed pressure of imports on the balance of payments;
- although the hydroelectric potentials which were most economic and closest to centers of consumption have been largely developed, the unit costs of transport reduced, making more distant sites viable;
- exploitation of hydrological diversities;
- longer useful lifetime for hydroelectric facilities;
- flood control;
- increase in costs of thermal plants, especially coal, because of the relatively low quality of Brazilian coal;
- increasing environmental restrictions that have to be met;
- deepening of the oil crisis in 1979, when all the importing countries sought to reduce their dependency on this fuel; and
- geopolitical factors that favorably influenced the decision to implement some projects, such as Itaipu and Tucuruí.

1.3.2 - NATIONAL ENERGY BALANCE 1970-2000

According to the Ministry of Mines and Energy - MME, electricity destined to meeting domestic demand (acquired by consumers, plus self-generation) was as follows:

[35] Including generating stations connected to the public grid.

Table 7 – Electrical Supply by Source (TWh)

Source	1970	1980	1990	1999	2000
Total Generation*	45.7	139.3	222.8	332.3	347.7
Hydroelectric Generation	39.8	128.9	206.7	292.9	307.6
Thermoelectric Generation	5.9	10.4	16.1	39.4	40.1
Nuclear			2.2	4.0	5.0
Coal	1.4	2.6	2.8	7.4	6.4
Natural Gas			0.7	2.0	3.8
Petroleum	3.7	5.2	5.4	16.0	14.1
Others	0.8	2.6	5.0	10.0	10.8
Net Imports		-0.2	26.5	39.9	42.4
Gross Supply of Electricity	45.7	139.1	249.4	372.2	390.1
Losses, Distribution and Storage	6.1	16.4	31.7	57.5	58.5
End Use Consumption	39.6	122.7	217.7	314.7	331.6

Source: BEN, 2001, except disaggregation for thermal generation in 2000 (normalized based on Patusco and e&e).
* Includes generating stations connected to the grid and self-generators.

The imports indicated in table 7 come from the Paraguayan quota of the Itaipu hydroelectric plant. Because Paraguay does not use its entire quota, it cedes the right of purchase to Brazil. It is a case of hydroelectricity produced at the border of the country, from an investment carried out with predominantly Brazilian funds. The sources included under "other" are predominately derived from biomass and therefore are renewable.

1.3.3 - IMPACTS ON GREENHOUSE GAS EMISSIONS OF HYPOTHETICAL SCENARIOS FOR ALTERNATIVES FOR ELECTRICAL GENERATION BETWEEN 1960 AND 2000

To assess the impact on emissions of different alternatives for sources of electrical supply, the following hypothetical scenarios will be considered:

I - Starting in 1960, 30% of actual hydroelectric generation would be replaced by thermal energy, principally coal and fuel oil. There would be a greater share of imported coal, allowing lower levels of SO_2 than would have been the case with the domestic coal that was used until now in thermal generation.

II - Starting in 1960, 75% of the actual hydroelectric generation would be replaced by thermal generation. In this case, emission levels could be reduced by using a 10% share of natural gas, in 1996-1997.

While in Case I CO_2 emissions would increase by 25% in 2000, in Case II this increase would reach 57% to 63%, depending on whether the nuclear share increases or not. It is estimated that from 1962 to 2000, the additional CO_2 emitted would have been 1.6 x 10^9 t, in Case 1, and 3.9 x 10^9 t, in Case 2. The emission levels in terms of population and GDP would have been as follows:

Table 8 - CO_2 Emissions

	1970	2000
t / person		
Observed	0.86	
Case I	0.91	2.61

Case II	1.02	3.26 to 3.41
t / 10^3 US$ (2000)		
Observed	0.45	0.59
Case I	0.46	0.73
Case II	0.52	0.92 to 0.96

Source: PIB População IEA, 2000.

Table 8 shows that while CO_2 emissions per capita have increased as a function of industrialization and the expansion of the amount of transport in spite of energy conservation efforts, CO_2 emissions per unit of GDP remained at the same order of magnitude. However, if hydroelectric development had been significantly lower, according to the two scenarios formulated, the emission rate per unit of GDP would have been substantially higher, and closer to those of industrialized countries, although still lower than other countries of Latin America.

Brazil's atmospheric emission levels resulting from the use of fossil fuels are among the lowest in the world, whether considered in per capita terms or in terms of GDP. Extensive use of a renewable source (hydroelectricity) also provides sustainability to the country's development and greater autonomy in energy supply.

It is probable that energy and environmental policy of Brazil will seek to maintain, over the next two decades, a high share of hydro energy in meeting the growing demand for electricity given the potential remaining to be exploited under conditions which are economically competitive with other sources, and the growing awareness of the need to avoid environmental degradation, especially in terms of climate change. In order for this development to be carried out, appropriate financial conditions need to be provided, and the long term environmental and energy benefits need to be taken into account in comparisons with alternative sources for electrical generation.

1.4 - STATUS AND PROSPECTS FOR NEW SOURCES OF RENEWABLE ENERGY IN BRAZIL

New sources of renewable energy include "modern biomass use", small hydroelectric facilities, and wind, solar (including photovoltaic), tidal and geothermal energy. "Modern biomass use" excludes traditional uses of biomass, such as firewood, and includes the use of agricultural and forestry residues, as well as solid wastes, for the generation of electricity and production of heat and liquid fuels for transport.

Brazil still has a predominately renewable energy matrix, which is not necessarily based on traditional energy sources such as wood, but on sources such as hydroelectricity and fuels such as ethanol. In remote areas, there is a pent-up demand that will lead to increased demand for solar photovoltaic energy, small scale wind systems and generation systems using vegetable oils. It is expected that the institutional and regulatory incentives introduced will reduce the space occupied by fossil fuels, in favor of local renewable sources.

Given that a substantial number of renewable energy projects registered with ANEEL could be implemented[36], it is expected that a part of the trend outlined in the Ten-Year Plan could be reverted, and that the share of renewable energy in electrical generation will not fall to 82%. It is expected that this matrix be diversified also through the inclusion of other forms of biomass, wind energy, and a greater role of small hydro facilities. Over the next 10 years, it is expected that these sources will represent around 5% of Brazilian supply[37]. As well, small scale cogeneration units and renewable community or individual systems for remote areas could, in the same time frame, serve around 500,000 homes that are not likely to be connected to the national grid.

1.4.1 - RECENT HISTORY OF RENEWABLES

In Brazil, the use of new forms of renewable energy got a major boost after the UN Conference on Environment and Development, known as Rio 92. Since then, more than 12 MW[38] of photovoltaic systems have been implemented and 21.4 MW[39] of wind systems, which serve to demonstrate the technical viability of these alternatives, both in the case of solar photovoltaic energy for meeting energy needs in certain niches, and for feeding the electrical grid in areas with substantial wind potential, such as coastline in the Northeast. The use of energy from small hydroelectric projects and sugarcane bagasse, along with other forms of biomass which are already established in the country, have been consolidating and expanding because of the restructuring of the electrical sector and the incentives offered to these sources and to electricity cogeneration.

In April 1994, the Ministers of Mines and Energy (MME) and of Science and Technology (MCT) called a meeting for the Definition of Guidelines for the Development of Solar and Wind Energy in Brazil, where a range of actions were raised in order to identify mechanisms and propose changes in governmental policies that would enable promotion of the use of these energy sources. The establishment of a Permanent Forum was recommended (established in October, 1994) to ensure the implementation of the guidelines and the creation of the Centers of Reference for the diverse technologies that would emerge, such as the Center of Reference in Solar and Wind Energy (CRESESB), the Center of Reference in Biomass (CENBIO), and the Center of Reference in Small Hydroelectric Stations (CERPCH), established in 1994, 1996 and 1997, respectively. The private sector also organized and created, in November 1994, the Brazilian Association of Renewable Energy and Energy Efficiency Companies (ABEER), made up of representatives of companies operating in these sectors in Brazil.

Other initiatives in the use of solar photovoltaic energy are being coordinated by various electricity concession-holders. CEMIG, from the state of Minas Gerais, established a model where a tariff is charged to cover part of the costs of meeting isolated homes, with the other part of the investment covered by a mandatory allocation of part of its profits in solar programs. COPEL, in the state of Parana, has been incorporating renewable solar systems as an option in its rural electrification program, while CESP, in the state of São Paulo, has implanted a pilot project in which a tariff is charged for services provided to residential solar systems (Seria photovoltaics ou agua; e cobrado so para donos destes sistemas?).

In the area of wind energy, several states have begun wind measurements, such as Minas Gerais, Ceará, Bahia, Paraná and Santa Catarina, and are now in different stages of negotiation to implement

[36] It is expected that projects for new renewable sources of electricity authorized between 1998 and 2002, but which still have not started construction, account for around 6300 MW. Cf. ANEEL Generation Information Bank – www.aneel.gov.br

[37] In 2002, Brazil proposed the "Brazilian Energy Initiative" under the Global Sustainable Development Summit (Rio +10), in Johannesburg, South Africa, which called on countries to commit to increasing the share of new sources of renewable energy to 10% of their domestic energy supply.

[38] According to estimates of the Photovoltaics Systems Laboratory of the University of São Paulo.

[39] Cf. ANEEL Generation Information Bank – www.aneel.gov.br

wind energy projects connected to the grid. The most promising projects are located in Ceará, which has 17.4 MW installed, and Paraná, with 2.5 MW.

In the area of small hydroelectric plants (SHPs), Brazil is extremely well-endowed, with extensive technical knowledge, production capacity and natural resources. According to the Center of Reference in Small Hydroelectric Plants (CERPCH), the interest in building new plants increased considerably in recent years, with a growing number of annual applications. This growth is primarily due to the introduction of regulatory incentives, stimulating an extensive program by the private sector.

Introducing the incentives described above would have the natural consequence of reversing the history of waste of agricultural and forestry residues, through the incorporation of technologies, which are either already developed or in diverse stages of development, for the efficient use of biomass energy. Agricultural residues, excluding those of sugarcane, represent an energy potential in the order of 37.5 million TOE (tonnes of oil equivalent) annually, equivalent to 747,000 barrels of oil per day, which is practically unused.

1.4.2 - REGULATORY FRAMEWORK

Based on article 175 of the 1988 Federal Constitution, which deals with federal state and municipal public services and defines what concessions and permits will go through a public tendering process, and the subsequent ordinary laws, the Brazilian electrical sector began a process of restructuring with the introduction of competition in both ends of the electrical production chain – generation and retailing, and free access to transmission and distribution, which until them were considered natural monopolies. There is therefore greater transparency and opportunities, including for renewable energy sources.

Law # 9427, from December 26, 1996, which created the National Electrical Energy Agency (ANEEL), regulates the concession of public electrical services and contains other provisions, including for at least a 50% reduction in the charges for the use of transmission and distribution systems, and free sale of energy to consumers of at least 500 kW and the exemption from payment of financial compensation for the use of water resources for projects involving small hydroelectric plants (SHPs). Decree # 2003, from September 10, 1996, defined and regulated independent and self-generation of electricity, which are important in generation of electricity from alternative and renewable energy sources.

On August 6, 1997, Law # 9478, addressing national energy policy, was sanctioned. The Law's provisions include guidelines for the rational use of energy sources, including alternative sources and technologies, through the economic utilization of the available inputs (clause VIII of Art. 1).

Particularly important were the incentives given by Law # 9648[40], from May 27, 1998, to small hydro facilities, which were exempted from paying "royalties" to states and municipalities, had a reduction of 50% on transmission and distribution tariffs, and could sell energy directly to any consumer with more than 500 kW and were exempted from the public bidding process, requiring only an authorization from ANEEL. After this law was created, similar benefits were advocated for the other renewable sources.

[40] Law # 9648, from May 27, 1998, changed various laws in the electrical sector, and among other things, established incentives to alternative renewable energy sources that replace thermoelectric generation using petroleum derivatives in isolated electrical systems. It allows these sources to take advantage of the benefits of the allocation system of the Fuel Consumption Account (CCC) for generation of electricity in isolated systems, as established in Law 8631, of March 4, 1993 (Para. 4 of Art. 11). This provision is regulated by ANEEL Resolution # 245, from August 11, 1999.

ANEEL's resolution n º 112, from May 18, 1999, established the requirements for obtaining the registration or authorization for the implantation, expansion or refitting of thermoelectric, wind, or photovoltaic generating stations, and of other alternative energy sources destined to selling energy under the form of independent production, exclusive use or the execution of a public service. This resolution was established by virtue of the need to modernize and complement the procedures contained in prior regulations, in order to facilitate the entrance of new generation sources, through simplifying rules and standardizing procedures. Among other provisions, it establishes the requirement of registration for plants with a generating capacity of up to 5 MW, and of authorization for plants with a capacity of greater than this capacity.

On July 2, 1999, the Ministry of Mines and Energy (MME), through Administrative ruling # 227, determined that Eletrobras hold a public call for proposals to identify the surplus electricity available from cogeneration, with the objective of bringing it to the market in the short term. It also determined that Eletrobras establish appropriate mechanisms for the purchase, directly or through companies under its control, of surplus electricity produced by cogenerators, duly authorized by ANEEL.

On August 11, 1999, ANEEL resolution n º 245 established conditions and terms for the subrogation of the benefits of the allocation of the Fuel Consumption Account - CCC to projects to be established in isolated electrical systems to replace thermoelectric generation using oil derivatives. The resolution allowed the use of funds from the CCC to wholly or partly replace existing uses, such as to meet new loads owing to expansion of the market. The following were explicitly listed: hydroelectric projects with a capacity of more than 1,000 kW and equal to or less than 30,000 kW, characterized as small hydroelectric plants, and other electrical generation projects using alternative renewable natural resources. The concept of Reference Energy was defined, which will be established for each project by ANEEL based on the market served, on the existing repressed demand, as well as on the long-term availability of energy from the project. Finally, the monthly values of funds that could be paid to qualified recipients and the time frames for use of these benefits were defined.

Pursuant to the relevant legal provisions, especially those in Para. 4 of Art. 11 of Law # 9648, of 1998, and in light of the compatibility of SHPs and other alternative sources and technologies for electrical generation with the characteristics of small isolated systems, ANEEL Resolution # 245 sought to encourage forms of generation with lower cost and environmental impact, in order to encourage socioeconomic development and the reduction of regional inequalities[41].

ANEEL resolution # 261, from September 3, 1999, regulated the requirement of using resources of electrical concession-holders in activities to reduce electricity waste and for technological research and development in the electrical sector for the two years 1999-2000, along with establishing that at least 10% of the annual operational revenue must be used in technological research and development projects in the electrical sector. The resolution established that presentation of programs must follow the Manual for Development of the Annual Program of Research and Development of the Brazilian Electrical Sector, which includes renewable energy among the five lines of research, along with

[41] This resolution was amended by changes made to Law # 9648 by Law # 10,438 /2002, which refers to the CCC. Law # 10438, from April 26, 2002, among other provisions, created the Incentive Program for Alternative Sources of Electrical Energy (PROINFA), the Energy Development Account (CDE), addressed the universalization of electrical energy services and changes legal provisions that affect the use of alternative sources and cogeneration of energy, as described below: a) extend to projects with a capacity of up to 30 MW, of qualified generation from wind, biomass and cogeneration the benefit of at least a 50% reduction in charges for the use of transmission and distribution systems; b) extends to wind energy, solar and biomass the benefits of marketing their energy to consumers or groups of consumers with a load of greater than or equal to 500 kW, in the interconnected electrical system; c) reduce to 50 kW the minimum load limit for marketing energy, when the consumer or group of consumers are located in an isolated electrical system; d) extend for another 20 years the proration system of the CCC in isolated systems, requiring, however, the establishment of mechanisms which encourage economic and energy efficiency, environmental protection and use of local energy resources; e) establishes new procedures and mechanisms for allocation of the resources of the Global Reversion Reserve (RGR), including the destination of resources for generation projects from alternative sources, especial small scale (up to 5 MW) for serving communities with isolated electrical systems.

energy efficiency, electricity generation, environment and strategic research. This resolution however, especially in terms of the operational revenue, was profoundly altered by Law # 9991, from July 24, 2000, which obliges companies holding concessions, permissions and authorizations from the electrical sector to invest a minimum of 0.75% of its net operational revenue in energy efficiency and technological research and development (see section 1.2.2).

Resolution # 281, from October 1, 1999, established the general conditions for obtaining access, including use and connection, to electrical transmission and distribution systems. In terms of incentives to alternative sources, there is a reduction of at least 50% in charges for using transmission and distribution systems for small hydroelectric plants (SHPs). There is also a complete exemption from these charges for projects that start up by December 31, 2003.

Resolution n º 21, from January 20, 2000, established the requirements for qualification of electricity cogeneration plants. These requirements include a minimum percentage of energy savings in relation to simple use of heat, and benefits small units of less than 5 MW as well as those above 20 MW. Plants using fuels of more than 25% fossil origin need to have an electrical generation yield of at least 24%, 27% and 31% respectively for plants of up to 5 MW, 5 to 20 MW and more than 20 MW. Plants with renewable fuels must have a electrical generation yield of at least 14%, 17% and 21% respectively for the same capacity ranges, or 10% less than for fossil fuels. This regulatory mechanism was based on incentives policies for to the rational use of energy resources, given that energy cogeneration contributes to rational energy use, since it enables a better use of fuels compared to generation of heat and electricity separately.

The regulatory values are set out in ANEEL resolution # 266, of August 13, 1998, which established the formulas for calculating costs of purchased energy to be considered in readjustments of the rates charged by distributors. These formulas contain percentage ranges that progressively limit the passing on of the price of energy purchased to the rates charged to final consumers. For a range of up to 5% of the regulatory values, the full amount can be passed on. Outside of this range, the profits or losses resulting from the amounts of energy contracted become increasingly assumed by the distributor. An ANEEL measure from July of 1999 which establishes the regulatory values in R$/MWh[42], as well as other benefits, permits the feasibility of new investments in expansion of the electrical supply (generation) with a stimulus to small hydroelectric projects, alternative sources and cogeneration. According to the text of the resolution, the regulatory values established by ANEEL are differentiated by type of energy source and based on the costs of new generation projects, on bilateral projects for purchase of electrical energy and on the guidelines of the National Energy Policy. Each contract for purchase of electricity is linked to the normative values in force at the time of signing the contract, as well as on the respective readjustment formula. These parameters remain constant for the respective contracts during the entire period they are in force. At the discretion of ANEEL, the normative values can be revised annually or whenever there are relevant structural changes in the electrical production chain, and cease to exist when the market conditions so warrant. Thus, the transitive character of the regulatory values is directly linked to the data of signing of the contract and to market conditions. The definition of the regulatory value will have no impact on current electricity rates authorized by ANEEL for the concession-holders. And the final consumer, with competition in the electrical sector, will benefit the most from this process.

1.4.3 – MODERN USE OF BIOMASS AND COGENERATION

[42] Type of Energy Source – Regulation Value (R$/MWh), updated by ANEEL resolution # 488, of August 29, 2002: competitive 72.35; coal-fired thermoelectric 74.86; small hydroelectric (SHP) 79.29; thermoelectric using biomass and residues 89.86; wind plants 112.21; solar photovoltaic 264.12. This resolution also establishes the Regulation Values for Natural Gas Fired Thermoelectric Plants. For more information see www.aneel.gov.br (1 US$ = R$ 2.3758).

Energy cogeneration is defined as the process of combined production of useful heat and mechanical energy, generally totally or partially converted to electrical energy, based on chemical energy provided by one or more fuels.

Considering these restrictions, the use of biomass in electricity generation emerges as a very efficient and non-polluting alternative. One of the positive aspects of the use of gasified biomass to generate electricity is that this does not contribute to global warming, since the carbon emitted in the form of CO_2 is absorbed from the atmosphere during the process of plant growth, through photosynthesis.

It is estimated that a considerable amount of energy can be obtained from tree plantations, sugar cane and other biomass sources. Many studies have shown that the energy generated by gasification of biomass could be favorably compared to that generated by hydro resources in Brazil in terms of costs and energy potential. Furthermore, the energy generated by biomass could also contribute substantially to the decentralization of electricity generation.

According to ANEEL[43], there are 30 co-generation plants (electricity producers and independent generators) in operation in Brazil, with an installed potential of 414 MW, with 62% of the installed capacity is located in the state of São Paulo.

Sugarcane bagasse and liquor are among the most important sources of energy in the sugar and alcohol and pulp and paper industries, respectively, along with the several types of hybrid systems with fossil fuels. The 2000-2009 Decennial Expansion Plan estimates the technical potential of cogeneration in these sectors in 2009 to be 5,750 MW, with a commercial potential of slightly more than 2,800 MW. In the sugar and alcohol sector the current installed capacity is around 1150[44] MW. In the pulp and paper sector there is 718 MW of capacity in operation (Eletrobras), and another 930 MW that could be obtained in the pulp and paper sector.

Some limited efforts have been made to reduce consumption of diesel oil in isolated systems in Amazonia. One such effort was carried out by the Rio Solimöes Institutional Support Foundation - UNISOL, a body linked to the Federal University of Amazonas, through an agreement with ANEEL, to teach isolated communities in the Legal Amazon to use solar energy and vegetable oil. The project's objective is to develop a 115 kW system based on vegetable oil in the Extractive Reserve of Média Juruá in Carauari (state of Amazonas), which will benefit 2500 people. The oleaginous native plants of the Amazon (*andiroba*, *murumuru* and *buriti*, among others), are a natural substitute for diesel oil. ANEEL chose the reserves of Rio Preto and Médio Juruá because these areas are preserved and monitored by Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA), with the populations organized through extractivist cooperatives, which facilitates the implementation of the agreement.

In mid-1999, ANEEL authorized the city of São Paulo to install a 26.3 MW thermal generating station in the district of Sapopemba, in the west zone of the city, to generate electricity using garbage as a fuel. The plant will be implemented through the Incineration and Electrical Energy Company (CIEL), which is being created for this end. All energy produced will be consumed exclusively by the city administration and any surplus can be used in public lighting.

In 1996, in Rio Grande do Sul, the first thermoelectric plant using rice husks as a fuel was built. With an installed capacity of 2 MW, it cost around R$ 2 million. The energy generated is sufficient for the consumption of 3000 families. The production will meet the entire demand of the industry, which processes 300,000 bags of rice in husks per month. The surplus energy is sold to the concessionaire

[43] ANEEL Generation Information Bank – www.aneel.gov.br
[44] Cf. ANEEL Generation Information Bank – www.aneel.gov.br

operating in the region. The industry reports that the rice husks available in the state would be sufficient to supply 600 thermoelectric plants of the size of the one in São Gabriel, for a total of 1,200 MW.

The General Electrical Distribution Company (CGDE) has announced the investment of US$ 64.5 million in the construction of 13 cogeneration plants. The units will have a total installed capacity of around 110 MW, around 8% of the current installed capacity of the state of Rio Grande do Sul. A company will be created for management of the project involving CGDE (80%), the electrical distributor State Electrical Energy Company (CEEE) (10%), and the engineering association Koblitz (10%). The plans will be submitted to the European Community Investment Partners, a European Union project for energy efficiency in Latin American countries. The three first units are in Dom Pedrito (6 MW), Capão do Leão (6 MW) and Piratini (10 MW). The fuel used in the first two will be rice husks, with wood wastes used in Piratini. Pelotas, Camaquã and Mostardas will be the next municipalities to receive plants.

Gas-fired micro-turbines for electrical generation in isolated systems will be the object of a research project, through an agreement signed in February 2000 between the Federal Engineering School of Itajubá in Minas Gerais (EFEI) and CEMIG. Different micro-turbines of up to 45 kW will be tested, fuelled by alcohol and gasified biomass, as well as natural gas. Dendê (African oil palm) oil, one of the vegetable fuels with the highest productivity per area planted, will also be considered.

1.4.3.1 – THE WOOD GASIFICATION PROJECT

The project 'Brazilian Wood BIG-GT Demonstration Project/Integrated Wood Gasification System for Electricity Generation" (WBP/SIGAME) seeks to demonstrate the commercial viability of electricity generation from wood (forest biomass) through the use of gasification technology integrated with a gas turbine, operating in combined cycle (BIG-GT technology – Biomass Integrated Gasification - Gas Turbine). This project is the result of the combined interests of a group of companies and Brazilian government bodies in the development of this technology, with the environmental protection objectives of the Global Environmental Facility (GEF), of the United Nations.

The objective of the project was to establish a replicable prototype, on a commercial scale, for generation of electricity, based on wood chip gasification, thereby avoiding CO_2 emissions from conventional thermal sources.

In 1991 the companies Centrais Elétricas Brasileiras (Eletrobras), Companhia Hidro Elétrica do São Francisco (CHESF), Companhia Vale do Rio Doce (CVRD) and Shell Brazil, committed themselves to given the necessary support to the then Science and Technology Secretariat – now the Ministry of Science and Technology (MCT) – so that this body would make a commitment to the United Nations for the use of GEF resources to continue the development of wood gasification technology, gas scrubbing and integration of this system with a combined cycle, in order to make technically and economically viable the use of forestry biomass as a fuel for thermoelectric generation of energy on an industrial scale.

With the preparatory stage completed, in 1996 Eletrobrás, CHESF and Shell created Consórcio SER, with the primary responsibility for implanting a demonstration plant, through which the desired objectives are intended to be achieved. Several problems, resulting from the different cultures of the organizations in the consortium, as well as institutional factors resulting from the changes under way in the Brazilian electrical sector, have resulted in successive delays in the start date for construction of the plant[45].

If these problems can be overcome, the next step, starting in the year 2003, is the installation of a 32 megawatt capacity thermoelectric demonstration plant. In terms of the prospects for WBP/SIGAME, independently of the results which are obtained, it will be one of the principal references in future decisions regarding the use of biomass as a primary energy source. Technically, the commercial success of the generation concept used in WPB/SIGAME would bring the prospect of opening up a new and broad market, both in the area of services and durable goods. This initiative will determine the sustainability of energy from biomass in developing countries and the possibilities that it offers for commercial activities in regions with low economic potential, the new technology will combine carbon sequestration with efficient electricity generation.

1.4.3.2 - SUGARCANE BAGASSE

In Brazil, because of the vast production of sugarcane and the experience with using ethanol, studies have been undertaken of the technical and economic viability of more extensive use of bagasse and sugarcane leaves in energy generation projects.

The plants need little electrical and mechanical energy compared to thermal, in their processes. Also, until recently, the legislation made it practically impossible to sell surplus electricity. Thus, existing cogeneration systems convert only around 4%[46] of the energy from bagasse to electrical and mechanical energy, with most of the remaining energy used as thermal energy. This situation is changing, as a function of the possibility of selling excess electricity.

Analyses of conventional systems (steam) for electrical generation in Brazilian plants and distilleries suggest the possibility of increasing the current levels of conversion of 4% to 16% or more, including the possibility of cogeneration throughout the year using residues (leaves and tops). The gasification/gas turbine technology (BIG/GT), still under development, could raise the rate of conversion of bagasse to electricity to above 27%. Furthermore, the electricity generation potential could come to use a substantial fraction of the total production das Brazilian industries. An evaluation of the cogeneration potential for sugar cane bagasse can be seen in Table 9.

Table 9- Cogeneration in plants: conventional and with gasification[a]

Consumption in process (kg. of steam /t. sugarcane)	500	340	Energy Surplus 80% Brazil (TWh) [e]	Generating Capacity, Brazil (GW)	
Scenarios	Energy, (kWh/t.cane)			Harvest [d]	Annual [d]
Co-generation, steam 100% of bagasse	57	69	13.6 – 16.6	3.1 – 3.8	
Co-generation, steam Bagasse + 25% leaves [b]	88	100	21.1 – 24.0		2.4 – 2.7
Co-generation, steam Bagasse + 40% leaves	115	126	27.6 – 30.2		3.1 – 3.4

[45] At the beginning of 2001, these problems had been overcome with the return of the project to the list of priority projects of the Brazilian government prepared by the Secretariat of International Issues (SEAIN) of the Ministry of Planning and Budget (MPO) and with the designation of CHESF as having sole responsibility for its management from that date onwards. This position was officially expressed to the World Bank in early April, 2001. Thus, apparently all the preconditions for the start of construction of the plant had been met, but over 2001 new obstacles were created, this time by the World Bank itself. This situation is only being overcome by direct negotiations with the GEF.

[46] Given electrical generation of 28 kWh/t of sugarcane (with 12 kWh/t sugarcane for electricity and 16 kWh/t sugarcane for mechanical energy) and 644 kWh/t sugarcane (thermal energy) from the use of 90% of the sugarcane bagasse (280 kg. of bagasse/t cane).

BIG – GT (partial) [a,c] Bagasse + 40% leaves		167	40.0		4.6

Source: Macedo, 2002.
(a) Conventional co-generation: steam cycles, condensation-extraction, 80 bar; using all the bagasse and in some cases complementing with crop residues. Gasification: cycles involving gasification of bagasse and use of gas turbines; technology not currently commercially available.
(b) Crop residues: not available today; amounts increasing in recent years.
(c) BIG – GT partial: part of the bagasse is still burned in boilers, not gasified. Systems with total gasification could have greater efficiency.
(d) Operation only for harvest (4400 h/year) and annual (8760 h/year).
(e) 80%: assuming that 20% of the potential will not be used, for various reasons.
(f) Thermal energy, today ~500 kg steam/t cane (~330 kWh/t. cane).

In July of 1997, the Copersucar Technology Center (CTC) began implementation of a technological development project, coordinated by MCT and planned to last two and a half years, and aimed at developing technology for the entire electricity production cycle with advanced conversion systems (gasification/gas turbine) based on sugarcane biomass.

Project BRA/96/G31 involved an extensive program, including assessment of all stages of the process from sugarcane harvest to the energy produced, seeking to increase the efficiency of this technology. This program included plans to:

- assess the availability, quality and cost of sugarcane straw for use in gasification systems;
- evaluate/develop agronomic regimes for sugarcane harvest without burning;
- test the atmospheric gasification process with straw e bagasse;
- integrate the BIG/GT process with a typical plant; and
- identify and evaluate the environmental impacts.

The assessments of impacts of the system BIG-GT on the atmosphere were concluded in March of 1998, and indicate that there is the potential for additional biomass available for energy, greater conversion efficiency and lower emissions with the reduction of burning of sugarcane.

The analysis was based on the harvest of burned sugarcane crops and identified future scenarios, depending on the type of harvest (3 scenarios/types) (table 10):

Reference: 100% of sugarcane is burned before harvest; 10t (MS)/ha of straw collected; energy self-sufficiency.
Future: 55% of sugarcane without burning, recovery of 100% or 50% of the straw in the unburned sugarcane, depending on the harvest regime.

Table 10 – Differences in CO_2 emissions between the future scenario and reference

Harvest type	Diesel used in agriculture (kg CO_2/t. cane)	Replacement of fossil fuel (kg CO_2/t. cane)	Difference in total emissions (kg CO_2/t. cane)	Brazil: 300 x 10^6 t. cane/year (10^6 t. CO_2/year)
Type 1 *	+2.1	-139	-137	-41.1
Type 2 **	+7.3	-139	-132	-39.6
Type 3 ***	+2.3	-87.5	-85	-25.5

* whole sugarcane with straw, 100% transported to plant;
** chopped sugarcane (extractor disconnected), 100% of straw transported to plant;
*** sugarcane chopped (extractor connected), baled, 50% of straw transported to plant.

The last column of Table 10, presents the hypothetical reduction of CO_2 emissions that could be achieved in Brazil with the BIG-GT technology implemented, according to the scenarios adopted.

The scenarios take into account reductions in emissions of methane and other gases resulting from the reduction of burning of sugarcane crops. Emission factors for burning of crop leaves were measured in a wind tunnel specifically for sugar cane[47], and the results differ from the general average values for burning of residues recommended by the IPCC (which are around 4 to 5 times greater). IPCC values were used to estimate the reduction in emissions of CH_4, CO and NO_x with partial collection (55%) of sugarcane without burning.

Table 11 – Reduction in emissions of CH_4, CO and NO_x from the partial collection of sugarcane without burning

Gases	total leaves burned/ t. of cane – difference between situation of reference and future	**Emission factors** (kg gas/ t. residues burned)		Impact on emissions (kg gas/t. cane)	Impact on emissions Brazil: 300 x 10^6 t. cane /year (t. gas/year)
CH_4	0.056 - 0.125 = -0.069	IPCC:	2.83	-0.195	-58500
		Tunnel:	0.41	-0.028	-8500
CO	0.056 - 0.125 = -0.069	IPCC:	59.5	-4.10	-1230000
		Tunnel:	25.48	-1.76	-527000
NO_x	0.056 - 0.125 = -0.069	IPCC:	4.37	-0.301	-90000
		Tunnel:	1.40	-0.097	-29000

Source: Macedo, 2002.

1.4.4 – OTHER NEW SOURCES OF RENEWABLE ENERGY

1.4.4.1 – Small Hydroelectric Projects

According to ANEEL, there are 205 SHPs in operation in Brazil, for a total of 865.6 MW, 40 projects under construction (504.9 MW) and 82 projects authorized (construction not started), which, if built, will add another 1.323 MW[48] to the system.

Measures have been taken to attract the private sector to hydroelectric plants. This includes regulatory measures to facilitate the process, as well as a new financing policy that has already been implemented, with BNDES financing up to 80% of the costs. Some effects can already be noted in the development of small-scale hydro in the private sector. However, according to the Association of Independent Energy Producers (APINE), the execution of a inventory study of the remaining potential sites in Brazilian drainage basins, would substantially minimize the risks and help to facilitate the process of expansion of this energy source. There are estimates that the remaining hydro potential which could be exploited by means of small hydro plants is in the order of 7000 MW.

1.4.4.2 - Solar photovoltaic energy

[47] There is a single complete study using appropriate methodology, in a wind tunnel (Jenkins, 1994). The IPCC recommends using "general" values for emissions on burning of agricultural residues when there are no specific data. These values are higher than those measured for sugarcane according to the above mentioned study.
[48] Data from 2002, according to the ANEEL Generation Information Bank – www.aneel.gov.br

The estimate of the Photovoltaic Systems Laboratory of the University of São Paulo (LSF/USP) is that there are 12 MWp[49] installed in photovoltaic systems in Brazil, distributed among community systems, with most of the systems provided by the Energy Development Program of States and Municipalities (PRODEEM), and residential systems sold directly by distributors, whether through direct sales or financed through existing lines of credit.

The Energy Development Program of States and Municipalities (PRODEEM), has a potential market of around 100,000 communities in Brazil currently without electricity. The goal for 1999, within the program Brazil in Action, was to serve 2000 communities and 400,000 people. By the end of the year the Program cumulatively served 4000 communities, benefiting more than 800,000 people.

Another source of financing that can be used in solar photovoltaic energy programs is Programa Luz no Campo (Light in the Countryside Program), which intends to increase the coverage of rural electrification in Brazil from 57% to 67.5%. The goal of the government is to provide lighting to one million new rural properties and homes. No amount or percentage of funding to be destined to renewable energy has been set, but it is clear that for a significant part of the territory be served solar photovoltaic energy is the least cost alternative. For the state of Bahia, this percentage is slightly higher than 5% of the resources. PRODEEM, which addresses community demands, and Luz no Campo, with residential demands, could add an average of 5 to 8 MW annually in photovoltaic systems in the next years.

The retail market will likely continue growing at an average annual rate of between 1 and 2 MW, especially with the growth of models of rotating funds and financing by micro-companies, created by non-governmental organizations NGOs in partnership with development banks, as for example with the initiatives of the Banco do Nordeste with the Association of Small Producers of the State of Bahia (APAEB), the Fundação Teotônio Vilela, and the Institute of Sustainable Development and Renewable Energies (IDER), which together have already implemented more than 2500 conventional systems

In the second half of the 1990s, the first experiences began to emerge related to the connection of photovoltaic systems to the conventional distribution grids, with Brazil becoming part of an emerging global trend towards the increasing importance of this technological application[50].

Table 12 – Characteristics of Brazilian photovoltaic systems connected to the electrical grid

System	Installation (year)[51]	Generating Capacity
CHESF	1995	11 kWp, polycrystalline
Solar Laboratory	1997	2 kWp, amorphous
LSF/USP	1998	750 Wp, monocrystalline
COPPE	1999	848 Wp, monocrystalline
Solar Laboratory	2000	1 kWp, amorphous

The contribution of photovoltaic generation to the country's energy matrix, based on the 12 MWp installed and a capacity factor for isolated photovoltaic systems of 12% annually (annual production of 1050 kWh/kWp), a figure which is compatible with the results obtained in the field, is around 12.6 GWh/year. It should be noted that systems connected to the grid operate with a higher capacity factor than isolated systems In Brazil, with these systems, capacity factors of between 15 and 19% (annual productivity of between 1300 and 1700 kWh/kWp).

[49] Data from 2002.
[50] By the end of 2001 there was 20 kW in systems connected to the public grid.
[51] Also to be included is LSF/USP, installed in 2000, 6.3 kWp, polycrystalline.

1.4.4.3 - Thermo-solar Energy

Solar thermal energy is emerging as one of the potentially most important solutions for Brazil, because it comes from a source that is abundant, renewable and clean.

Through a joint effort, a project (Gerahélio) was designed and submitted to GEF which aims at identifying the most appropriate solar technology and the size of a pre-commercial plant based on solar concentrators (in the order of 30 MW). The project was approved by GEF, which provided the resources needed for its development of around US $330,000.

This project is being developed through the cooperation of several Brazilian companies, including Eletrobras, Petrobras, Chesf, and the Companhia de Desenvolvimento dos Vales do São Francisco e do Parnaíba (CODEVASF), under the guidance of the Ministry of Mines and Energy (MME). The technical management of the project is carried out by the Center for Electrical Energy Research (CEPEL), in partnership with the Brazilian Sustainable Development Foundation (FBDS), which has been addressing the issue since 1994. The most likely site for the installation of the pre-commercial plant is the semi-arid Northeast region, in the state of Bahia.

In terms of the use of solar energy for domestic water heating, in individual houses, apartment buildings and commercial applications, especially in hotels, the annual growth rate of at least 30% observed in recent years should be maintained.

1.4.4.4 - Wind Energy

Brazil has around 19 MW[52] of wind energy installed, which is very modest compared to the estimated potential. The recent "Atlas Brazilian Wind Potential", prepared by CEPEL with financing from the Ministry of Mines and Energy and PETROBRAS, shows an enormous natural potential, in the order of 143 GW, which could become an important alternative for diversification of the mix of electrical generation in Brazil. Although not all this potential can be economically exploited, there is a huge space for growth in the use of wind energy in Brazil[53].

There are good opportunities for Brazil in the integration of the interconnected grid of the great blocs of generation on the coastline of the North and Northeast regions. The wind regimes mapped by different institutions in these regions show a system which complements the water regime, with stronger winds in the most unfavorable hydrological periods and a characteristic of ideal composition of generation, since the winds are, for all the seasons, most intense in this period. In the South region of Brazil, in particular in Rio Grande do Sul, excellent winds for energy generation were also found. In the analysis of the opportunities for energy application in Brazil, the possibility of integrated operation of Brazil's hydro system should be considered.

The most important developments expected in wind energy in Brazil are centered in the states of Ceará, Rio Grande do Norte and Paraná. In Ceará two 30 MW projects are planned, based on an agreement between the state government and Ceará Electrical Company (COELCE), with funding from the Japanese organization OECF. Another large-scale project results from an agreement signed between Thyssen-Krupp and the government of Ceará for the creation of a wind farm of 100 MW.

[52] In 2002, around 22 MW, considering the wind farms in Mucuripe (state of Ceara), with 2.4 MW of installed capacity, and Bom Jardim da Serra (Santa Catarina), with another 0.6 MW of installed capacity.
[53] The Electrical Energy Crisis Management Chamber (GCE), through resolution # 24, from July 5, 2001, created the Emergency Wind Energy Program (Proeólica), with the objective of enabling the installation of 1050 MW of wind generation capacity by December of 2003, integrated into the national interconnected electrical grid. The Incentive Program for Alternative Electrical Energy Sources (Proinfa), in accordance with Law # 10,438, of April 2002, whose Article 3 establishes a goal for installation of 1100 MW of wind energy by 2006, guaranteeing the purchase by Eletrobras, of energy produced by wind farms installed under the program for 15 years.

There are also studies for a wind farm of 50 MW in Salinópolis, in Pará, by the company Wobben; a 100 MW facility in Jericoacoara (CE), by COELCE; a 50 MW facility in Cabo Frio (RJ) by the companies Proven / Vestas and the expansion of the Parque de Palmas facility, in Paraná, adding another 85 MW in the region[54].

Development of wind energy technology in Brazil takes place in universities, research centers and concession-holders, with a scientific and technological production that only gained recognition at the end of 1970s and throughout the 1980s. These activities intensified at the end of the 1990s, in an attempt to respond to the greater maturity achieved by wind energy technologies.

Over this entire period, several groups and projects were created, including the Aerospace Technical Center (CTA), Federal University of Paraíba (UFPB), University of Campinas (UNICAMP), Federal University of Minas Gerais (UFMG) and CEPEL. At the same time, electricity concession-holders Eletrobras, Chesf and CEMIG began inventories of wind energy potential, and installation of pilot plants. In the 1990s, other concession-holders, especially COELCE, COELBA, COPEL, CELPA and CELESC, began prospective measurements and also installed wind generation facilities.

In 1996, the first Brazilian factory producing windmills was installed: Wobben Windpower Indústria e Comércio Ltda., a subsidiary of the German company Enercon GmbH, one of the largest manufacturers in the world of wind turbines. The plant was installed to produce large windmills and their components, both for export and to serve the domestic Brazilian market[55].

The table below presents the principal wind facilities operating in Brazil:

Table 13 - Principal Wind Facilities in Brazil

Site	Inauguration	Generating Capacity (MW)
Camelinho-MG	Aug/1994	1.0
Taíba - CE	Dec/1998	5.0
Prainha - CE	Jan/1999	10.0
Palmas - PR	Feb/1999	2.5
Fernando de Noronha - PE	Mar/2000	0.25

Source: CRESESB, 2001[56].

Certainly, the possibility of incentives and conditions such as a guarantee of purchasing on the part of concessionaires, and financing through BNDES and Eletrobras, with the Reserva Global de Reversão (RGR)[57], will allow a rapid development of this source of energy.

1.4.4.5 – Electricity generation from vegetable oils

[54] The situation of wind farms has changed very rapidly, especially after the year 2000. It is expected that projects for new wind generation projects authorized between 1998 and 2002, but which still have not started construction, account for around 5000 MW. For updated data see ANEEL Generation Information Bank – www.aneel.gov.br

[55] In February of 2002, Wobben inaugurated its affiliate in the State of Ceará, in the Port Industrial Complex of Pecém. The production capacity of the Sorocaba and Pecém plants is planned to reach 600 MW per year in 2003.

[56] The wind farms of Mucuripe (Ceara) and Bom Jardim da Serra (Santa Catarina) were inaugurated in, respectively, in November of 2001 and April of 2002, with installed capacity of respectively 2.4 and 0.6 MW.

[57] See Law # 10,438, from April 2002. See footnote 43.

Supplying electricity to isolated communities is a significant challenge to be faced by Brazilian society, in attempting to improve the living conditions of its most needy populations and the suppression of the strong regional disparities (see section 1.5). Electrification of small isolated communities, however, faces great obstacles represented by the high cost of transmission lines, transport of diesel oil and by the low purchasing power of members of these communities.

For the North of the country, where only 2.6% of rural properties were provided with electricity – primarily due to the scattered small communities located far from the electricity generation centers[58] and where the conventional electrical transmission lines are economically unviable – the generation of electricity from vegetable oils is a local, viable and sustainable in socioeconomic and environmental terms. Most importantly, this region is home to an enormous diversity of native oleaginous plants and favorable edaphic and climatic conditions for the cultivation of exotic species which are highly productive in oils, thus enabling the employment of local labour, the stimulation of economic activities and improvement in housing, health and educational conditions. Thus, isolated efforts are been carried out by Brazilian companies and institutions in the use of vegetable oils for energy.

In December of 1996, a project was begun with the objective of generation and distribution of electrical energy for the community of Vila Boa Esperança, in the Municipality of Moju, in the state of Para, through the implantation of a micro-plant for extracting oil from palm, produced in the community self, which would be used as a fuel in a “multi-fuel” motor-generator group.

The community consists of 200 houses with a total of 1000 residents, whose principal activity is subsistence agriculture and timber extraction. There is no health clinic, hospital, water treatment station or leisure area. The only public facilities is an elementary school with a capacity for 200 students.

Fifteen hectares of oil-palm were planted, which will produce sufficient fruit to supply the oil needed to run the motor-generator group (AMS, model MF-4RTA-GS, with 106 kW capacity in continuous use working six hours per day, year-round). In this phase, because the oil-palm plantation takes three years from planting to collection of the first fruits, palm oil is being supplied by the company Dendê do Pará S.A. (DENPASA), in the agreement signed with the project proponents.

The choice of oil-palm oil results from the fact that the oil-palm plantation has the highest yield per hectare planted, with productivity of 3-5t oil/ha/year, while the productivity of soybean, for example, is in the order of 0.4 to 0.5 t oil/ha/year. Also, the soil and climate conditions in the Amazon region allow oleaginous plants from Africa to adapt easily.

The installation, already in operation, allowed the electrification of 100 residences, the public school and the establishment of street lighting. As a result of these services, there have been significant improvements in the socio-economic and cultural life of the community. The electrification of the public school allowed its nighttime operation with a literacy course for adults and the alteration of some social habits.

Some of the residents purchased a considerable number of domestic appliances and electronic items, in a clear demonstration of the improvement of family comfort and living conditions. The initiative also served to stimulate actions on the part of the government. The mayor of Moju (PA) is implementing a water supply system that will provide improvements in the community’s hygiene.

In the face of all these transformations, there is at this moment a migration of families form other nearby communities without electricity to the community of Vila Boa Esperança (PA).

[58] Kaltner, 1998.

1.4.4.6 - Biogas in sanitary landfills

Sanitary landfills are used for the final disposal of urban solid waste, principally consisting of household waste. This consists of around 50% of moist organic material, which is principally food waste, and thus can decompose relatively rapidly. Of the other 50%, called dry waste, there are metals, glass and plastics (non-biodegradable waste), papers, cardboard, wood and rags, which are organic produces consisting principally of cellulose, and thus subject to slower degradation. This composition, confined to closed environments, starts a process of aerobic decomposition – while there is oxygen in the air in the spaces in the waste (which are in inverse proportion to the degree of compaction of the waste in the landfill) – which goes through successive stages dominated by bacteria and facultative and aerobic fungi. The methane appears a few days or weeks after the disposal of waste in the landfill, as soon as the oxygen has been consumed.

In the biomass sector, the use of thermoelectric energy from biogas is beginning to become a reality, especially from methane generated in sanitary landfills and in sludge digesters in urban sewage treatment stations. There is a still unquantified potential for biogas in sludges from agro-industrial processes.

Sanitary landfills started having the technology implemented in 1979, as a result of the crises from the oil price shocks. In São Paulo this was initially planned for the Bandeirantes and Sapopemba sanitary landfills. The principal innovation, which was incorporated in the techniques of landfill operations, was the placement of convergent horizontal drains for the drainage wells, with the dual function of draining leachate to the bottom drains and the gas for capture at the upper surface of the landfills. These horizontal drains are implanted in the surface of each new layer of waste of around five meters thick, and it is not uncommon to have from ten to twenty such layers, totaling from fifteen to thirty million tonnes of waste.

In 1998, the municipality of São Paulo, through its Municipal Environment Secretariat, started a bidding process to award concessions for areas of municipal sanitary landfills (there are seven landfill sites) for the exploitation of the methane generated in them. A call for tenders was issued for two landfills in operation, with a maximum installed capacity of around 20MW each, with the provision that half of this potential must be destined to supplying 50% of the energy consumption of the Municipality of São Paulo in the municipality itself.

The anaerobic process that takes place in the sludge digesters of urban sewage treatment stations generate the same biogas of sanitary landfills, and its energy use uses the same technological principals and the same equipment for energy capture in landfills. The capture of gas is thus simpler, since its generation occurs in confined environments, in contrast to landfills, which involves an suction operation in the interior of landfills with greater technical complexity. The disadvantage of this use is the still low percentage of sewage treated in Brazil.

Yet to be assessed is the potential for biogas generation from agro-industrial residues such as barley bagasse in beer production or the many forms of organic sludge. The industries do not necessarily need to invest in the construction of digesters, but simply pump or transport it to idle sewage digestion facilities or form a “pool” of industries for extraction of the energy fraction of their sludges before the final disposal of digested sludges, which could be animal food, as occurs today with the non-digested barley residues in breweries. Organic sludge can also be processed in dryers, resulting in palletized powder, suitable for burning in furnaces or boilers for generating steam or thermoelectricity.

As leading edge technology the market is offering the thermal destruction through plasma, at very high temperatures, with high efficiency of treatment of sludge and residues – including non-biodegradable – and high energy yield.

Industrial and sanitation companies are also trying to make viable the use of the huge quantity of sludge generated in their sewage and effluent treatment stations for energy production. Initial studies indicate the sustainability of these uses, and their environmental and economic attractiveness.

1.5 - PROGRAM FOR ENERGY DEVELOPMENT OF STATES AND MUNICIPALITIES - PRODEEM

1.5.1 - CHALLENGE: ENERGY FOR ISOLATED COMMUNITIES

Created in December of 1994, by presidential decree, the National Program for State and Municipal Energy Development (PRODEEM), of the Federal Government, is coordinated by the Ministry of Mines and Energy (MME) through the National Department of Energy Development (DNDE).

It is aimed at serving isolated sites that are not provided with electricity through the conventional grid[59], and which can obtain this energy from local renewable sources, thereby promoting the social and economic development of these areas.

Given the great imbalance between urban and rural social development, the program involves much more social integration and keeping people on the land that increasing supply in the Brazilian energy matrix. In the medium and long term, the expectation is to develop all the existing potential in the communities, through the application of available technologies and those in development (such as biomass, wind, solar, hydrokinetics, etc.), contributing in a decentralized and clean manner to meeting the objectives of universalizing access to energy, as well as diversifying the energy matrix, which is currently highly dependent on rainfall regimes.

PRODEEM, with the name “Energies of Small Communities”, is part of the Programa Avança Brasil (PPA). The program reflects a greater awareness on the part of bodies responsible for incorporating mechanisms that permit a greater knowledge of ecological and socio-productive systems of small communities, and this of the existing relations between these two systems, giving priority to the development of the available energy potential.

Government efforts to make social programs more effective in eradicating poverty has led to the creation of the Alvorada Project, aimed at improving the Human Development Index (HDI) of Brazil’s poorer communities. In the compendium of this project, which covers 12 different programs, PRODEEM is responsible for electrical energy services for implementation of the social programs of remote communities.

The activities of “PRODEEM Social” are aimed at providing energy to schools, health clinics, community centers, water pumps, etc, through installing photovoltaic systems in these community facilities, either directly or through partnerships with state governments. “PRODEEM Market”, on the other hand, is aimed at developing the latent market potential in rural communities. Its activities are directed at developing the basic conditions for implementation of self-sustaining management models compatible with the available human, technical, institutional and economic resources, through working both on supply and demand of energy.

[59] In 1995, according to data from Eletrobras, of the 5,835,779 rural properties in Brazil, only 1,604,247 of them, or 27.5% of the total, were electrified.

PRODEEM has a great diversity of partners, at the three levels of government, including:

Federal Level[60]: MME, MCT, MPOG, MEC, INCRA, FUNAI, Alvorada Project, Casa Civil, centers of excellence, federal universities, ELN, CHESF, ANEEL, Eletrobras, Petrobras, CPRM, etc.

State Level: state governments, universities, NGOs, concession-holders, rural electrification cooperatives, etc.

Local Level: municipal governments, NGOs, agro-technical schools, CEFET's, SENAI, SEBRAE, EMATER, micro companies, resident's associations, cooperatives, etc.

It's partnerships also include international cooperation provided by the Interamerican Development Bank (IBD), through the funds FUMIN and JSF, with support from UNDP[61]. This cooperation is focused primarily on developing business models and lines of microcredit compatible with the objectives of "PRODEEM Market".

In the coming years, it is expected that the cooperation requested from the Japanese agency JICA[62] will be forthcoming, aimed at the institutional strengthening of the program.

The resources provided through the cooperation projects will complement PRODEEM's core budget, which because of the nature of the federal government's priority program, receives preferential treatment from the Alvorada Project and Avança Brasil, which channels the necessary resources for development of the program. The priority for PRODEEM Social is the purchase of photovoltaic systems to meet the goals established by the Alvorada Project, with the purchase of 18,000 community units, with 3000 photovoltaic units in 2001, 6000 in 2002 and 9000 in 2003.

The great challenge for the program at the moment is to develop a management model that can coordinate all the agents involved in the three levels of government, and mobilize the existing technical, financial, and institutional resources, as well as ensure the sustainability of the systems in the field, given the limitations imposed by the geopolitical diversity of Brazil, the widely dispersed remote communities, low purchasing power and consumption levels of users, the high cost of the installations, difficulty of access to the communities, and the fact that legal and regulatory frameworks are still being development, among other problems inherent to the process.

PRODEEM intends to benefit around 14 million Brazilians, most of them in rural areas and distributed over approximately 60,000 communities, three million rural establishments, 58,000 public schools and 3000 indigenous communities.

1.5.2 – Specific Objectives

Social Development: installation of micro-systems for energy production and use in needy communities that are not linked to the electrical grid, thus supporting in a systematic and permanent manner the attendance of basic social demands.

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[60] The Federal Government's PPA 2000 – 2003 calls for allocation of R$ 90,000,000.00 in 2001, R$ 133,000,000 in 2002 and R$ 160,000,000.00 in 2003 for this program.

[61] The UNDP has made a grant to the program of around US$7,000,000, along with various specialists that work directly on the problem.

[62] Two other significant sources of financing are in process – US$ 300,000,000.00 requested from the Japan Bank for International Cooperation, and another for technical assistance, provided by the World Bank, which will be applied directly to supplying energy to communities.

Economic Development: use of renewable and decentralized energy sources for supplying small producers, new settlements and isolated populations.

Complementing Energy Supply: complementary production of energy through decentralized renewable sources, destined to all consumers.

Technological and Industrial Basis: promoting development of technologies and production of non-conventional energy systems and the corresponding training of human resources for their installation, operation and maintenance.

The technologies involved in the program include the use of photovoltaic panels, windmills and wind generators, small hydro facilities, biomass fuels (alcohol, vegetable oils, forestry and agricultural wastes), biodigesters, etc.

1.6 – HYDROGEN POWERED COLLECTIVE TRANSPORT PROGRAM

Fuel cells have many advantages, such as high efficiency, modularity, clean and silent operation, reliability, reduced maintenance and flexibility as to fuel used. More specifically, hydrogen powered fuel cells have zero emissions if hydrogen is produced by electrolysis of water and small net emissions if hydrogen is produced from biomass or ethanol.. Brazil has especially attractive conditions in that it can obtain hydrogen from hydroelectric energy, in years when secondary hydroelectric energy is available.

Hydroelectricity makes up a large part of primary energy sources in Brazil. While the seasonal storage of large excess amounts of hydro capacity in the rainy season (secondary energy) is not practical, there is sufficient excess peak capacity in the daily cycle of electrical energy supply in the São Paulo Metropolitan Region to supply 12,000 fuel cell powered buses at an acceptable cost.

Research about the use of hydrogen as fuel has been carried out in several countries, focusing especially on its use in mass transport in large urban centers. This is because hydrogen has great environmental benefits, and can be stored, transported and converted into other forms of energy.

Although various different fuel cell technologies exist, the favorite candidates for road transport are *proton exchange membrane fuel cells* (PEMFC). Fuel cells are inherently more efficient at converting chemical energy into mechanical energy than internal combustion engines. They also reach maximum efficiency with an incomplete load, while internal combustion engines present minimum efficiency under these conditions. Thus, fuel cells are particularly advantageous in vehicles that operate most of the time stopping and starting, like urban buses. Fuel cells propulsion has been installed successfully in a range of urban buses and demonstrated in operation.

Such equipment is in fact based on the reaction of hydrogen with oxygen from the air, in fuel cells, which are electrochemical devices. Through this reaction electrical energy is generated, which is used in an electric motor. The vehicles using this process are thus electrical driven vehicles.

The propulsion system for hydrogen powered vehicles consists of a hydrogen storage sub-system and a fuel cell subsystem, in which hydrogen and oxygen are converted directly through an electrochemical reaction, which produces electricity, with water vapour as a byproduct.

The goals for initial power density and compactness were achieved, so that fuel cells fit into the engine compartment of urban buses, and improvements are ongoing. There is still a need for considerable improvements in durability, to create an operating period which is comparable to the time between overhauls of diesel bus engines. Very substantial reductions from current cost levels are still needed to make fuel cell buses competitive with diesel buses. Such cost reductions are planned by manufacturers, but they have yet to be achieved, since the fuel cells in existence today are only prototypes.

In spite of the advantages of these fuel cells, there are limitations in terms of storage of fuel, in the specific case of hydrogen. The alternative is to use a fuel processor, which uses a reforming process to provide a hydrogen rich gas for use in the system. Thus, the hydrogen used to feed the cell can be produced *in situ* through reforming of the fuel, from a range of sources, including natural gas, methane, propane, naphtha, methanol, or ethanol.

However, reforming liquid fuels in the bus itself in an unnecessary complication for urban buses, which substantially reduces the efficiency of the entire energy chain. It is preferable to fuel the bus with hydrogen gas, which can be stored in a compressed form in the bus.

Of the various supply options which are economically possible, those that use centrally concentrated hydrogen require distribution channels for it, which are highly unlikely to be justifiable just for a project involving buses. The reforming of natural gas and electrolysis of water on site are both accessible. The first option involves lower costs, but continues to generate carbon dioxide emissions. Net carbon dioxide emissions with the latter option depend on the source of the electricity – zero if the electricity is from a renewable resource. On site electrolysis is the best option for Brazil. Electricity needs to be available at US$ 0.03/kWh. The on-site conversion systems are available at competitive costs, which could fall still further. Physical security systems are necessary, but are only burdensome when the bus needs to be internally stable because of difficult winter climatic conditions. Where appropriate safety measures are taken, hydrogen is no more dangerous than any other gaseous or liquid fuel.

Thus, hydrogen generated by electrolysis in bus garages is the ideal solution for supply. The garages and maintenance sites of the Metropolitan Urban Transport Company (EMTU) offer an excellent environment for installing a hydrogen generation and fuelling site, and for maintenance of fuel cell powered buses.

Hydrogen fueled buses have an energy yield of 45%, compared to 36% from the best diesel buses, and have very favorable characteristics for urban service, maintaining their high yield at low speeds, in contrast with thermal engines.

Buses play and will continue to play a fundamental role in urban transport in Brazil, which has a large fleet of urban buses. Although the majority are low technology and low cost buses, around 10% of the fleet is higher technology buses with longer life, operated under better conditions. The replacement of these vehicles by fuel cell buses is economically accessible. Buses are the dominant form of public transportation in metropolitan regions, which have grave problems of pollution and congestion. Diesel fueled vehicles greatly contribute to polluting emissions, with diesel buses contributing a significant proportion of these emissions. Their replacement by fuel cell powered buses could result in significant health gains, while creating a potential market of 500 fuel cell buses per year for 10 years, replacing only the more sophisticated diesel buses.

There should be no serious problems in implementing fuel cell buses in Brazil, since the country already has a large and modern infrastructure for manufacturing buses and trolley buses. The costs projected for the life cycle of fuel cell buses are entirely competitive with those of trolley buses, which they can complement because of their greater flexibility. They are in the same cost range as diesel buses, and are competitive if the external environmental costs of diesel fueled buses are taken into account.

Table 14 – Environmental Impact of Fuel Cells (U. S. Standard)

	Gas combustion*	Oil combustion*	Coal Combustion*	Fuel Cells**
Particulates	0.2	0.2	0.2	0.0000045
NO_x	0.3	0.5	1.1	0.20-0.028
SO_x	-	1.2	1.9	0.00036
Smoke	Opacity 20%	Opacity 20%	Opacity 20%	Negligible

* values in kg of pollutant/MWh.
** doesn’t take into account emissions from use of energy sources in obtaining the primary energy nor of construction of conversion equipment.

In 1994, work began on the Project Environmental Strategy for Energy: Hydrogen Fuel Cells Buses for Brazil (ESE/HB) implemented by the São Paulo Metropolitan Urban Transport Company, the Energy Application Agency of São Paulo and the University of São Paulo, with resources from the Global Environment Facility (GEF), managed by the United Nations Development Program (UNDP).

Phase I of the project *Environmental Strategy for Energy: Hydrogen Fuel Cells Buses for Brazil*, completely financed by GEF/UNDP, involved the assessment of the situation and prospects for sales of buses. This phase has been completed and culminated in the presentation of a proposal to the GEF for Phase II.

Phase II of the project, to begin after approval of the proposal by the GEF, consists of the acquisition, operation and maintenance of eight hydrogen fuel cell buses, with the hydrogen production and bus fuelling station, along with performance monitoring and evaluation of these buses.

The buses will be used for four years, traveling a total of one million kilometers, in order to:

- develop means of collective transport with zero emissions of pollutents, which contributes to the reduction of levels of carbon dioxide (CO_2), nitrogen oxides (NO_x), particulates, etc.;
- obtain knowledge of globally innovative technology, allowing Brazil to take a leading position in light of its potential market;
- develop this technology in Brazil, together with bus operators, manufacturers, universities and schools, seeking to create a new market;
- develop Brazilian specifications for hydrogen fuel cell buses.

Phase III will involve the beginning of industrial production in Brazil and a fleet of around 200 buses based in one garage. Phase IV will involve full-scale production and development in São Paulo and other cities.

1.7 - RECYCLING

Recycling involves the reutilization of materials and wastes that are generally seen as garbage. Although recycling doesn’t contribute directly to the reduction of greenhouse gas emissions, it results in the reduction of production of inputs, and thus has an indirect effect on mitigation of global warming.

Given the economic, social and environmental advantages, recycling in Brazil has been expanding steadily, with increasing government incentives for these initiatives. There has been a great advance in Brazil in terms of recycling, as shown in the table below:

Table 15 - Recycling in Brazil

Material		Recycling rate (%)
Aluminum		78
Glass containers		42
Paper	Office	22
	Corrugated	72
	Film	15
Plastic	Rigid	15
	PET	26
Steel cans		40
Tires		20
Long Life Carton Packaging		15
Used Lubricating Oil		18
Urban Compost*		1.5

Source: CEMPRE, 2000 – www.cempre.org.br –* * process of transformation of non-hazardous organic solid waste – vegetable and animal wastes – into a high quality and low price fertilizer.

Some waste markets involve recycling industrial, 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 most commonly recycled materials in Brazil are shown in Table 15. Thus, it is fundamentally important to implement a waste recycling system in which it is possible to separate the material which can be recycled.

In a pioneering initiative, Business Commitment to Recycling (CEMPRE) collected information about the selective collection programs implemented by municipalities, presenting data about composition of waste, operating costs, markets for recycled material, and public participation. As a result, Cyclosoft: an up-to-date databank on curbside recycling programs in Brazilian cities was created, in order to publicize the programs analyzed and enable the more efficient management of local recycling programs.

According to the data assembled, there are recycling programs in 128 municipalities throughout Brazil (with the greatest concentration in the Southeast and South of the country). Studies were completed in 16 municipalities – Angra dos Reis (RJ), Belo Horizonte (MG), Brasília (DF), Campinas (SP), Curitiba (PR), Embu (SP), Florianópolis (SC), Porto Alegre (RS), Ribeirão Preto (SP), Salvador (BA), Santos (SP), São José dos Campos (SP), São Paulo (SP), São Sebastião (SP), Santo André (SP), Itabira (MG) – in which a total of 6 million people have access to curbside recycling programs.

The program "Brasil Joga Limpo" is one of the components of the Multi-year Plan (PPA) 2000-03, known as "Avança Brasil". Its objectives include waste reduction, increasing the rate of recycling and of appropriate final disposal, recycling, reuse and treatment of solid wastes, as well as ensuring appropriate means of disposal. The target public includes public and private companies, organizations and institutions which provide services whose activities generate wastes.

The Program is needed to reduce the use of natural resources and waste in consumption of materials and energy and to increase the reuse of materials recycling, while reducing waste volume in sanitary landfills and resulting increase in landfill lifetime. There is also a growing demand on the part of municipalities for actions aimed at urban sanitation, waste recycling and appropriate disposal of solid wastes.

The lines of action of the Program include encouraging projects in the period 2000-2003 with resources from the National Environmental Fund (FNMA), coming from the General Budget of the federal government and shared with states and municipalities; implementation of an environmental information system for integrated waste management; creation of regulations and legal instruments to support integrated management of solid wastes. The Program also offers support to demonstration projects in support of integrated management of solid wastes and environmental sanitation[63]. With the support of the German cooperation agency (GTZ), it has resources to be used in 15 municipality. Also, it will continue giving strong support to the Waste and Citizenship Program, coordinated by the United Nations Children's Fund (UNICEF)

1.8 - CHARCOAL INDUSTRY

1.8.1 - HISTORY OF CHARCOAL USE IN BRAZIL

Charcoal is obtained from wood and firewood[64] in a process of controlled combustion, in ovens, which increases its concentration of carbon. This chemical process is called pyrolysis. Charcoal has a greater heating power than the original solid fuel: 3300 kcal/kg for commercial firewood, compared to 6800 kcal/kg for charcoal.

The majority of the wood processed in the transformation of coal used to be harvested from natural forests, contributing to deforestation. This practice occurred in Brazil since the colonial period, and was justified by both technological and social factors.

In technological terms, the conversion of wood into charcoal – generally carried out in ovens made of clay bricks, simple to build, of low costs and easy to operate – is very rudimentary, allowing production by small autonomous low-income producers.

From the social point of view, the production of charcoal from native forests is one of the principal sources of income from poor populations in rural areas, especially in the cerrado region.

Starting in the middle of the 20th century, concerns emerged about deforestation for charcoal production, because of the reduction of supply of raw material for industries and increased distances between the charcoal ovens (*carvoarias*) and their principal consumers (steel plants). As a result, in the 1940s, some steel plants in the state of Minas Gerais began reforestation projects, ensuring part of the raw material necessary to production and thereby giving rise to forestry plantations.

[63] In the years 2000 and 2001, 248 municipalities were served.
[64] By definition, "wood" is the woody part of the trunks and branches of trees, and "firewood" is the part of the branches, sticks or fragments destined as fuel.

Reforestation projects[65] currently supply more than half of the needs of industries that use charcoal as a basic input, specifically steel and cement production. In general, the share of wood coming from forestry plantations to be used for charcoal has grown to 71.7% of the total in 2000 (Table 16).

Table 16 – Consumption of charcoal from reforested areas

Charcoal Consumption		Share from Reforestation	Charcoal from Reforestation thousand m³	Emissions Avoided thousand tC
Year	thousand m³			
1990	33636	34.0%	11436	2898
1991	29224	42.3%	12362	3133
1992	26828	38.9%	10436	2645
1993	28840	43.5%	12545	3179
1994	29432	54.0%	15893	4028
1995	27352	52.0%	14223	3604
1996	25344	70.0%	17741	4496
1997	24256	75.0%	18192	4610
1998	21924	67.4%	14777	3745
1999	22240	70.0%	15568	3945
2000	22600	71.7%	16204	4106

Source: BEN. 2001 (Consumption) and ABRACAVE. 2001 (Reforestation).
Note: Emission factors used 0.63 toe/t CV and 1.609 tC/toe.

1.8.2 – USE OF CHARCOAL IN METALLURGICAL AND CEMENT INDUSTRIES

The consumption of charcoal occurs primarily in the metallurgy industry (mainly steel) and in the cement industry, with some use other sectors (table 17).

Table 17 – Consumption of charcoal in the principal industrial sectors - 1000 m³

Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Industrial	33636	29224	26828	28840	29432	27352	25344	24256	21924	22240	22600
Pig Iron and Steel	27040	22800	21256	23300	24048	22068	19144	20048	18388	18848	19184
Steel Alloys	2240	3020	2560	3100	2708	2360	3580	2400	2012	2256	2260
Cement	2168	1548	1272	1412	1604	1752	2260	1492	1260	952	968
Non-Ferrous and Other Metallurgy	1576	1264	1272	700	760	904	192	160	136	136	140
Mining and Pelletizing	212	220	192	20	16	0	0	0	0	0	0
Chemicals	200	180	164	176	184	148	80	40	32	0	0
Others	100	100	56	68	72	80	32	48	88	48	48
Brickmaking	80	72	44	52	32	36	48	60	0	0	0
Textiles	20	20	12	12	8	4	8	8	8	0	0

Source: BEN, 2001
* Specific Mass of charcoal: 250kg/m³ BEN, 2001.

[65] The principal reforestation technology is that of planting short-rotation trees.

There has been an overall reduction in charcoal consumption over the years analyzed. Particularly since 1994 there was a trend towards reduction in charcoal consumption because of its replacement by coal, largely resulting, from the privatization process in the steel sector. With privatization, many companies integrated with charcoal production were shut down and the process shifted to imported coal. With lower costs, over the short and medium term coal facilitated the increase in scales of production. However, the pig iron derived from charcoal ovens had a higher quality, compensating the use of this raw material in the production of some higher-value iron and steel products. In recent years, there has been a rise in the use of coal in coking plants to obtain coke, as well as a return to fuel oil in the cement industry.

Brazil is one of the few countries that still uses charcoal in the metallurgy production process, especially in the pig iron and steel industry. In many countries, steelmaking processes have replaced charcoal with coal.

However, the development and diffusion of plantation technologies and the favorable climatic conditions in Brazil have provided a reduced period between planting and harvest, which makes the use of planted forests economical, providing gains for the industrial sector.

As a result, the share of charcoal produced from plantations in the total charcoal consumption in industry has increased, and the area of native forests harvested has dropped in the period 1990-2000. Thus, because of the use of a renewable source of energy – charcoal from planted forests – avoided emissions of 40,389,000 t C in the industrial sector in this period.

1.9 – BRAZILIAN BIOFUELS PROGRAM (PROBIODIESEL)

1.9.1 - CONCEPT

Biodiesel fuels are obtained from mixing, in different proportions, diesel and ester of vegetable oils.

The Brazilian Biofuels Program (PROBIODIESEL) will develop the technology for production and use of ethyl and methyl ester biodiesel. In the first phase, until 2003, tests will be carried out on ethyl ester from soybean and ethanol, and methyl ester from soybean. In Phase II, by 2005, the production chains for biodiesel will be developed from other vegetable oils and/or residual oils.

Table 18 – Characteristics of some oleaginous plant products with potential energy uses

Species	Origin of Oil	Oil Content (%)	Cycle for Maximum Efficiency	Months to Harvest	Yield in Oil (t/ha)
Oil palm (Elaeis guineensis)	Nut	20	8 years	12	3.0-6.0
Avocado (Persia americana)	Fruit	7-35	7 years	12	1.3-5.0
Coconut (Cocus numifera)	Fruit	55-60	7 years	12	1.3-1.9
Babaçu Palm (Orbinya martiana)	Nut	66	7 years	12	0.1-0.3
Sunflower (Helianthus annus)	Grain	38-48	Annual	3	0.5-1.9
Canola (Brassica campestris)	Grain	40-48	Annual	3	0.5-0.9

Castor Bean (Ricinus communis)	Grão	43-45	Anual	3	0.5-0.9
Peanut (Arachis hypogeae)	Grain	40-43	Annual	3	0.6-0.8
Soybean (Glycine max)	Grain	17	Annual	3	0.2-0.4
Cotton (Gossypium hirsut)	Grain	15	Annual	3	0.1-0.2

Source: Nogueira, L. A. H. et al. Dendroenergia: fundamentos e aplicações. Brasília, Agência Nacional de Energia Elétrica, 2000. p. 43.

PROBIODIESEL's objective is to develop production technologies and a consumer market for biofuels; establish a national network of biodiesel, to unite and harmonize the activities of specialties and entities responsible for the development of this economic sector; development and approve specifications for the new fuel for Brazil; and attest to the technical, economic, social and environmental viability and competitiveness, based on laboratory, bench and field tests.

The principal strategy is to develop the biofuel (methyl ester or ethyl ester) from production of oleaginous crops (soybean, oil palm, castor bean and babaçu palm) or domestic ethanol, thereby generating employment and income in the various regions of the country. Furthermore, it is intended to ensure greater autonomy in the supply of liquid fuels, contribute to improving Brazil's international contribution to global environmental issues, establish its position on the vanguard in the development of new markets for potential under-utilized (agricultural) products, create significant alternative markets for Brazilian commodities (petroleum/gas, soybean and sugar/alcohol sectors) and byproducts (glycerin) with excess supply on the international market, and development domestic technologies for production of fuels.

The development of PROBIODIESEL will allow the development of the technical and economic competitiveness of biodiesel, enabling environmental benefits and generating new business opportunities for agribusiness, assemblers and the autoparts sector.

The biodiesel to be tested by 2003 will be produced and developed by Ecológica Mato Grosso S.A. (ECOMAT) and the Brazilian Association of Vegetable Oil Industries (ABIOVE) in partnership with the other entities of the Brazilian biodiesel network.

1.9.2 – HISTORICAL SUMMARY AND CURRENT SITUATION

In 1895, Rudolf Diesel began research on the use of petroleum byproducts as fuel for his invention, an engine which ignites by compression. During the World Exhibition in Paris, in 1900, he used peanut oil to demonstrate his new engine. He said that the diesel engine could be fuelled with vegetable oils and support the development of countries using it.

In Brazil, since the 1920s the National Institute of Technology (INT) has been studying and testing alternative and renewable fuels, for example alcohol from sugarcane.

More recently, motivated by the demands of the Second World War and the oil prices, governments of different countries, in partnerships with the private sectors and research centers, have been developing and testing biofuels in municipal fleets, especially in large urban centers.

Since the 1970s, Brazil, through the INT, the Institute for Technological Research (IPT), and the Executive Committee of the Cocoa Farming Plan (CEPLAC) has been developing projects involving vegetable oils as fuels, including dendiesel (diesel from oil palm, or *dendê*).

In 1983, the Brazilian government, motivated by rising oil prices, mandated the implementation of the National Program for Energy from Vegetable Oils (OVEG Project), which tested the use of biodiesel and fuel mixtures in vehicles running for more than one million kilometers. This initiative, coordinated by the Secretary of Industrial Technology of MIC, had the participation of the automobile industry, autoparts manufacturers, producers of lubricants and fuels, the vegetable oils industry and research institutes.

The technology feasibility of the use of the fuel was demonstrated, using the logistics of existing distribution. However, at that moment, the costs of biodiesel were much higher than diesel, and for this reason the production of biodiesel was not implemented at a commercial scale.

In 2000, a pilot plant for the production of methyl ester biodiesel was installed in Ilhéus, Bahia, on the *campus* of Santa Cruz State University, with a daily production capacity of 1400 liters, which could be adapted for the production of ethyl ester (tower distillation and/or centrifuge for separation of ester from glycerin).

The Federal University of Paraná (UFPR) has been developing production technology for esters from soybean oil, for mixing with diesel, since 1983.

The 1990s were characterized by commercial production and construction of industrial scale plants, stimulated by the relative competitiveness of oil prices and vegetable oils and an interest in addressing environmental concerns.

From January to March of 1998, under the coordination of the Paraná Institute of Technology (TECPAR), a field experiment was carried out in Curitiba on the monitored use of biodiesel B20 (USA), a mixture of 20% of soybean ester with the metropolitan diesel of Paraná, for a fleet of twenty urban buses that operated normally with the new fuel.

In 2000, ECOMAT, in the State of Mato Grosso, built a biofuels plant that currently produces AEP 102, which is a special soybean ester additive to the alcohol-diesel mixture, along with methyl and ethyl ester biodiesel (in bulk).

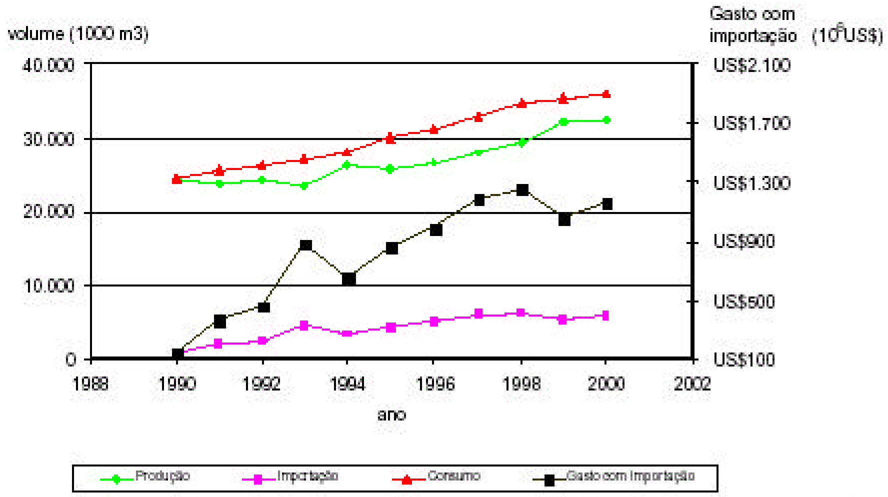
Currently in Brazil, the program PROBIOAMAZON, managed by the Ministry of Agrarian Development (MDA) and the Ministry of Science and Technology (MCT), is the largest vegetable oils program being implemented, with an anticipated production of around 500,000 tonnes/year of palm oil in the North Region, through production in settlements of the National Institute of Colonization and Agrarian Reform (INCRA).

Biodiesel emerged as an alternative for reducing dependency on oil derivatives, and has established a new market for oleaginous plant products. This also results in the reduction of the current dependency on imports of diesel oil, in the order of 6 millon cubic meters per year, reducing the burden on the balance of payments and creating wealth in rural areas. Recent increases in the price of gasoline in Brazil increase the need to develop alternatives to complement fossil fuels.

In the year 2000, the production of diesel vehicles in Brazil passed the barrier of 100,000 vehicles per year[66]. Diesel oil is currently the petroleum derivative with the highest consumption in Brazil, and given the production profile of Brazilian refineries, a growing fraction of this product has been imported, as shown in Figure 6.

[66] Principally trucks, light commercial vehicles and buses were produced, which together with the agricultural equipment and thermoelectric generation in isolated systems, account for a demand of approximately 37 million m^3 in 2001.

Figure 6 – Production, demand, imports and spending on imports of diesel oil



Source: ANP.

The mixture of vegetable ester with diesel oil in different proportions (or the use of pure ester) will allow a reduction in consumption of oil derivatives, with prospects for the reduction of pollution emissions in urban transport systems. There is an immediate impact on the level of pollution in cities, with an improvement in the quality of life of their inhabitants.

Biodiesel should meet the technical specifications as being a unique product, without need for specifying the origin of the vegetable oil or what type of alcohol is being used in production, but rather a set of physical and chemical properties for the final product which will ensure its suitability for use in diesel engines.

The introduction of biodiesel on the market will represent a new dynamic for agribusiness and will have a multiplier effect on other economic segments such as transport and distribution involving vegetable oils, alcohol, diesel oil as well as the inputs and byproducts of the production of vegetable ester.

The feasibility of biodiesel, however, requires the implementation of an organized structure for production and distribution, in order to achieve competitiveness in the potential markets. The introduction of biodiesel will thus require investments throughout this chain to ensure supply and the prospect of return on capital invested in its development, as well as its sustainability over the long term.

In this process, there are technological issues in pre-commercial phases to be resolved in laboratory, bench and field test phases, and in particular the technological path to be developed for biodiesel production using ethanol.

MCT and Petrobras, through the National Science and Technology Plan for the Petroleum and Natural Gas Sector (CTPetro), support a plan with the participation of the Federal Universities of Rio Grande do Sul and of Pelotas and the Regional University of Alto Uruguai, with the basic goal of refining and implementing the physical and chemical testing methods proposed by the *American Society for Testing Materials* (ASTM), for Brazilian biodiesel; and also assess the properties of the mixtures of biodiesel and diesel mixtures in different proportions.

Production Capacity and Availability of Biodiesel in Brazil

Brazil, the world's second largest producer and exporter of soybean oil, could gradually become an important producer and consumer of biodiesel, and also has the opportunity to use other typical vegetable oils from the different regions of the country.

The availability of biodiesel production from soybean involves principally the production of around 42.5 million tonnes planned for 2002, with 47% in the Center West and 40% in the South region.

Brazil can significantly expand its production of soybean and soybean oil, given its agricultural frontier of 80 million hectares, to 240 million tonnes per year. The installed capacity for crushing of soybean is 32.4 million tonnes per year[67].

The competitiveness of Brazilian ethanol production in different regions of Brazil, through PROALCOOL, the existing production and distribution infrastructure, the knowledge and performance of technologies developed for the sugarcane production change and the automotive sector, the opportunity to replace imported diesel and contribute to reducing the need for foreign currency, the generation of income, since 35% of petroleum processed in Brazil is transformed into diesel, for a market of 35 billion liters per year, the prospects of improving the quality of diesel consumed, the excess production of soybean oil, the economic, social and environmental advantages of the production and consumption of renewable fuels, the security of supply from producing fuels directly in the different regions of Brazil, the new and changing international agricultural policies, the strengthening of the domestic biofuels industry, whether for freight or mass transport or for generation of electricity, especially in isolated systems, are all reasons for encouraging and recommending the immediate startup of the National Biodiesel Program.

Characteristics and Properties of Biodiesel

The production of biodiesel in Brazil presents the following opportunities, especially for modern diesel cars:

- it doesn't contribute to the greenhouse effect (avoids emissions of around 2.5 tonnes of carbon dioxide per cubic meter of biodiesel used);
- reduction of emissions of the pollutant carbon monoxide (CO) and of mutagenicity through elimination of aromatic compounds, a great reduction of hydrocarbon (HC) emissions and black smoke and significant reduction of polycyclic aromatic hydrocarbons (PAHs) from the sulfur content of the fuel, compared to diesel;
- it is not toxic;
- current technology allows diesel vehicles to meet the EURO III standard – particulate retention devices – regenerative filters (with B100 they can operate better because of the absence of sulfur and particulate material);
- prospects of exporting biodiesel as a low sulfur content additive, especially to the European Union where the sulfur content is being reduced in stages from 2000 ppm in 1996, to 350 ppm in 2002, and to 50 ppm in 2005;
- prospects for use of fuel and input from renewable source;
- biodegradable;
- superior performance and use of smaller and smaller engines;
- improved cetane number, higher than that of diesel (greater than 50, providing improved ignition) and lubrication (reduced wear, especially in the injection system);
- appropriate combustion and flash points (safer to handle);

[67] In 2001 around 22.8 million tonnes were crushed (30% idle capacity).

- quickly expanding market, especially in Europe, an advantage in exports of vehicles, engines and components;
- fuel economy;
- new business opportunities, especially in agribusiness, and generation of jobs and income;
- tax burden of fuels defined;
- growing demand for diesel in Brazil (with implications for dependency on imports, on balance of payments and on fuel quality);
- diversification of energy matrix;
- improved transport logistics.

2 - PROGRAMS AND ACTIVITIES CONTAINING MEASURES THAT CONTRIBUTE TO ADDRESSING CLIMATE CHANGE AND ITS ADVERSE EFFECTS

This section will analyze the replacement, in Brazil, of fossil energy sources with high carbon content per unit of energy generated by others with lower content, or which generate greenhouse gas emissions with lower global warming potential. Despite not being sustainable over the long term, the programs and activities analyzed here have the objective of helping to mitigate climate change and contribute to the ultimate objective of the UN Framework Convention on Climate Change, which is to contribute to the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

Brazilian demand for electricity has grown much more quickly than that for primary energy or the economy (GDP) of the country. This trend will likely continue for the coming years and will require new strategies for energy planning, such as for example the Thermoelectric Priority Plan (PPT) from 2000. Thus, an analysis of the current national electrical energy system is necessary to outline future prospects and their implications for greenhouse gas emissions.

The programs and activities analyzed here include the prospects for increasing the share of natural gas in Brazil's energy matrix and its impacts on greenhouse gas emissions, the reduction of fugitive methane emissions in petroleum and natural gas production in Brazil and in the distribution of natural gas in São Paulo; and the reduction of vehicular emissions in urban transport in São Paulo.

This section also analyzes the development of nuclear energy in Brazil, which – while it doesn't contribute directly to anthropogenic emissions of greenhouse gases – because it relies from mineral resources and is thus exhaustible, it cannot be considered sustainable over the long term. Furthermore, the environmental impact of thermonuclear plants have also been strongly emphasized in recent decades, and is a leading concern of environmental movements.

Methane gas generated in waste treatment can be used as an energy source or can be burned when not used, thus avoiding its release to the atmosphere and generating carbon dioxide emissions, with a lower global warming potential than methane. Given the predominantly organic nature of wastes in Brazil, this reduction is covered in section 1.4.4.6, as a new renewable source of energy.

2.1 - THE BRAZILIAN ELECTRICAL SECTOR

According to ANEEL data, the electricity market in Brazil experienced a growth of around 4.5% per year, and should exceed 100,000 MW in 2008. Government planning for the medium term shows the need for investments of around US$ 6-7 billion/year

Over the last two decades, electricity consumption has grown much faster than the Gross Domestic Product (GDP), because of the population growth in urban areas and efforts to increase electricity supply and to modernize the economy.

The Brazilian electrical system is distinguished by the long distances of transmission lines and a predominantly hydroelectric generation capacity. The consumer market (47.2 million customers) is concentrated in the South and Southeast regions, which are more industrialized. The North region is served largely by small generating stations, mostly diesel thermoelectric.

The classes of residential, commercial and rural consumption increased their shares considerably, while the industrial sector had a lower share of this growth, principally because of the use of more efficient technologies in the end use of electricity, allied with measures to rationalize consumption implemented especially in the 1990s.

In recent years, the Brazilian energy sector has undergone significant institutional reforms with the objective of increasing energy efficiency and resolving supply problems to meet the growing demand for electricity.

Since the mid-1990s, new opportunities have emerged for the private sector, allowing generation for self-consumption – with or without the sale of excess electricity – and generation for sale. These rules allow sales to companies which supply public services, large consumers or business groups.

The entry of private capital in the electrical sector, previously primarily state-owned, brought profound changes in the old model. The investors started to pursue plants with lower generating capacity, which were constructed at lower costs and more rapidly than hydroelectric plants, based on new technologies. This led to considerable changes in electricity generation sources.

2.1.1 - CHANGES IN ELECTRICAL GENERATION SOURCES

Electricity generation in Brazil has very distinctive characteristics in the average global context, in terms of reliance on fossil fuel sources. Brazil has a privileged position of having established, since the middle of this century, a base of renewable hydroelectric energy sources. In 2000, the primary fossil fuel sources in thermal generation accounted for 6.9%; renewable thermal sources 3.1%; and nuclear 1.5%[68]. The remainder (88.5%) of the electricity was generated from hydro power.

Thermal sources of electrical generation in Brazil in recent decades has contributed less than 10% of the electricity generated. Thus, the primary fossil fuel sources in electrical generation, in Brazil, contribute much less to global atmospheric emissions (on a per capita basis) than the majority of industrialized countries.

[68] Disaggregation for thermal generation in 200,0(normalized based on Patusco and e&e. Includes generating stations connected to the grid and self-generators.

However, the best hydroelectric opportunities in Brazil have probably already been exploited, especially in the Center-West, Southeast and South regions. The exhaustion of new hydroelectricity potential in watersheds close to the large urban centers indicates that, if new large-scale hydro plants were built, they would be distant from these areas (there is a great electricity generation potential to be exploited in the North region, especially in the Amazon Basin), which would involve higher energy costs, because of the increase in transmission costs, and possibly environment restrictions.

In the short term, natural gas has become an important alternative for the necessary expansion of electricity generating capacity. The expectations of a rapid increase in the share of natural gas in the energy matrix conformed to a strategic governmental decision that, through Petrobras, it would invest in the construction of the Bolivia-Brazil gas pipeline. In this context, the federal government instituted the Priority Thermoelectric Plan (PPT), by decree # 3371, on February 24, 2000. Through administrative decree # 43, of February 25, 2000, the Ministry of Mines and Energy defined 49 thermoelectric plants as part of PPT[69], for an anticipated total nominal capacity of around 16 GW.

According to the decree creating it, the thermal plants forming part of PPT have a guaranteed supply of natural gas for a period of up to twenty years, according to the rules established by the Ministry of Mines and Energy; a guarantee of investment of a standardized value to the electricity distributor, for a period of up to twenty years, according to the National Electrical Energy Agency (ANEEL); and a guarantee from the Brazilian Development Bank (BNDES) of access to the Program for Financial Support to Priority Investments in the Energy Sector.

Combined with the private interest in thermoelectric generation, the development of energy use of natural gas and the creation of a consumer market, which also includes urban distribution for domestic use, should increase Brazilian reserves. Thus, it is expected that the expansion will adjust to the growth in demand and become sustainable.

Although it has a greater impact on greenhouse gas emissions than hydroelectric facilities, the replacement of fossil fuels by others with lower carbon content is a technical measure for reduction of emissions from thermoelectric generation. Natural gas, for example, with better conversion efficiency than other fossil fuels, results in lower CO_2 emissions per unit of energy generated.

The technological profile of thermal generation projects will determine to what extent carbon emissions increase from the Brazilian electrical sector. The best available technical options could ensure that the use of fossil fuels in electrical generation becomes a new and promising element in the diversification of the Brazilian energy matrix, while at the same time ensuring a reduced impact on the environment.

It should not be forgotten that the diversification of the Brazilian energy matrix, in order to meet a growing demand, should also involve a significant share of renewable energy sources, principally biomass sources, as discussed above (see section 1.4), as well as nuclear energy (see section 2.6).

[69] Since the launch, the PPT has changed: it began with 49 plants, grew to 55 in 2001, and in February of 2002 had 38. Plans for plants were removed from the PPT because they did not advance in the schedule established by the National Electrical Energy Agency (ANEEL) and did not meet the requirements set by the Electrical Energy Crisis Management Chamber (GCE). The schedule for implementation of the plants included in the original PPT was frustrated largely by the impasse generated by the exchange rate risks associated with the price of natural gas, which was quoted in dollars, while the contracts signed for electricity purchases were in Brazilian Reais.

2.2 - PROSPECTS FOR NATURAL GAS IN BRAZIL AND ITS ROLE IN REDUCING GROWTH OF GREENHOUSE GAS EMISSIONS

2.2.1 TRAJECTORY AND SHARE OF NATURAL GAS IN THE BRAZILIAN ENERGY MATRIX

Proven reserves of natural gas in Brazil grew sharply in the mid-1980s, with the discovery of highly promising areas for exploration in the Campos Basin, on the north coast of Rio de Janeiro. From 1980 to 1990, reserves jumped from 52,544 to 172,019 million m^3, as shown in Table 18, for an average annual growth of 12.5% in that period. In the 1990s, continuous exploration activities increased the total proven natural gas reserves at the rate of 2.5% per year, reaching 220,999 million m^3 in 2000.

Production of natural gas in Brazil grew in a similar manner, with a rate of growth of 19.9% per year in the period from 1980-85, but only 7.8% per year in the 1990s. This production is strongly conditioned by oil production, because of the existence of association gas and oil reserves, especially in the Campos Basin, and the strong weight of basic petroleum derivatives in energy demand from the wide range of activities that make up the national economy.

Table 19 - Proven Reserves and Production of Natural Gas in Brazil, 1980-2000

Year	**Proven Reserves** (10^6 m^3)	Annual Production (10^6 m^3)	**Reserves/ Production** (years)
1980*	52,544	2,205	23.8
1985*	92,734	5,467	17.0
1990	172,019	6,279	27.4
1991	181,724	6,597	27.5
1992	192,534	6,976	27.6
1993	191,051	7,355	26.0
1994	198,760	7,756	25.6
1995	207,962	7,955	26.1
1996	223,764	9,156	24.4
1997	227,650	9,865	23.1
1998	225,944	10,833	20.9
1999	231,233	11,898	19.4
2000	220,099	13,328	16.6
% annual increase (1990-2000)	2,5	7,8	-

Source: PETROBRAS/SERPLAN until 1998 and ANP, according to ANP Administrative decree # 009, of January 21, 2000, for 1999 and 2000.

Note: The total amounts of production include gas re-injected, flared and losses

* Proven reserves from the years 1980 and 1985 were calculated using the PETROBRAS classification criteria until 1996, whose methodology was principally based on the technical aspects of reserves. Data from the period of 1990-97 were obtained through the SPE/WSP (*Society of Petroleum Engineers*/*World Petroleum Congress*) classification criteria, adopted by PETROBRAS in 1997, whose methodology places equal emphasis on technical and economic aspects, incorporating the guarantee of economic return as a parameter in the determination of reserves.

The ratio of proven reserves to production of natural gas in 2000 indicates a useful life of these reserves of 16.6 years, given current production levels. However, over the 1990s this level declined by an average of around 5% annually, explained in part by the recent priority given to natural gas as a high quality energy source, which brings pressure to increase production and for greater use in end use consumption.

The balance for natural gas in Brazil is presented in Table 20. There was a high rate of flaring in 1991, which in spite of having been reduced over the decade remained high in 2000. These losses are principally due to the gas associated with petroleum, in cases where the use of gas is determined by petroleum production, as occurs in the Campos Basin, the principal oil producing area in Brazil. It should be added that often the infrastructure for access to gas is expensive and makes its use unviable, and it may not be technically possible.

An analysis by ANP showed a paradox in this context: if on the one hand the initial expansion of natural gas in Brazil was supported by the growth of gas associated with petroleum, on the other hand this associated nature became an important limiting factor in its expansion. Of all the gas produced, more than three quarters is associated, and only 19.1% (in 2000) of Brazilian gas has a non-associated origin. This profile, highly dependent on oil production, explains the high rate of non-use of gas in Brazil. In a market that has been continually expanding over recent years, enabling the importation of gas from neighboring countries, this loss is strongly questioned, even more because of the waste of a non-renewable energy resource, which in addition to producing emissions, could be replacing other energy sources which are more environmentally destructive.

In this context, some goals have been established for the use of Brazilian natural gas. As part of this, Petrobras created a Zero Flaring Plan (see section 2.3) and ANP began to monitor the use of the oilfields in the country. This plan, created in 1997, has been producing results, as shown in Table 20, and demanding investments in infrastructure and new forms of distribution of production.

Table 20 – Balance for Natural Gas in Brazil (10^3 m^3)

	1991	2000
Imports[1]	-	2,211
Production	6,291	13,328
Total Supply	6,291	15,539
Reinjection	1,141	2,729
Flaring and Losses	1,715	2,370
Domestic Supply	3,435	10,440
Self-Consumption (Petrobras)[2]	708	2,916
NGL[3]	332	743
Sales	2,395	6,572
Adjustments	-	208

Source: ANP, 2001.
[1]Refers to imports from Bolivia.
[2]Refers to self-consumption by Petrobras and production in the natural gas processing units (UPGN).
[3]Natural Gas Liquids (NGL) - the portion of natural gas which liquefies in the UPGNs.

Although natural gas still holds a secondary position in Brazilian energy consumption and production, the rapid expansion in its production in the period 1980-2000 was only exceeded by the growth in oil production, as shown in table 20. This situation resulted in the doubling of the share of natural gas in primary energy production in the Brazil over the period in question, reaching a share of 6% in 2000. However, in terms of the domestic supply of primary energy, the share of natural gas in this year is only 3.7% of the total, even with imports of Bolivian gas. This is due to the high amount reinjected (20% of production) and also to flaring/losses (18% of production).

Table 21 - Primary Energy Production Brazil - 1980-2000 - 10^3 toe

Year	Petroleum	Natural Gas	Coal	Uranium U_3O_8	Hydro	Biomass*	Total
1980	9,083	2,134	2,436	0	37,383	40,772	91,808
1985	27,493	5,292	3,459	992	51,729	52,653	141,618
1990	31,906	6,077	1,878	47	59,945	48,221	148,074
1991	31,518	6,386	2,064	0	63,157	48,204	151,329
1992	31,861	6,753	1,841	0	64,769	47,014	152,238
1993	32,551	7,120	1,789	0	68,169	46,302	155,931
1994	33,804	7,508	1,985	0	70,384	48,851	162,532
1995	34,907	7,700	1,998	0	73,632	47,073	165,310
1996	39,720	8,863	1,844	0	77,073	47,532	175,032
1997	42,777	9,511	2,129	0	80,902	49,895	185,214
1998	49,571	10,443	2,043	23	84,526	48,918	195,524
1999	55,252	11,517	2,060	0	84,936	48,974	202,741
2000	63,540	12,858	2,381	129	89,208	45,032	213,148
% annual increase (1980-2000)	10.22	9.4	-0.1	-	4.4	0.5	4.2

Source: MME, 2001, assuming 1 MWh = 0.29 toe.
Note: * Includes firewood, sugarcane produces, lye and other vegetable wastes.

Table 21 shows that the performance of end use natural gas consumption over the 1980s and 1990s was higher than the other sources, with an average growth of 11,1% per year, or more than double the rate of growth of end use consumption of electricity, the principle consumption source in the Brazilian energy matrix. In this period, the share of natural gas in end use consumption increased 4.5 times, reaching a share of 3% of the total energy consumed in Brazil in 2000.

Table 22 – End Use Energy Consumption in Brazil - 1980-2000 (10^3 toe)

Year	Petroleum Derivatives (1)	Natural Gas (2)	Coal and Derivatives (3)	Electricity	Biomass (4)	Total
1980	52,001	860	4,457	35,584	34,800	127,702
1985	47,080	2,176	7,708	50,334	42,892	150,190
1990	55,728	3,015	7,413	63,121	40,141	169,418
1991	56,246	3,028	8,829	65,358	40,206	173,667
1992	57,781	3,213	8,535	66,837	39,930	176,296
1993	59,948	3,540	8,981	69,938	39,633	182,040
1994	63,217	3,660	9,296	72,440	42,245	190,858
1995	67,512	3,829	9,543	76,793	41,148	198,825
1996	72,393	4,422	10,005	80,529	41,628	208,977
1997	78,053	4,803	10,291	85,460	42,988	221,595
1998	81,128	4,965	9,990	89,039	43,086	228,208
1999	81,102	5,488	9,569	91,262	43,667	231,088
2000	82,665	7,094	10,274	96,163	39,068	235,264

% Annual Increase (1980-2000)	2.34	11.13	4.26	5,10	0.58	3,10

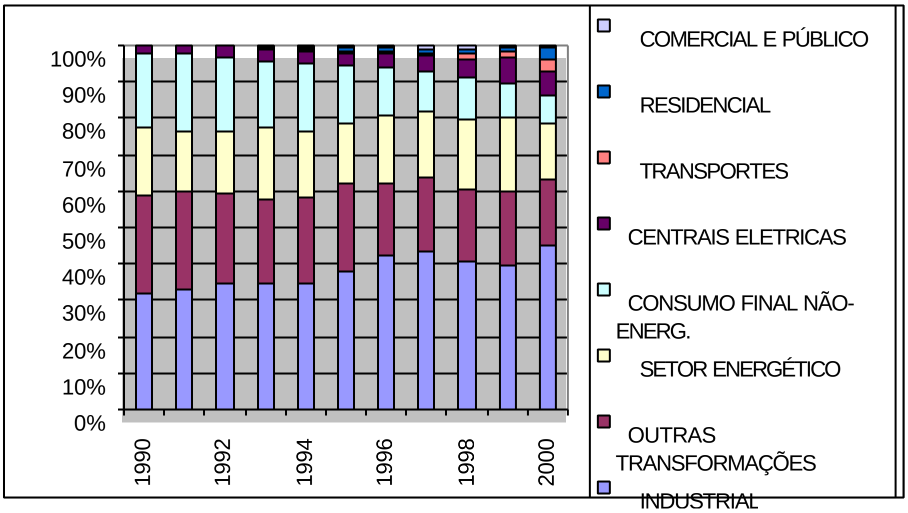
Source: MME, 2001.

Note: **(1)** Includes diesel oil, fuel oil, GLP, naphtha, kerosene, gas distributed through pipelines, other secondary petroleum products, and other non-energy petroleum products. **(2)** Includes "wet" natural gas and "dry" natural gas. **(3)** Includes coal, coking gas, coal coke and tar. **(4)** Includes firewood, sugarcane bagasse, other primary renewable sources, and ethyl alcohol.

The industrial sector accounts for the largest share of natural gas sales in Brazil – 75% in 2000. The share of the transport sector increased significantly between 1990, when it was almost zero, and 2000, when it accounted for 5%. Electrical generation has also become significant, and already represents 10% of sales, approximately five times the percentage in 1990.

Although the other sectors had a total share of 10% in end use energy consumption of natural gas in Brazil in the year 2000, they had grown significantly over the 1990s – for example 66.2% in the case of transport. Of course, these growth rates can be partly explained by the simple arithmetic impact that an initial expansion has on the calculation of relative annual variations. However, there is no doubt that the growth is also mirrored in the emergence of new prospects and opportunities for natural gas in particular end use applications, such as the case of direct cooking and for the residential and service sectors – replacing manufactured gas or LPG – or as a vehicle fuel for road transport.

Figure 7 – Distribution of Consumption of Natural Gas



Source: BEN, 2001.

The penetration of natural gas in end use energy consumption, although still in the early stages, has been favored by incentive policies in different economic sectors to replace other sources, especially fossil fuels, where natural gas is presented as a more efficient and economically viable energy option. Such initiatives are guided by the current consensus around the decisive role that natural gas can have on the definition of a model of sustainable development for Brazil. Thus, the use of natural gas is intended to both reduce external dependency on oil and derivatives and their weight on the trade balance, and avoid the use of other more greenhouse gas intensive sources, and therefore the worsening of climatic impacts resulting from global warming.

2.2.2 - PROSPECTS FOR USE OF NATURAL GAS

The prospects for use of natural gas in thermoelectric generation are promising and are attracting an increasing number of companies interested in exploiting this area of energy production. The availability of extensive reserves in the country and the establishment of facilities for importing gas by private enterprise – the result of the current process of liberalization of the hydrocarbon sector – increase the possibility of a natural gas in the domestic market in the medium term, which contributes significantly to the allocation of investment in gas-fired thermal plants.

Along with its proven reserves of natural gas, Brazil has a huge supply market in Latin America, especially in bordering countries such as Bolivia, Argentina and Venezuela. Another option for reinforcing supply of gas in Brazil to import liquified natural gas (LNG) by sea from exporting countries such as Algeria (with reserves of 4.520 billion m^3), Nigeria (3.510 billion m^3), Australia (1.260 billion m^3) and Trinidad and Tobago (600 billion m^3).

Thermoelectric generation gives natural gas the role of an agent of decentralization in the operation of the electrical system, as well as a force for energy integration between Brazil and the neighboring countries. An example of this is the importance of natural gas in supplying thermoelectric plants in the South and Southeast regions, as in the case of the 600 MW Uruguaiana Thermoelectric Plant, using gas from Argentina. Also, the supply of natural gas to thermoelectric plants is a fundamental factor in the financial viability of the operation of gas pipelines under construction in Brazil, ensuring minimum levels of consumption and therefore supply to the potential centers of consumption of natural gas.

The strategic role assumed by natural gas in the expansion of generating capacity of self-producers, independent producers, as well as the private sector concessionaires of the public service, also results from its advantages compared to fuel oil and other fossil fuels used in thermoelectric generation, such as its lower corrosive power, the reduction in equipment maintenance, greater control of combustion in the production process, and the elimination of fuel stockpiles.

In addition, natural gas fired thermoelectric plants and cogeneration systems will bring great benefits in terms of stability of future electrical supply, because of its greater capacity for adaptation of supply to demand, because of its potential modularity and the short construction time of these projects, along with the better management of the load curve of the electrical system, which reduces peak demand from the system, avoiding the installation of additional generating capacity. Another advantage is the possibility of installation near the large load centers, saving transmission costs and contributing to the reduction of levels of electricity losses and increasing operational reliability.

According to Brazilian government estimates[70], the opportunities for use of natural gas in the various sectors of the economic should raise the share of this source in the Brazilian energy matrix from the current 2.6% to 12% in the year 2010.

On the demand side, natural gas has shown great versatility, adapting to a broad range of application, which includes the production of LPG and natural gasoline, replacement of LPG and manufactured gas in residential, commercial, industrial and other uses, use as a raw material in the petrochemical and fertilizers industry, replacement of diesel oil in bus fleets and public service utilities, and replacement of petroleum derivatives in industry and generation of industrial heat.

However, among the principal trends of penetration of gas is its use as a fuel for thermoelectric generation, which is a determining factor in reducing the risk of possible restrictions on electricity supply in periods of unfavorable hydrological conditions. This trend was institutionalized as the federal government's Priority Thermoelectric Generation Program (PPT), developed in order to encourage thermoelectric generation.

[70] Natural Gas Committee, Portaria # 9, of September 16, 1991, of the National Energy Secretariat.

In terms of global sustainability, the replacement of oil derivatives and other fossil fuels by natural gas is positive, since the use of natural gas results in lower emissions of gases responsible for the greenhouse effect. This change is expected principally in the transport and industrial sectors. But in electrical generation, where the high share of hydro energy gives Brazil favorable conditions in terms of greenhouse gas emissions, the significant increase of the share of thermoelectric generation projected for the coming years will bring new factors into play in the debate over environmental issues, related to expansion of the electricity supply, because of the significant increase in greenhouse gas emissions.

2.2.3 - GREENHOUSE GAS EMISSIONS FROM NATURAL GAS FIRED THERMOELECTRIC PLANTS *VIS-À-VIS* FUEL OIL FIRED THERMOELECTRIC PLANTS

The expansion of thermoelectric generation in Brazil will introduce qualitative changes in the set of environment externalities of the electrical sector. Also, with the rapid increase in the number of thermoelectric plants, the focus of attention is shifting more and more to the issue of air quality control, because of emissions of pollutants such as sulfur oxides (SO_2 and SO_3), nitrous oxides (NO and NO_2), carbon dioxide (CO_2), particulates of carbon (C), carbon monoxide (CO), and heavy metals, all derived from incomplete combustion (with the exception of CO_2) of fossil fuels and their impurities, along with other derivatives of secondary reactions occurring in the atmosphere, such as sulfuric acid (H_2SO_4) and nitric acid (HNO_3).

Environmental demands from society civil at the local level are expected to increase, seeking to lessen the severity of the impacts of concentrations of these substances in the air. Among the most serious impacts are the harmful effects on the health of the population, ranging from pulmonary and cardiovascular diseases to the increased incidence of carcinogenic processes, and the emergence of new atmospheric phenomenon, such as acid rain formed by the fall in pH of rainwater through its contamination by sulfuric or nitric acid.

However, it is the global impacts that pose the greatest obstacles to the growth of thermoelectric generation in Brazil. Such environmental limitations will certainly be reflected in the costs and technical and economic viability of construction of conventional thermoelectric plants, and demand improvements in current technological levels. Thus, the use of natural gas to replace other fossil sources traditionally used in thermoelectric generation, is presented as the most appropriate option in the full development of thermoelectric generation in Brazil, because it allows the increase in energy efficiency of generation and especially the mitigation of much of the adverse impacts caused by such sources on the environment.

The comparison of carbon emissions contained in CO_2, based only on the chemical characteristics of the fuels and on their energy contents, shows that the combustion of natural gas emits 218 mg C/kcal, allowing the reduction of 44.5% in relation to emissions from burning European coal, which has 393 mg C/kcal. Compared to heavy fuel oil, which emits 307 mg C/kcal, the reduction in emissions resulting from the adoption of natural gas is 29.0%. Compared to the use of light fuel oil (290 mg C/kcal), burning natural gas allows a reduction of 24.8% in total carbon emissions.

These results differ somewhat from the emissions calculated based on electrical energy generated, which depends also on the efficiency of the technologies use in thermoelectric plants. However, natural gas remains a real alternative in reducing the rate of growth of greenhouse gas emissions, with coefficients of emission of carbon dioxide per kWh generated lower than that of fuel oil and coal in thermoelectric generation in the principal technologies used – ie. conventional steam cycle, gas turbine and combined cycle, as shown in table 23.

Compared to burning fuel oil, the use of natural gas enables the reduction by 27% of total carbon dioxide emissions in plants equipped with conventional steam cycle generating technology. In facilities with gas turbine, reductions in CO_2 obtained by using natural gas compared to fuel oil rises to 31%. For combined cycle thermoelectric generation, this change in energy source would mean a reduction in CO_2 emissions of 28%.

Table 23 – Comparison of Pollution Emissions between some Thermoelectric Generation Fuels and Technologies – Specific Emission per Unit of Energy Generated (g/kWh)

	Natural Gas	Fuel Oil		Coal		
		Heavy	Light	European	Colombian	Brazilian (average)
Conventional Steam Cycle						
CO_2	493	675	n.a.	872	859	590-1248
SO_2	0	16.9	n.a.	6.2	5.7	5.7-68
Particulate Material	0	0.09	n.a.	32.1	24.2	119-390
Gas Turbine						
CO_2	622	n.a.	900	n.a.	n.a.	n.a.
SO_2	0	n.a.	2.2	n.a.	n.a.	n.a.
Particulate Material	0	n.a.	0	n.a.	n.a.	n.a.
Combined Cycle						
CO_2	438	n.a.	607	n.a.	n.a.	n.a.
SO_2	0	n.a.	1,5	n.a.	n.a.	n.a.
Particulate Material	0	n.a.	0	n.a.	n.a.	n.a.

Source: ROSA, L.P., SCHECHTMAN, R., 1996.

Note: Efficiencies were based on the upper calorific power (UCP). In the conventional steam cycle, an efficiency of 38.1% was used for natural gas, 39.2% for heavy oil, 38.8% for European and Colombian coals, and 33% for Brazilian coals. For gas turbines and combined cycle, the values used for efficiency were respectively 30.1% and 42.7% for natural gas, and 27.7% and 41.1% for light oil.

Another important characteristic of natural gas, also noted in table 23, which shows its low level of environmental damage, is the absence of sulfur dioxide (SO_2) and particulate materials resulting from inert material in the fuel, which are typically found as byproducts of burning coal and, in lesser quantities, heavy fuel oil.

However, the effectiveness of natural gas in reducing emissions of contaminants and in overcoming the barriers imposed by the environmental impacts related to the greenhouse effect depends on a rigorous control of losses. This is because methane, the chief component of natural gas, when released to the atmosphere through leaks or incomplete combustion, also contributes to climate change to a greater degree than carbon dioxide (CO_2).

2.3 – PETROBRAS'S PROGRAMS TO IMPROVE UTILIZATION OF NATURAL GAS IN THE CAMPOS BASIN

The Campos Basin is Brazil's principal producing region, with around 80% of the country's oil. It extends from the coast of the state of Espírito Santo, along the entire state of Rio de Janeiro, to the

State of São Paulo. Leadership in the development of the deep water production technology use in these oil fields resulted in various awards and international recognition.

Because of the increased production in this region and with the prospects for growth in the natural gas market, in 1997 Project Zero Flaring (PQZ), consisting of actions to improve the utilization of gas from the Campos Basin. The objective of the project is to increase the availability of gas on the market, improve the utilization of energy resources and reduce pollution emissions[71].

PQZ was the first project completely coordinated by the unit Exploração e Produção da Bacia de Campos, with investments of around US$ 177.4 million applied to the upgrading and modernization of the compression system for the Basin. The activities included acquisition of ten new compressors, as well as the implementation of improvements to existing ones. Its activities are distributions over 17 platforms along the Rio de Janeiro coastline. A pioneering and important project for the strategy of gas recovery, which is also part of PQZ, is the injection of gas for storage, to ensure the stability of gas supply to the market. With financing from banks and Japanese companies, PQZ has already implemented 89% of its activities and its completion is set for 2003.

With the implementation of the actions under way, the estimated reduction of gas flaring in 2001 is 6.2 million m³/d, with a total of around 3.4 million m³/d in 2005. This reduction of half the flaring is occurring in parallel with an increase of almost 100% in production, which will exceed 15.9 million m³/d in 2001, increasing to 27.5 million m³/d in 2005. Thus, the improvement in the process is in the order of 400% over this period, with the result that the indicators for gas utilization, which were already comparable to other countries such as the USA and Mexico, are approaching benchmark values at the global level.

Huge benefits justify the implementation of the project: better use of energy from gas associated with oil production; making more gas available for electrical generation through a thermoelectric program being carried out by the federal government; contribution to the governmental goal of increasing the share of gas in the Brazilian energy matrix and reducing emissions of pollutants such as carbon monoxide and nitrogen compounds; and reducing emissions of greenhouse gases.

Another important tool in reducing gas flaring is the Gas Distribution Master Plan (PDEG). The objective of this plan is to identify bottlenecks in the system of gas transportation, thereby anticipating potential problems that could impede the distribution of gas to be produced in the Campos Basin. According to this plan, analyses are made for a period of 20 years of the entire gas transportation complex, including high and low pressure compressors, pipelines and gas processing capacity of the existing and future platforms. This distribution complex consists of almost 50 platforms and more than 1000 km of gas pipelines.

From the perspective of global climate change, the Zero Flaring Program is of special importance, since between 2002 and 2005 the program will prevent approximately 15 million tonnes of CO_2 from being released to the atmosphere.

[71] In 2001, the PQZ was expanded and complemented with other activities, including creation of the Gas Optimization Plan (POAG). POAG emerged in 2001 and absorbed the PQZ, since it was broader and had the same objectives. The plan included the installation of new compressors, expanding the capacity of other existing ones and changing the system for raising oil in some wells, going from gas-lift to centrifuge pumps, thus liberating compression capacity for the export of gas to the continent. Also part of POAG were activities involving review of procedures, control of stocks and personnel training. Investments in this project exceeded the 200 million dollar mark.

2.4 - REDUCTION OF FUGITIVE METHANE EMISSIONS IN NATURAL GAS DISTRIBUTION IN SÃO PAULO

The fugitive emissions from piped natural gas in distribution systems occur primarily in pipes through leaks at joints and components. It also occurs through accidents and at the point of final consumption – whether residential, commercial or industrial.

In 2005, with an estimated market of 90 million m^3/d of natural gas, the country could be wasting the equivalent of the consumption of a 1000 MW thermoelectric plant, representing not only economic losses, but also considerable environmental costs because of fugitive methane and its contribution to global warming.

The São Paulo Gas Company (COMGAS) has been implementing measures to reduce emissions of methane gas in the natural gas distribution pipeline system, concentrating on reducing the waste in the system, both in the network and in the final residential and non-residential point of consumption.

The principal document produced by COMGAS consists of an inventory of fugitive methane emissions from natural gas distribution pipelines in Brazil, carried out in 1997, following the IPCC methodology, on the recommendation of the Ministry of Science and Technology - MCT. This inventory guided the actions of COMGAS in reducing leaks in the system, thereby contributing to the reduction of atmospheric methane emissions.

There are no measurements in Brazil from monitoring of fugitive emissions from piped gas. In order to assess the gains from emissions reduction activities, there is a crucial need to implement monitoring in a continuous and consistent form. Thus, carrying out an inventory is in fact a fundamental step in starting a long-term process.

Since it was privatized in 1999, the company has managed to reduce the share of gas not accounted for from 5.2% to 2.05%, principally through renovation of the networks, replacing cast iron pipes which date from the beginning of the distributor's activities, at the end of the 19th century – by polyethylene pipes, which along with being easier to install, reduce losses in the system, with lower leakage levels and greater durability. Of the approximately 1000 km of cast iron pipes inherited from the privatization, the goal is to replace 398 km by the end of the concession period, in 2009.

For systems built with steel or polyethylene, with welded joints. For these, periodic maintenance is sufficient to control leaks, giving special attention to particular installations (valves, pressure regulation stations, measuring devices, etc.).

In addition, small leaks may not be perceptible by odor. In this case, an instrument consisting of a vehicle with air collectors coupled is used in an "on line" analysis to measure the amount of gas in the air. When a leak is detected, a "bypass" is applied in planned maintenance activities, or whenever it is technically possible, the gas contained in a specific stretch is transferred to another, without purging to the atmosphere.

According to the inventory of fugitive natural gas emissions from pipelines in the distribution network, Brazil is practically negligible in the total balance of GHG emissions.

However, additional measures to control emissions of this nature are desirable, including:

- implementation and operation of a risk management system, so as to reduce leaks from accidents, and when they occur to be contained in time;
- when carrying out maintenance operations or operation in the network in which it is necessary to drain the stretch of pipe, to avoid purges of gas to the atmosphere;
- ongoing maintenance program for equipment in the network;
- educational campaigns for residential, industrial and commercial consumers;
- technical support for consumers to regulate their combustion and maintenance equipment in the internal network; and
- recovery program for cast iron networks.

2.5 - PROGRAMS IN THE STATE OF SÃO PAULO FOR REDUCTION OF VEHICLE EMISSIONS IN URBAN TRANSPORT

During the 1990s, the São Paulo Metropolitan Region (RMSP) was subject of severe episodes of air pollution, especially during the winter, because of the combination of pollutant emissions and climatic conditions unfavorable to dispersion, resulting in serious problems to public health. Since 1981, concerns with vehicle emissions has increased because of the growing concentration of CO and suspended particulates in the atmosphere. At the end of the 1980s, it became obvious that the phenomenon was linked to vehicle emissions, and that urgent measures were necessary.

In 1996, the government of the State of São Paulo, through the State Environmental Secretariat - SMA, implemented a more aggressive policy to fight atmospheric pollution cause by mobile sources, especially passenger vehicles. A range of strategies was adopted to raise awareness of the relation between private automobile use, air pollution and human health. Seeking to improve air quality in the RMSP, more energetic measures were applied to control vehicle emissions based on the relevant legislation, and also based on the precepts in Agenda 21, especially the Precautionary Principle and the Polluter Pays Principle. The set of policies that began with the "Respira São Paulo" ("Breath São Paulo") Campaign resulted in a legislative bill (Of the State Policy of Vehicle Pollution Control and Sustainable Transport), sent to the Legislative Assembly in 1997.

Operation Winter

This is a set of preventative and corrective actions under development since 1976, seeking to protect the health of the population and intensified in the period of May to September, because of meteorological conditions[72], or during the severe pollution episodes, in accordance with the standards established by the relevant regulations.

Operation "Rodízio" (Day without a car)

Operation "Rodízio", held from 1995 to 1998, consisted of restricting the circulation of approximately 20% of the automobile fleet in São Paulo and in another 9 municipalities in the RMSP, in the winter months, when there is greater difficulty in dispersion of atmosphere pollutants. With the withdrawal of these vehicles and the resulting fluidity of traffic flow, it is estimated that reductions in total emissions of CO from the fleet has been reduced by 19% in 1988. Another important aspect of Operation "Rodizio" was that it raised awareness of the population about the relation between air quality and

[72] Thermal inversions, still air and drought obstruct the process of air circulation, thus aggravating pollution.

transportation, along with generating pressure on authorities to invest in the expansion and improvement of the quality of public transport.

Table 24 - Data about reduction of carbon monoxide (CO), calculated based on estimates of the fleet circulating and emissions (tonnes/day)

Reason/Period	1996	1997	1998
Due to reduction of vehicles in circulation	329.1	319.4	273,9
Due to increase in traffic fluidity	200.2	189.2	174,9

Source: CETESB/SMA, 1999.

Table 25 - Reduction in Total CO (tonnes) from Operation "Rodízio"

	Start date	End Date	Tonnes
1996	05/08	30/08	10,586
1997	23/06	26/09	42,460
1998	04/05	25/09	55,070

Source: CETESB, 1999.

Telemetry Network

CETESB invested US$ 1 million in renovating and expanding its telemetry network, consisting of 25 stations, which monitors air quality in the RMSP and in Cubatão. The company is again measuring pollutants such as NO_2, which since 1993 were not being assessed. CO, which had been measured by only five stations, came to be monitored in eight.

Conversion of diesel buses to vehicular natural gas (VNG)

In 1991, a municipal law was promulgated in the RMSP requiring the replacement of diesel fueled buses or engines by others using vehicular methane gas (natural gas), in the entire collective transport fleet within a ten year period.

Over the ten years following this legal requirement, attempts were made to find the best way to implement it, and other laws and decrees were promulgated aiming at making the original law more appropriate and flexible. During this process, many measures were taken by the Municipality of São Paulo in order to comply with the legislation. Along these lines, some companies forming part of the transport system made acquisitions and adaptations of their buses, resulting in a total fleet of around 250 buses using VNG, of a total of 12.000 buses[73].

Technological improvements for fuels

Improving Brazilian fuels has been part of the efforts to integrate policies for air quality improvement. Prominent institutions such as PETROBRÁS, ANFAVEA and IBAMA, as well as the State Environment Secretaries and other bodies linked to fuel production, were involved in the process of defining quality standards for fuels. Significant results include the improvement of technical specifications of fuels.

[73] In the end of 2001, a new law was promulgated that removed the obligation to replace diesel powered buses by those running on VNG, which also involved a change of focus: the concern was no longer about the fuel used, but rather about the gases emitted, based on CONAMA resolutions (see item 7.5.) for emissions of diesel cycle automotive vehicles.

As a result of these measures, significant environmental gains were achieved, including the reduction of 80% in ambient concentrations of lead, making viable the use of catalytic converters that diminish emissions of pollutants by around 90%, and the maintenance of environmental concentrations of sulfur dioxides below legal limits. Comparative data obtained through the telemetric network show a slight improvement in ozone levels, and a small reduction of breathable particles PM10s. The most significant reductions are in CO levels: there was an improvement of 10.8% in these emissions compared to the figures five years earlier.

2.6 - THE ROLE OF NUCLEAR ENERGY IN REDUCTION OF GREENHOUSE GAS EMISSIONS IN BRAZIL

2.6.1– THE BRAZILIAN ENERGY SECTOR AND NUCLEAR ENERGY

At the end of 2000, the installed generating capacity of the country was 74,903 MW[74], with 88.5% of this total provided by hydroelectric plants. With two units in operation (Angra 1 and 2, with capacity of 675 and 1309 MW respectively), nuclear energy accounts for 1.5% of the total installed capacity of the country. Although modest from a national perspective, this nuclear plant is important to the local supply of the state of Rio de Janeiro, which is the second most important state of the country in terms of contribution to GDP.

For 2006, the Ten Year Plan calls for an installed capacity of around 98,000 MW, with 81% in hydroelectric plants, and 3.5% in nuclear plants (Angra 1, 2 and 3[75], totaling 3275 MW).

2.6.2 - INSTITUTIONAL ASPECTS OF THE NUCLEAR SECTOR

In 1997, the nuclear division of FURNAS, the company responsible for most of the electricity supply in the most developed region of Brazil, was founded as a state engineering company - Nuclebrás Engenharia (NUCLEN), responsible for the planning, management of construction, and bidding for equipment for nuclear plants. The new company, called Eletrobrás Termonuclear S.A. (Eletronuclear), is responsible for the planning, bidding and monitoring of Brazilian and foreign equipment, management of construction, assembly and commissioning of nuclear plants and is the only owner and operator of nuclear plants in Brazil. Also, it is responsible for acquiring the necessary know-how and promotion of private industry. Other actors in the nuclear sector are Eletrobras, for coordination and financing of the national energy program; CNEN, the licensing authority; Industrias Nucleares do Brasil (INB), fuel supplier; NUCLEP, Brazilian manufacturer of heavy components; the private Brazilian engineering companies and the private Brazilian suppliers of mechanical and electrical equipment.

2.6.3 - THE CONTRIBUTION OF NUCLEAR ENERGY TO REDUCTION OF GREENHOUSE GAS EMISSIONS

[74] Includes 3442 MW from self-generators.

[75] In its meeting on December 5, 2001, the National Energy Planning Council (CNPE) approved the carrying out of studies for the construction of Angra 3, for which part of the project is ready.

Nuclear energy does not directly emit greenhouse gases (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, etc.) or any gas that causes acid rain (sulfurous anhydride, nitrous oxides). Furthermore, it does not emit any carcinogenic, teratogenetic or mutagenic metals (arsenic, mercury, lead, cadmium, etc.) as does the use of fossil fuels. The use of nuclear energy also does not emit gases or particles that cause smog in cities or the destruction of the ozone layer.

Although the third largest source of electrical generation in the world, avoiding emissions of considerable amounts of carbon dioxide and pollutants, nuclear energy has been considered by the general population more as an environmental threat than as an unlimited source of energy, as was expected at the beginning of its technological development. The environmental impact of thermonuclear plants have also been strongly emphasized in recent decades, and is a leading concern of environmental movements. Aside from the remote, but not negligible, possibility of soil, air and water contamination by radionuclides, warming of water of the receiving body from discharge represents a risk to the local environment.

Along with the constant precautions in terms of safety and the high costs of disposal of the nuclear wastes, some point to economic and financial restrictions in relation to thermonuclear plants. Nuclear reactors are not compatible with the trend towards liberalized energy markets, which favors generation technologies which allow plants with lower capacity and faster and lower-cost construction.

Nuclear energy is the only energy technology that treats, manages, contains and isolates its wastes to completely protect human health and the environment. Solutions for the final disposal of low, medium and high-level radioactive wastes are in use in various countries. In addition, the waste management and disposal technologies are advancing continually, including fuel transmutation and recycling. The implementation of these improved technologies could help to increase public acceptance of nuclear energy.

Proponents of nuclear energy argue that it is the only energy technology that treats, manages, contains and isolates its wastes to completely protect human health and the environment. Solutions for final disposal of low, medium and high-level radioactive wastes exist and are in use in various countries.

Furthermore, waste management and disposal technologies are advancing continuously, including transmutation and recycling of fuel. The implementation of these refined technologies could help to increase the public acceptance of nuclear energy. Along with this, because of the fact that nuclear energy is a highly concentrated form of energy, nuclear plants and fuel cycle facilities do not need large areas. Thus, the environmental impact of nuclear energy on land, forests and waters is minimal and does not require the displacement of large populations.

Thus, the fact is that since the start of operations in 1982 to the end of 1998, Angra 1 generated 26,916 GWh of electricity. If this amount of electricity were replaced by electricity generated by conventional thermal plants, an additional 13.1 or 26.2 million t of CO_2 would be emitted, based on combined cycle natural gas fired plants or modern coal plants, respectively[76]. This amount of avoided emissions would be substantially higher if the complete energy chain were taken into account, including mining/extraction to combustion, including transport.

In the period of 1984-2000, using the same hypotheses as in section 1.3.3, in Scenario I avoided CO_2 emissions would be in the order of 9.6 million tonnes of CO_2 and in Scenario II in the order of 24 million tonnes of CO_2.

[76]The coefficients of emissions used were 1 t CO_2/MWh for coal plants and 0.5 t CO_2/MWh for combined cycle gas plants, for the combustion process only.

Given this, it could be concluded that nuclear energy along cannot resolve the environmental problems of the world, in particular the reduction of greenhouse gas emissions. However, the use of nuclear energy should be seen as an option to be considered for electricity generation with the lowest risk of increasing the global warming.

3 - RESEARCH AND SYSTEMATIC OBSERVATION

In accordance with article 4.1 (g) of the Convention, a variety of research projects and systematic observation related to the problem of climate change have been carried out in Brazil.

In this context, teams of Brazilian researchers are participating in an international effort in global research programs related to climate change, including the Global Climate Observation System (GCOS), the Global Ocean Observation System (GOOS), and the Pilot Research Moored Array in the Tropical Atlantic (PIRATA).

Among the research initiatives led by Brazil are the Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA), which seeks to expand understanding of the climatological, ecological, biogeochemical and hydrological functions of the Amazon region, the impact of land use changes on these functions and the interactions between Amazonia and the global biogeophysical system of the Earth.

The projects carried out under the Pilot Program for Protection of Brazilian Rainforests (PPG7) and the development of regional climate change models are other examples of important research being carried out in Brazil. There is also research under way related to glaciology and climate change.

Finally, the chapter analyzes the “Brazilian Proposal” – the document submitted in May 1997 by Brazil titled “Proposed Elements of a Protocol to the United Nations Framework Convention on Climate Change, Presented by Brazil in Response to the Berlin Mandate”. This proposal is intended to produce a paradigm change by creating objective criteria for assessing the responsibility of each country for causing climate change, in terms of the relative and differentiated responsibility of each country in contributing historically, through anthropogenic greenhouse gas emissions, since the Industrial Revolution, to the increase in temperature of the earth’s surface.

Brazil is thus undertaking and cooperating in scientific research and in systematic observations in order to clarify, reduce or eliminate the remaining uncertainties regarding the causes, effects, magnitudes and trends over time of climate change.

3.1 - WORLD CLIMATE PROGRAM

Several international research initiatives are currently underway at the global level, primarily carried out under the auspices of the World Meteorological Organization (WMO) and the Intergovernmental Panel on Climate Change (IPCC). Given the complexity of climatic research, a global approach to the issue is necessary, as well as the involvement of researchers spread all over the globe.

Thus, many Brazilian research institutions and researchers are participating in a global effort, through a range of international programs and projects, in order to better understand the current situation and future prospects of climate change on the planet, as presented in the following table:

Table 2

International Program/Project	Activities	Institutions / Person Responsible
Monitoring and Collection of International Data		
Global Climate Observing System (GCOS)	Ensure the acquisition of information for the monitoring and detection of climate change and responses to it; and apply this information in socio-economic development and research on better climatic understanding, modeling and prediction.	INMET (C. Athayde) INPE/CPTEC (C. Nobre)
Global Ocean Observing System (GOOS)	Collect, analyze and disseminate data and information on oceans, coastal regions and enclosed and semi-enclosed seas, in order to allow reliable predictions of oceanic and atmospheric conditions, along with facilitating coastal zone management and supplying the research needs regarding changes of the global environment.	DHN – Marinha (J. Romaguera Trotte)
Global Climate Research Program		
Global Energy and Water Cycle Experiment (GEWEX)	Study atmospheric and thermodynamic processes that determine the global hydrological cycle, its equilibrium and adjustments to global changes.	INPE/CPTEC (J. Marengo) USP (P. Silva Dias e M. A. Dias)
Climatic Predictability and Variability (CLIVAR)	Investigate the variability of the climatic system of the Earth and predict these variations, through monitoring of the variations of surface conditions (ocean temperature, humidity of soil and vegetation, snow and ice cover) which affect the climate	INPE/CPTEC (J. Marengo e C. Nobre) USP (P. Silva Dias) UFPR (A. Grimm)
Stratospheric Processes and their role in Climate (SPARC)	Concentrating on the interactions of dynamic, radioactive and chemical processes, the goal is the construction of a stratospheric climatological reference and improved understanding of temperature,	INPE (V. Kirchoff)

	ozone and water vapor trends in the stratosphere.	
Arctic Climate Study System (ACSYS)	Understand variation in the Arctic Ocean and changes that include ocean-ice processes.	INPE (A. Setzer)
International Geosphere-Biosphere Program		
Global Change in Terrestrial Ecosystems (GCTE)	Understand how global changes will affect terrestrial ecosystems.	INPA (Niro Higuchi)
International Global Atmospheric Chemistry (IGAC)	Understand how atmospheric chemistry is regulated and the role of biological processes in the production and consumption of atmospheric trace gases.	USP/Physics Institute (Paulo Artaxo)
Past Global Changes (PAGES)	Discover the significant climatic and environmental changes that occurred in the past and their causes.	INPE/CPTEC (J. Marengo)
Global Analysis, Interpretation and Modeling (GAIM)	Develop comprehensive prognostic models of the global biogeochemical system and link these models with those of the climate system.	INPE/CPTEC (C. Nobre)
Training		
Global Change System for Analysis, Research and Training (START)	Develop a system of regional networks for collaboration between scientists and institutions that carry out research on regional aspects of global change, evaluate its causes and impacts and provide information relevant to policymakers and politicians, principally related to capacity-building in developing countries.	INPE/CPTEC (C. Nobre)
Assessments of Impacts and Adaptations to Climate Change (AIACC)	Develop a regional training system for START projects involving the use of global and regional climate scenarios regarding assessment studies of vulnerability to climatic change	INPE/CPTEC (J. Marengo)

3.2 - “PIRATA” PROGRAM

PIRATA (Pilot Research Moored Array in the Tropical Atlantic) is a project involving Brazilian, French and U. S. scientists, carried out through international cooperation. It is considered one of the five largest oceanographic programs in the world.

The project consists of implementing a pilot system that provides atmospheric and oceanic data in the tropical Atlantic Ocean. PIRATA calls for launching and maintaining a dozen “Atlas” buoys between 1997 and 2000, anchored on the high sea in the middle of the Atlantic Ocean, near the Equatorial region, at a depth of up to 500 meters.

The buoys, together with the marigraphs and meteorological stations on the Data Collection Platforms (DCPs), will be able to measure sea temperature and obtain data about meteorological conditions in the region. The data obtained will be transmitted via satellite through the ARGOS and SCD services, and can be available in practically real time on the Internet.

The data obtained will assist scientists in understanding ocean-atmosphere interactions in the tropical Atlantic region, enabling the formulation of models for seasonal prediction of climate in this region and in the adjacent continental areas.

The proposal for the PIRATA program was based on the success of the Tropical Ocean Global Atmosphere (TOGA) system, which carried out monitoring of the Pacific Ocean, following the same principles, between 1985 and 1994. Investigation of the interaction of atmosphere and tropical oceans in the Pacific region, where the El Niño phenomenon occurred, proved of great relevance in the study of climate variability on a scale of years and even decades.

During the pilot phase of the PIRATA program, from 1997 to 2000, it was intended to assess engineering, logistics and maintenance problems that could arise in the implementation of the observation system. It is expected that, at the end of the successful completion of the project's pilot phase, other countries could join in the maintenance and possible expansion of PIRATA, to make it an Atlantic extension of the Global Climate Observing System (GCOS) and of the Global Ocean Observing System (GOOS). In addition, the information obtained by PIRATA will be a great contribution to the international research effort undertaken by the World Climate Research Program (WCRP), especially for the "post-TOGA" activities (CLIVAR-GOALS).

The construction of buoys, assembly of equipment and its maintenance are being financed by the National Oceanic and Atmospheric Administration (NOAA) and NASA, from the U. S. Brazil is responsible for the installation of seven buoys, two marigraphs, and meteorological stations located in the Atol das Rocas and in the São Pedro and São Paulo Archipelago, with an anticipated budget of US$ 2.5 million.

Brazil has great interest in the extension of the PIRATA program. This interest results from the fact that, from a meteorological and oceanographic point of view, there is a need from permanent monitoring of this region, including inter-hemispherical heat transport, which occurs beneath the surface of the ocean in that region. In addition, the data to be collected are indispensable in improving climate predictions, as well as for shorter term weather forecasts. Temperature anomalies end up determining extreme rainfall events in the Northeast of Brazil, which are only predictable if there is permanent monitoring of this variable.

The detailed document containing the scientific justification for the extension of the program will be formally submitted to the PIRATA Steering Group, for implementation in the 2002-2003 two-year period, given the existence of the necessary resources.

3.3 - LARGE SCALE BIOSPHERE-ATMOSPHERE EXPERIMENT IN AMAZONIA - LBA

The Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) (lba.cptec.inpe.br/lba/index.html) is an international research initiative led by Brazil. The LBA was planned to generate new knowledge required for understanding climatological, ecological, biogeochemical and hydrological functions of the Amazon region, the impact of land use changes on these functions and the interactions between Amazonia and the global biogeophysical system of the Earth.

The LBA is centered on two principal questions, which are addressed through multidisciplinary research, integrating studies in the physical, chemical, biological and human sciences:

How does Amazonia currently function as a regional entity?

How will changes in land use and climate affect the biological, chemical and physical functioning of Amazonia, including its sustainability and its influence on global climate?

In the LBA, emphasis will be placed on observation and analysis that will expand the knowledge base regarding Amazonia in six areas: Climate Physics, Carbon Storage and Exchange, Biogeochemistry, Atmospheric Chemistry, Hydrology and Land Use, and Vegetation Cover. The program is designed to address the principal issues raised in the Framework Convention on Climate Change (FCCC) and will provide a knowledge base oriented to the sustainable use of land in Amazonia. To this end, data and analyses will be used to define the present state of the Amazonian system and its response to current perturbations, and will be complemented with model results to provide an understanding of possible changes in the future.

In the component Climate Physics, meteorological and hydrological studies are carried out on nested spatial scales, from small experimental areas up to the entire Amazon Basin, emphasizing the determination and understanding of spatial and temporal variations of energy and water flows. The variations of climate and the response of the Amazon system to these variations will be determined on daily and seasonal time scales. The fields generated by a numerical weather prediction model will be stored and used in a four-dimensional data assimilation (4DDA) routine as a basic tool in the analysis of observations.

The duration of the LBA will take into account on direct observations of interannual climatic variations, possibly including the effects of the El Niño – Southern Oscillation (ENSO) cycle. Data collected from field studies will be used to improve the representation of the most important dynamic processes in meteorological models. The results will contribute to improving the General Circulation Models used in studying the interactions between climate change and plant cover in the Amazon region.

The component Carbon Storage and Exchange focuses on two principal questions: (1) do the native ecosystems of Amazonia function as a net carbon sink? and (2), how much carbon is lost as a result of the changes in plant cover and in land use, such as deforestation for agricultural purposes and those resulting from selective timber extraction? Long term surface measurements of carbon storage and flows will be made in experimental areas, strategically located along the gradients of intensity of land use, vegetation and climate, and will be complemented by airplane instrument observations and by modeling. The results of ecological models will be used along with a geographic information system (GIS), to estimate the carbon balance in Amazonia. Observations by airborn instruments will allow estimates of integrated carbon flows in the entire Basin over short periods of time, and could be used in model verification.

The Biogeochemical component focuses on nutrient recycling and greenhouse gas emissions by natural and secondary forests and by areas subject to different types of management. Observations will be made over several years in strategic sites, covering different land uses and a range of soil fertilities. The measurements will quantify flows of trace gases (principally methane and nitrous oxide), of nutrients (including transport to rivers) and modifications in their stocks. These data will be complemented by periodic aircraft-based observations, surveying on multiple spatial scales and manipulation experiments. The data will be unified in a GIS and linked with models of ecosystem functioning. The principal results will be used in analyses of the effects of land use changes on flows of greenhouse gases; diagnostics of the effects of climatic variations and land use changes on balances of nutrients and trace gases; and assessments of the implications for sustainable land use of changes in the dynamics of nutrients resulting from different types of management.

In the Atmospheric Chemistry component, the concern is to understand the current influence of Amazonia on the global and tropical concentrations of oxidants (ozone, hydroxyl), their precursors (nitrous oxides, hydrocarbons, carbon monoxide) and aerosols, as well as to complement the studies of greenhouse gases (carbon dioxide, nitrous oxide, methane), proposed in the components Biogeochemistry and Carbon Storage and Exchange. Experiment planning combines long-term surface observations and intensive measurements with aircraft based instruments. Aircraft surveys will map exchanges of gases and aerosols between the biosphere and atmosphere, at the scale of the Amazon region, complementing surface observations, and investigating the transport of gases and aerosols across the boundaries of the Amazon Basin. Large-scale three dimensional atmospheric chemistry models, using assimilated meteorological observations (obtained in the Climate Physics component), and data from airplane and surface observations will be applied to quantify the exchange of trace gases and aerosols between the Amazon region and the global atmosphere.

The Hydrology component addresses issues related to the quantity and quality of water in the Amazon Basin. Reservoirs and flows of water, controls on the movement of water in soils and rivers and the transport of associated materials will be determined by a set of sites representing a range of land use intensities.

Changes in Land Uses and Vegetation Cover, will identify the physical, social and economic causes of these phenomena. Studies of deforestation and changes in forests at the scale of the Amazon region will be carried out using satellite data and surveys of census statistics. Case studies will be carried out to illustrate how land use changes affect vegetation cover. Research to define the external conditions and factors that cause these changes will focus on the development of predictive models of changes in vegetation cover and land uses.

The LBA combines new analytic instruments and innovative and multidisciplinary experiments in a powerful synthesis that will generate new knowledge useful in addressing outstanding issues and controversies. It also provides a new understanding of the environmental controls over flows of energy, water, carbon, nutrients and trace gases between the atmosphere, hydrosphere and biosphere of Amazonia, ensuring the scientific basis for policies regarding the sustainable use of natural resources of the region. The expansion of capacities and research networks within and between the Amazon countries linked to the LBA stimulates training and research relevant to sustainable development, supporting the process of policy formulation for the sustainable development of the region.

3.4 - PILOT PROGRAM FOR PROTECTION OF TROPICAL BRAZILIAN RAINFORESTS (PPG7)

At the 1990 G-7 summit (Germany, Canada, United States, France, Italy, Japan and the United Kingdom), held in Houston, Texas, the German Chancellor Helmut Kohl proposed the creation of a pilot program to prevent the increase of the rate of deforestation in the Brazilian tropical forests, which reflected the growing concern of the international community with deforestation in Brazil.

The program guidelines were outlined by representatives of the Brazilian government (Interministerial Committee), the World Bank and the European Commission, in response to the recommendations made at that meeting, which was approved by the G-7 and the European Community in December of 1991.

In 1992, the Executive Directors of the World Bank adopted Resolution # 92-2, establishing the Rain Forest Trust Fund to finance the pilot program for the protection of tropical forests of the Brazilian Amazon and Mata Atlântica.

After authorization from the Brazilian Senate in August of 1993, an agreement was signed on February 25, 1994 between Brazil and the World Bank to implement the pilot program. Brazil agreed to provide 10% of the total funds available for the program.

For the first phase of the program, US$ 291.1 million were approved by the G-7, by the Commission of the European Union, and by the Netherlands. Of this amount, US$ 58.2 million was allocated to the Fund, to be implemented in the period of 1995 to 2001, and US$ 232.9 was destined to bilateral assistance.

The World Bank is responsible for coordination of the program between the donors and the Brazilian government, along with administration of the Fund. The Bank started the work in 1992, on the same date the Fund was created. The first projects were approved in 1994 and implemented starting in 1995, with the Ministry of Environment (MMA) serving as the Brazilian representative responsible for coordination of the program and the objectives.

The Rain Forest Unit of the World Bank, in Brasilia (DF) coordinates the preparation of the plans between the Brazilian Government and the donors. It assesses the proposals and monitors progress on the projects, using the traditional criteria of the institution, but accepts a somewhat greater risk because of the experimental character of the program.

The Trust Fund supports the preparation, supervision and monitoring of the projects, along with financing studies of special interest to the program's objectives. 20% of the financing of the Pilot Program comes from the Fund, which has received approximately US$ 56 million to date.

Brazil provides a counterpart from the Federal and State budgets; and the Brazilian government agencies provide their own infrastructure and personnel to manage the project. The participants from the Project also contribute to the program: local communities make contributions, for the most part, in the form of labour and materials.

Progress on the program is the responsibility of the Brazilian Government, through the Environment Ministry (MMA), the Ministry of Justice (MJ) and the Ministry of Science and Technology, and has the support of the World Bank, of the European Union (EU), and the donor country members of the G-7.

3.4.1 - INSTITUTIONAL ASPECTS OF PPG7

The Pilot Program for Protection of Brazilian Rainforests - PPG7 is a set of integrated activities seeking to strengthen and expand the environmental benefits from Brazilian tropical forests, in a manner compatible with the development of the country. The program has the following general objectives:

- demonstrate the viability of harmonizing economic development and environmental protection in tropical forests;
- preserve biodiversity of tropical forests;
- reduce the contribution of tropical forests to global greenhouse gas emissions;
- provide an example of international cooperation between developed and developing countries in environmental issues of a global scale.

The PPG7 supports a broad set of integrated projects that contribute to the reduction of deforestation of tropical forests in the Amazon Region, and at the same time seek to protect biodiversity, reduce greenhouse gas emissions and use forest resources in a sustained manner. These projects are structured in four subprograms:

Natural Resource Policy Subprogram: seeks to ensure the sustainable use of natural resources and contribute to the definition and implementation of an appropriate model of integrated environmental management for the Legal Amazon, including projects involving ecological-economic zoning, environmental monitoring and vigilance, environmental inspection and enforcement, and environmental education;

Demonstration Projects Subprogram: includes three types of demonstration projects:
- Type A Demonstration Projects A - PD/A: seeks to contribute to the conservation and preservation of the Amazon, the Mata Atlântica and associated ecosystems, by supporting sustainable development through the participation and integration of local contributions;
- Environmental Education Project: with specific activities planned for the Amazon region, possibly in the areas of influence of the Ecological Corridors Project. Its objective is to contribute to the conservation of nature, the sustainable use of natural resources and the dissemination of local knowledge;
- Indigenous Demonstration Projects (PD/I): destined exclusively to indigenous populations and lands. It is expected that through these projects it will be possible to finance initiatives on the part of indigenous groups that promote the sustainable management of natural resources and environmental protection on their lands, thereby contributing to the maintaining the physical and cultural integrity of indigenous peoples.

Management of Natural Resources and Conservation Units Subprogram: aimed at developing sustainable management models for Conservation Units and areas recovering from human interference, and promoting the sustainable management of natural resources. This subprogram involves 6 projects:
- Extractivist Reserves: specific objectives are to promote the implementation and regularization of land title of four extractivist reserves; the strengthening of extractivist reserves and installation of social and community infrastructure on the reserves; the improvement of productive and commercial capacity of the reserves; the refinement of maintenance and sustainable management of the natural resources on the reserve; support to management and to appropriate and participatory administration of the project;
- Protection of Indigenous Lands and Populations: seeks to contribute to the protection and conservation of indigenous areas of the Legal Amazon, for monitoring of the well-being of indigenous populations through the regularization of land title and improvement of protection, along with increasing the compatibility of traditional indigenous forest management with appropriate technologies, as a way of conserving and improving the quality of life of these populations;
- Support to Forest Management in the Amazon: seeks to develop strategies to enable integrated and sustainable forestry management in the Amazon, with the participation of interested sectors, to ensure compatibility between economic activities and conservation of natural resources;

- Ecological Corridors: the project seeks to contribute to the protection of biodiversity of ecosystems of Amazonia and the Mata Atlântica, ensuring the capacity for their self-regulation and minimizing anthropogenic impacts on them;
- Management of Natural Resources of Floodplains (*Várzea*): seeking to promote the conservation and rational use of floodplains, with emphasis on fishing and management of other forms of wild aquatic life, through technologies linked to improvement of quality of life in regional communities;
- Monitoring and Control of Deforestation and Burning: seeks to improve monitoring and control of deforestation, of fires and forest degradation in selected areas of the Amazon. This project is expected to provide support to federal and state environmental bodies in Amazonia in developing and implementing a unified monitoring system for deforestation, burning and forest degradation, and at the same time strengthen local capacity to control deforestation and illegal burning.

Science and Technology Subprogram: seeks to promote production and dissemination of scientific and technological knowledge relevant to the conservation and sustainable development of the Amazon region, through two components: directed research projects, with completion date of December of 2002, and science center projects, completed in December of 1999. The proposal for a research network in the Amazon Region of Phase II of this subprogram is being development, and calls for, among other things, support to established and emerging scientific groups, as well as those being formed, as well as the establishment of efficient mechanisms for dissemination of results to the various sectors of society.

Other Projects: along with the projects cited above, linked directly to the subprograms, there are others that are directly responsible to the Executive Secretary of the Pilot Program:

- Monitoring and Analysis Support Project (AMA): this project seeks to promote learning about the Pilot Program and the application and dissemination of its strategic lessons;
- Marketing Project: its objective is to support initiatives in the area of production, processing and marketing being carried out in the Amazon. The project is also expected to support the government in implementing public policies of incentives to sustainable agro-extractivism in the region. The intention is to maximize the use of natural resources and generate income for the agro-extractivist population, which has been providing environmental services important to conservation of the Amazon forest, thereby ensuring their permanence in the region;
- Management, Monitoring and Policies Project of the Pilot Program: the general objective is the integrated and coordinated implementation of structural and demonstration subprograms, in order to ensure satisfactory results in terms of management, monitoring and formulation of public policies for the region covered by the Pilot Program.

3.5 - REGIONAL CLIMATE MODELS: EXTENDED RANGE SIMULATIONS FOR SOUTH AMERICA USING THE ETA REGIONAL MODEL

The ETA model, used at National Center for Environmental Prediction (NCEP) in the United States, was configured to run over the South American continent, with a resolution of 80 km. In Brazil INPE's Center for Weather forecasts and Climate Studies (ETA/CPTEC) uses it. This limited area model has 38 atmospheric layers and its domain includes part of the adjacent Atlantic and Pacific Oceans. The model runs in weather prediction mode with a 6-hour forecast, and extending to 72 hours. It is currently run to make seasonal climate predictions, with horizontal resolutions of 80 and 40 km. A regional model with greater resolution could better resolve orography than General Circulation Models

(GCMs). For South America, the model response to synoptic and subsynoptic systems is crucial, in particular for the south and southeast regions that are frequently swept by frontal and convective systems.

In an attempt to improve climate prediction in South America, this study is carried out to evaluate the performance of the regional model for predictions for extended periods, that is, of around um month. In this preliminary study, the regional ETA model was used to produce predictions of one month in South America under dry and rainy conditions (for some extreme rainfall events, in an experimental mode).

The ETA/CPTEC regional model proved capable of producing one-month climatic predictions for South America in a continuous run. The results were compared to predictions by the GCM in order to evaluate the positive contribution of regional runs. The regional predictions showed that the greater resolution could provide more details to the predictions, especially for the temperature fields near the surface. The magnitude of variables predicted were in general closer to the observations. It should be remembered that part of the quality of the regional predictions depend on the quality of the prediction of the global model. The ETA/CPTEC regional model presented good quality rain forecasts, with the best predictions obtained in the Center-South region of South America, as well as in the most northerly part of the Northeast and the north of the Amazon.

The results of these preliminary tests are encouraging. The next steps for this work consist of preparing the model for seasonal predictions. The use of predicted ocean surface temperatures and improved treatment of water transport in the soil and atmosphere are being considered, as well as a representation of topography, vegetation and soil that more closely resembles reality. These data will presumably contribute to enabling longer term predictions of around three months with the ETA/CPTEC model over South America, thereby generating continuous and operational seasonal predictions similar to those carried out with a global climate model (see section 5.10).

In the initial phase of the project "Extended Range Simulations over South America" the ETA/CPTEC model was for the first time integrated in the "climatic mode", that is, run continuously for a greater period of time that that used to produce weather predictions (60 hours) over South America. The model was evaluated in terms of stability and quality of predictions produced for an integration of the longer period, proving capable of reproducing the climatic conditions with good spatial resolution. The next step is expected to be the completion of a climatic run of ETA/CPTEC, of at least 10 years, to represent the climatology of this model, and thus to study and determine the abilities of the model and the predictability of the climate in different regions of the country and of South America, similar to the evaluations made with CPTEC's global climate model.

Another study is being carried out at CPTEC titled "Modeling Emissions and Transport of CO2 from Areas of Burning in Amazonia." During the dry season, fires in areas with high biomass concentrations in the central region of Brazil and in Amazonia contribute significantly to an increase in CO_2 emissions to the atmosphere. To estimate the CO_2 balance during this season, numerical experiments with the gas transport model were conducted from August to September of 1995. This generated interest in including aerosols and smoke from burning of biomass in the radiation parameters within the ETA/CPTEC model, which will be of great importance in the modeling of climate changes resulting from increased greenhouse gases and aerosols.

3.6 –FLORAM PROJECT

The FLORAM Project was conceived at the end of the 1980s, at the Institute for Advanced Studies of the University of São Paulo (IEA/USP) with the objective of promoting the forestation/reforestation of a vast area in Brazil, in order to capture a large quantity of carbon through existing biomass or biomass which it is proposed to plant or replant. The original goal of the project was to fix 115 x 10^9 tC in phytomass, over a period 30 years, covering an area of 20 x 10^6 ha. However, no projects have yet been implemented based on the proposal.

Based on the identification of the areas with greatest potential for reforestation, three primary mechanisms were given priority:

Reforestation with species native to the region itself: the goal is to preserve some unique ecosystems;

Corrective reforestation: intention is to resolve emerging problems or implementing ecological/landscaping programs in critical regions, including planned contouring, reforestation along waterways and barriers to desertification;

Large-scale reforestation (intensive silviculture): intends to encourage industrial reforestation, characterized by high productivity clonal plantations, to preserve regions devastated by environmentally destructive industrial practices.

A new FLORAM working group (GT-FLORAM), also coordinated by the Institute of Advanced Studies of the University of São Paulo (IEA/USP), has been working towards adapting the initial objectives of the project to the current discussions related to the United Nations Framework Convention on Climate Change.

3.7 - RESEARCH IN GLACIOLOGY UNDER THE ANTARCTIC PROGRAM

3.7.1 – GLACIOLOGY AND CLIMATE CHANGE

The ice cover of the planet (16 million km^2) plays a fundamental role in the global environmental system, because it is one of the principal controlling factors of the planetary climatic system and is closely linked to the circulation of ocean currents.

The Antarctic Ice Sheet contains 90% of the ice on the planet, covering 13.95 million km^2, with an average thickness of 2160 meters and a maximum thickness of 4776 meters. If this volume of ice (33 million km^3) melted, it would mean an increase of 70 meters in the average sea level. Any modification of this mass, therefore, would have important consequences for the coastal regions of the entire planet. Furthermore, the majority of water at the bottom of oceans is formed either below the floating ice shelves or under the ring of sea ice that surrounds that continent. The area covered by sea ice in the southern hemisphere varies seasonally between 3 and 19 km^2, significantly affecting the pattern of energy exchange between the ocean and atmosphere through the year. Also important is the fact that the Antarctic Ice Sheet is the principal heat sink of the planet, and therefore one of the most important drivers of the climatic system.

Antarctic ice is extremely sensitive to environmental changes, and could react suddenly, in ways still not entirely understood, to climatic alterations caused by human actions. Therefore the international glaciology community is especially interested in understanding how this ice interacts with other parts of the planetary environmental system and its response to global environmental changes (principally those resulting from human activities) and in monitoring these changes on the continent.

Scientific interest in the region is also warranted because the stratigraphy and chemistry of the polar snow and ice and of the high-altitude no-polar glaciers provide one of the best paleo-climatic techniques, allowing the reconstruction of atmospheric changes going back 440 thousand years. Recent research in Antarctica as well as in Greenland has revealed that glaciers function as a natural archive of the environmental history of the planet. Analysis of the evidence contained in ice cores extracted from great depths allows scientists to infer the climatic changes that have occurred over the historic period.

Because of their low temperatures, glaciers preserve the chemical components that make up the atmosphere in each historical period. The ice samples register the impacts of natural phenomenon such as volcanic eruptions, as well as anthropogenic impacts such as the high concentration of lead at the height of the Roman Empire and the rising levels of carbon dioxide and methane dating from the start of the Industrial Revolution.

3.7.2 – BRAZILIAN ANTARCTIC PROGRAM - PROANTAR

In view of the strategic importance of this region, in 1959 several countries signed the Antarctica Treaty, through which they committed to use Antarctica only for peaceful purposes, and also committed to international cooperation for the development of scientific research. Brazil became a party to this treaty in 1975.

The Brazilian Antarctic Program (PROANTAR) was created by decree nº 86,830, of January 12, 1982. The Program is developed and implemented by the Interministerial Commission for Ocean Resources - CIRM, in accordance with the international commitments assumed by Brazil under the Antarctic Treaty. The Ministry of Science and Technology (MCT), through the National Council for Scientific and Technological Development (CNPq), is responsible for the selection and tracking of scientific activities of PROANTAR.

PROANTAR involves interrelated scientific research and activities undertaken by Brazil on the Antarctic Continent. The selection of research projects for PROANTAR is based on their relevance to scientific questions involving the Antarctic environment and the scientific competence of the researcher. The scientific emphasis of PROANTAR also takes into account the objectives and directives coming from the National Policy for Antarctic Issues (POLANTAR), and the scientific programs and initiatives proposed by the Scientific Committee for Antarctic Research (SCAR), an international body linked to the International Council of Scientific Unions (ICSU).

Logistical support for the research projects of PROANTAR is provided by the Ministry of the Navy do Brazil, involving the operation of the Oceanographic Support Ship Ary Rongel, the maintenance of the Commandante Ferraz Antarctic Station, the installation and maintenance of the shelters and camps, and transportation of researchers. These latter activities are also supported by the Brazilian Air Force (FAB).

3.7.3 - ARCTIC AND GLACIOLOGICAL RESEARCH LABORATORY (LAPAG)

The Antarctic and Glaciology Research Laboratory (LAPAG), created in 1992, is located within the Department of Geography of the Institute of Geosciences of the Federal University of Rio Grande de Sul (UFRGS), and functions as an interdisciplinary center for Antarctic research.

The principal objective of LAPAG is the introduction of glaciological science to Brazil, and is the first Brazilian group specializing in research about ice and snow. The work plan involves research activities in Antarctica and in the Andes, teaching, and advising in the Graduate Program of Geosciences and Geography.

The research is carried out in cooperation with national and international institutions, from for example the Center for Antarctic Research of USP; the Atmospheric Pollution Study Group of IF/USP, the National Observatory of CNPq; the Institute of Physical Geography of the University of Frieburg - Germany; the *Laboratoire de Glaciologie et Géophysique de l'Environnement*, in Grenoble, France; The Institute of Geography of the Academy of Russian Sciences - Moscow, and the *Laboratório de Estratigrafia Glaciar y Geoquímica de la Nieve*, in Mendonza, Argentina.

The research program of LAPAG, financed by the Brazilian Antarctic Program (PROANTAR), the National Council of Scientific and Technological Development (CNPq), and by the Coordinating Foundation of Personnel Improvement for Higher Education (CAPES), focuses on two areas:

- monitoring of the ice cover of the subpolar Antarctic islands by means of remote sensing techniques, with the objective of detecting changes in the volume of ice and establishing linkages with variations in climatic parameters;
- chemical analysis of snow and ice samples to reconstruct the South American climate over the last 2000 years.

O LAPAG undertakes field expeditions in Antarctica. In the austral summer de 1997-98, this laboratory coordinated a glaciological expedition to the ice cap of the King George Island of the South Shetland Archipelago. After the loss of 7% of the area covered by ice over the last 40 years, it was decided to implement a continuous monitoring program on the island to evaluate the impact of climate changes in the region.

3.8 - SIMPLIFIED CLIMATE MODEL

3.8.1 - THE CURRENT PARADIGM OF GLOBAL EMISSIONS

The UN Framework Convention on Climate Change was based on accounting for emissions through preparation by each country of an inventory of their anthropogenic emissions by sources and removal by sinks of all greenhouse gases not controlled by the Montreal Protocol. These inventories will provide the basis for all policies and measures established to mitigate climate change.

There are two principal reasons for using a country's emissions as the principal indicator in the Convention. First, to give policymakers a certain level of control and to establish regulations for anthropogenic emissions (or at least a part of them) based on those estimates. The goals should be established according to the emissions for a base year to the developed countries.

Second, in the case of urban atmospheric pollution or water contamination, the real emissions are normally used as a measure of the responsibility of polluters. This procedure is justified by the fact that, when the residence time of the pollutant is relatively short, the concentration of the pollutant is proportional to that of the emission[77]. The prejudicial effects are related to the concentrations of (short-life) pollutants, and as a result the emissions is a valid measure of the effect to be mitigated. However, this is not the case for the problem of climate change, because of greenhouse gases having a long lifetime. In the case of the greenhouse effect, the dependence of temperature on emissions is a complex matter.

The choice of a convenient base year is completely irrelevant from the point of view of the atmosphere, both in terms of cause and of resolving the problem of climate change, but it is recurrent in this discussion and in the Climate Change Convention. For the atmosphere, immediate action would reduce emissions or cause an increase in sinks, reducing future levels of concentrations of greenhouse gases and contributing to mitigation of climate change. The political choice of using emission levels as a basis for the Climate Change Convention is not contributing to resolving the problem of global warming from the perspective of the atmosphere.

3.8.2 - CONSTRUCTING A NEW PARADIGM

The current concentration of greenhouse gases in the atmosphere is the result of past emissions since the Industrial Revolution (the period after 1750). The current generation is bearing the burden of the effects of prior interferences in the climate system resulting from human activities over the last two centuries, especially by developed countries. By the same token, current human activities throughout the world will affect the future climate over the next two centuries.

The need to move from the basis in annual emissions to another indicator that could better reflect the problem of global warming was identified by the Brazilian delegation in the meetings of the convention from 1992 to 1996. The fundamental point was to relate net anthropogenic emissions to the resulting climate change, and define a single measure for global climate change.

The idea was that, using as a basis the results of a General Circulation Model, it would be possible to establish a very simplified model (simpler than a box diffusion model) that would take into account the entire essence of the problem of global warming. This model would be based on the essential description of the problem, ignoring irrelevant details, and describing the relations between greenhouse gas emissions and climate change. The parameters for this essential model should be defined using the results obtained by supercomputer models, ensuring that all the complexities of the GCMs are duly taken into consideration.

As a first approximation, atmospheric concentrations on emissions during a certain period of time are directly proportional to the accumulation of the emissions up to the year in question. However, the older the emission, the less is its effect on concentration, because of the exponential decay of greenhouse gases in the atmosphere, with each gas having a different lifetime.

The physics of radiative forcing indicates that the rate of deposition of energy on the earth's surface – the warming itself – is directly proportional to the concentration of the greenhouse gas.

The increase in temperature of the global surface is approximately proportional to the accumulation of radiative warming over time. Radiative warming is, in turn, proportional to the atmospheric concentration of greenhouse gases. As a result, the increase in temperature is proportional to the accumulation of atmospheric concentrations of greenhouse gases.

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[77] Most of the arguments of this section are included in the document "Proposed Elements for a UNFCCC Protocol", presented by Brazil in response to the Berlin Mandate, submitted on May 28th, 1997, FCCC/AGBM/1997/Misc. 1/Add.3

Thus, the idea of the Brazilian delegation was to demonstrate that a very simple method of calculation could be used instead of complex climatic models, further maintaining the correct functional dependency between the increase in average surface temperature and the emissions over a period of time. This proposal address the central question of the relationship between the greenhouse gas emissions of the Parties over a period of time, and the effect of their emissions in terms of climate change, measured in terms of the increase in average temperature of the earth's surface.

3.8.3 - THE BRAZILIAN PROPOSAL

The Brazilian document titled "Proposed Elements of a Protocol to the United Nations Framework Convention on Climate Change, submitted in May of 1997 in Response to the Berlin Mandate", presented two elements for discussion in relations to the Berlin Mandate process. The first element was to establish the individual responsibility of countries in terms of causes of the greenhouse effect. The second element established the idea of a Clean Development Fund to replace the unpopular concept of joint implementation at the time and put an end to the North-South impasse that was growing during the process. The quantification of the principal of common but differentiated responsibilities was one of the basic goals underlying the proposal.

The first problem faced in writing the proposal to go from causes (emissions) to effects (global warming) was the establishment of objective criteria to measure climate change.

It thus became of paramount importance to establish the relation between net anthropogenic emissions and the resulting climate change. Recognizing that climate change must have a complex geographic distribution, it would be important to have a single measure of global climate change.

The variable chosen to measure climate change was the change in average temperature of the earth's surface. Other consequences of climate change that could be used as a variable, such as the rate of change in average temperature of the earth's surface, and the increase of average sea level, are derived from the change in average temperature of the earth's surface.

This criteria is intimately linked to the physical reality of warming caused by the greenhouse effect, a property which is not applicable to absolute emissions, which are an instantaneous "snapshot" of a situation in an arbitrarily chosen year. In addition, the average temperature of the earth's surface can be used as an indicator of global warming, and the attribution of responsibility of each country can be made in terms of its relative contribution to the total temperature increase. The heart of the model corresponds to a process of double accumulation that is the essence of global warming. The accumulation of emissions increases concentrations and for each annual level of concentrations, the accumulation of radiative forcing increases the temperature (average over the earth's surface).

The change in temperature is also an objective measure of climate change, since it can be argued that the prejudicial effects of climate change are in some direct proportion to this change.

It should be noted that remaining uncertainties in current knowledge of the absolute value of forecast temperature change do not affect the conclusions about the relative contribution of countries. This is reflected, for example, in the margin of uncertainty regarding climate sensibility (it is known that the change in temperature resulting from doubling the carbon dioxide concentration is between 1.5 and 4 degrees Celsius). Future improvements, to the extent that they progressively reduce the uncertainties, can be easily incorporated by updating the calibration constants of proportionality in order to improve the precision of the absolute results, without prejudice to the figures for relative contributions.

By reconstructing a series of anthropogenic emissions by sources and removals by sinks of greenhouse gases in all sectors in the past, it is possible to calculate the relative proportion of the total temperature increase that can be attributed to each individual country. Therefore, the estimate of relative responsibility of a given country for causing global warming can be provided, even given the current uncertainty of the absolute increase in temperature that can be attributed to the enhanced greenhouse effect alone.

Given that the Convention contains the crucial principal of common but differentiated responsibility, the Brazilian proposal provides an objective criteria for differentiation of responsibilities, along with a means for quantifying the relative responsibility of developed countries in relation to developing countries as a result of their contribution to atmospheric concentrations of greenhouse gases at the time the Convention was negotiated[78].

3.8.3.1 - Evaluation of the relative responsibility of the Annex I countries compared to the non-Annex I countries

Using this simplified approach, an evaluation of the relative responsibility of Annex I countries compared to the non-Annex I countries over the period until 2200 was carried out, taking into consideration the concentration estimated in 1990 as being attributable to both groups of countries. Published historical data about CO_2 emissions from the energy and cement sectors for each country in the period from 1950 to 1990 were used[79], together with a retroactive extrapolation to the period prior to 1950, to estimate the atmospheric concentrations in 1990.

The effect of the emissions of other greenhouse gases was not considered because of a lack of available data. However, this effect is known to be small if compared to that of carbon dioxide, according to the Second Assessment Report of the IPCC. In addition, the relatively short residence time of methane in the atmosphere tends to reduce the importance of the historical emissions of this gas. For these reasons, carbon dioxide emissions from the energy and cement sectors are likely a good proxy for the estimate of the increase in average global surface temperatures for the purposes of evaluating the relative responsibilities of Annex I and non-Annex I countries.

The conclusions demystify the relevance of the discussion about the year in which the emissions of Annex I and non-Annex I countries become equal, because in this hypothetical year the responsibility for causing global warming will still be largely attributable to the Annex I countries.

A process is being developed under the Subsidiary Body for Scientific and Technical Advice to consider the Brazilian proposal (see www.unfccc.int/issues/ccc.html). Various countries have also established groups of scientists to analyze the proposed new approach. Much work needs to be done in order to create a consensus about a measure for climate change that takes into account both equity and responsibility, and which will be accepted by all countries.

[78] The estimate of the contributions of each country to the initial concentrations in 1990 could take into consideration the differences in starting points of each Party, as mentioned in Article 4.2 of the Climate Convention.

[79] These data were obtained from the Oak Ridge National Laboratory in the U.S. This is a far-ranging and high-quality collection of data. The current set of available data was improved after the submission of the Brazilian Proposal. See the Internet site http://cdiac.esd.ornl.gov/

4 - EDUCATION, TRAINING AND PUBLIC AWARENESS

According to Article 4.1 (i) of the Convention "all parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, shall … Promote and cooperate in education, training and public awareness related to climate change and encourage the widest participation in this process, including that of non-governmental organizations."

Since Brazil was the host country of the Earth Summit, Brazilians have a general notion of issues of global warming and of the hole in the ozone layer. But in general, people are not very aware of climate change or of the Climate Convention. This is a very complex e technical issue, difficult for non-specialists to understand. Also, there is very little written material available in Portuguese (the Brazilian national language), even for specialists. The initial attempts to mobilize institutions and specialists were very difficult, because of the lack of knowledge about the Brazilian obligations in the Convention, related legislation and the costs and benefits involved for the participating institutions.

Despite these difficulties, there have been attempts to expand education, public awareness and training regarding issues related to climate change.

Several educational programs implemented in Brazil are in accordance with the objectives of the Convention. Of special note are the National Environmental Education Program (PRONEA) and the National Environmental Education Policy (PNEA), which has a broad program of environmental education in Brazil. Also of great importance are the programs "PROCEL in Schools" and "CONPET in Schools", directed especially at children and adolescents through partnerships with teaching institutions. Their objectives are to expand the awareness of professors and students about the importance of using electricity, petroleum derivatives and natural gas in the best manner and to widely promote actions towards this end.

The Brazilian Climate Change Forum (FBMC), created in 2000 and chaired by the President of the Republic, seeks to promote the awareness and mobilization of society about global climate change, through carrying out a range of activities in this area.

The Brazilian Internet site on climate change has contributed to the increase of public awareness about the issue in Brazil, through making available information about the entire process of negotiation for the Convention, the principal references about climate science, and the current state of preparation of the National Communication. Furthermore, some publications in Portuguese (such as the Portuguese version of the official text of the Convention and the Kyoto Protocol), articles from newspapers, magazines and journals, and organization of seminars and presentations have helped in generating awareness of an issue that until a short time ago was totally unheard of in Brazil.

4.1 - ENVIRONMENTAL EDUCATION

4.1.1 - HISTORY

Article 225, Paragraph 1, VI, of the Constitution states that: “All persons have the right to an ecologically balanced environment, which is an asset of common use and essential to a healthy quality of life, and both the Government and the community shall have the duty to defend and preserve it for present and future generations (…) In order to ensure the effectiveness of this right, it is incumbent on the Government to (…) promote environmental education at all school levels and public awareness of the need to preserve the environment.”.

The development of the concept of environmental education raised the need to create a political instrument in Brazil for such activities. In 1994, the Ministries of Environment (MMA), Education (MEC), Culture (MINC) and of Science and Technology (MCT) produced the National Program of Environmental Education (PRONEA), thereby meeting a constitutional requirement, along with international commitments assumed by Brazil.

4.1.2 - DIRECTIVES DO NATIONAL ENVIRONMENTAL EDUCATION PROGRAM (PRONEA)

The activities of PRONEA are organized around two perspectives: the first, devoted to the deepening and systematization of Environmental Education for current and new generations, delivered through the school system; and the second oriented to good environmental management, seeking to create public awareness and the production of appropriate information throughout society. Priority is given to reaching three publics:

- Public consisting of decision-makers in organizations and those with capacity to influence decisions that affect environmental issues, including public administrators, parliamentarians, members of the Judiciary and the Public Prosecutors’ Office (*Ministério Público*), liberal professionals, scientists, private leaders of the business sector and social movements, etc.;
- Public consisting of users of natural resources, including farmers, loggers, fisher folk, prospectors, miners, and participants in other extractivist activities;
- Public consisting of those working in communication media and social communicators in general, including the spoken, written and televised media, cinema, theatre and other forms of Brazilian art and culture.

Although there is a felt need to reform this program, it continues in force, and should made compatible with the 1999 law nº 9.795, that created the National Environmental Education Policy.

4.1.3 – GUIDELINES OF THE NATIONAL ENVIRONMENTAL EDUCATION POLICY (PNEA) AND LINES OF ACTIVITIES

Sanctioned by the President of the Republic on April 27, 1999, lei nº 9.795 "addresses environmental education, institutes the National Environmental Education Policy, and contains other provisions." The law recognizes environmental education as an urgent, essential and permanent component in the entire educational process, formal and non-formal, as recommended by Articles 205 and 225 of the Federal Constitution.

The National Environmental Education Policy is a programmatic proposal for promoting environmental education in all sectors of society. In contrast with other laws, it doesn't establish rules or sanctions, but establishes responsibilities and obligations.

In defining responsibilities and forming part of the agenda of the various sectors of society, the National Environmental Education Policy institutionalizes environmental education, legalizes its principals, transforms it into an object of public policies, and provides society with an instrument for demanding the promotion of environmental education. Finally, the Environmental Education Policy legalizes the requirement to address environmental issues in a transversal manner, as proposed by National Curriculum Parameters and Guidelines[80].

The Secretariat of Basic Education of MEC, through the Environmental Education Coordination Office (COEA), has the mission of formulating and proposing quality policies for basic education to support the state and municipal school systems, promoting and expanding the possibilities of students to exercise their rights as citizens.

Created in December of 1988, COEA has among its functions that of encouraging the integration of the transversal theme of environment in school educational projects, stimulating activities that improve teacher training and diversified learning on the part of students, in order to provide them with tools to position themselves in regard to national and global environmental issues.

To achieve its missions, COEA, in accordance with the National Environmental Educational Policy, defined two priority activity areas:

- environmental education projects in school life;
- integration of environmental issues in the basic education disciplines.

These activity areas are based on four basic strategies:

Institutionalization of environmental education: this strategy seeks to universalize environmental education in basic teaching, making its presence in schools more concrete. To achieve this objective, it is important to ensure the continuity and permanence of actions in accordance with Article 2 of Law # 9795, of 1999: "Environmental education is an essential and permanent component of national education, and should be present in a coordinated manner at all levels and modalities of the education process, in both a formal and informal manner". Thus, the institutionalization also means ensuring coherence and continuity in the commitment of the Ministry of Education (MEC) to Environmental Education activities.[81]

Information: the production and availability of environmental information, the dissemination of knowledge and technologies and the assembly of a databank are the activities linked to environmental education, as set out in Article 8 of Law # 9795, of 1999. The guarantee of democratization of information in the area of environmental education provides quality content, ensures equality of access to knowledge, and contributes to building capacity of professionals of environmental education in formal teaching.

[80] For one year the Environmental Education Technical Group of CONAMA, at the time chaired by COEA/MEC discussed proposals for regulating the law. On June 25, 2002, the Regulation of Law # 9795 by Decree # 4281 was signed by the President of the Republic.
[81] The Brazilian Information System for Environmental Education and Sustainable Practices has been implemented since 2002 and can be accessed at the website http://www.mma.gov.br/port/sdi/ea/index.cfm

Coordination: institutional coordination is one of the responsibilities of COEA, as a federal institution, which ensures the participation and coordinated work of partners, encouraging cooperation between the various regions and institutions of the country, as proposed by Law # 9795, of 1999.

Training of professors: ongoing training for professors of basic education is the basic policy of the Secretary of Basic Education (SEF), as set out in the Law of Guidelines and Foundations of National Education, # 9394, from December 20, 1996 (Article 67, II). PNEA emphasizes ongoing training as one of the fundamental strategies for implementing environmental education (Article 8, Para. 2, I).

4.1.4 - OTHER INITIATIVES

4.1.3.1 - National Curriculum Parameters

The proposal for the National Curricula Parameters of the Ministry of Education identifies the environmental dimension as a transversal theme and having and interdisciplinary approach. It emphasizes the need for creation of aware citizens, able to decide and act in the social and environmental reality with a commitment to life and the well-being of each person and of society, at the global and local level. This requires that the school, along with having information and ideas, works towards the creation of values and com o development of abilities and behaviors that embody a new ethic in the interactions with the environment.

4.1.4.2 - Project of Training, Support (OR Monitoring??) and Development of Educators in Environmental Education

The Project of Training, Support and Development of Educators in Environmental Education, under the responsibility of Environmental Education Coordination Office of MEC and the National Environmental Education Program Directorate of MMA, is carried out under the Brazil-UNESCO Agreement, with the objective of supporting the consolidation and development of Environmental Education in Brazil, in formal and informal contexts.

4.1.4.3 – Supporting Integrated Environmental Education Projects

The goal of the activity “Supporting Integrated Environmental Education Projects”, carried out by the National Environmental Fund (FNMA) is to support integrated projects that pursue community awareness and education, capacity-building and training in pursuit of environmental protection and conservation. This activity is carried out through the thematic line of FNMA – Environmental Education, which is divided into three sub-lines: construction of local/regional Agenda 21 (see section 7.2), construction of institutional and community environmental agendas, and environmental education for sustainable development.

4.2 - EDUCATIONAL PROGRAMS IN ELECTRICITY CONSERVATION AND RATIONAL USE OF DERIVATIVES OF PETROLEUM AND NATURAL GAS

4.2.1 - "PROCEL IN SCHOOLS"

4.2.1.1 - History

Among the diverse activities developed by PROCEL, one is specially directed at children and youth, through teaching institutions. This is called "PROCEL in Schools".

With the signing of a Technical Cooperation Agreement between the Ministry of Mines and Energy (MME) and the Ministry of Education (MEC) in December of 1993, the guidelines were established for the activities of "PROCEL in Schools", including to:

- train Brazilian teachers at the primary and secondary (technical and trade school) education levels to work with their students in all aspects of fighting waste of electricity, including the professors and students of National Industrial Training Service (SENAI) and National Commercial Training Service (SENAC);
- develop educational and teaching materials about energy, to be distributed free of charge to teaching staff and students;
- establish a way to involve students of institutions of medium and higher learning in using technological resources in fighting waste of energy and changing habits of its use.

To achieve these objectives, PROCEL formed a partnership with the Environmental Education Program called "A Natureza da Paisagem" (The Natural of Landscape), developed by the Center for Culture, Information and the Environment and raised to the status of an official program of UNESCO. This program was, therefore, adapted to the themes of Energy and Prevention of Waste, becoming "A Natureza da Paisagem - Energia"(The Natural of Landscape - Energy) This methodology has, along with the fundamental principals, specific processes for implementation, monitoring and evaluation.

The implementation of the project "PROCEL in Schools" in the area of education (in the municipal or state spheres) is to be carried out in an institutional manner, such that the project develops freely, without interference from political changes that could obstruct its development.

The implementation of the project involves:

- raising awareness in the area of education (Secretariats of Education, Associations Private Schools (SINEPE's), SENAI, SENAC, etc.), with the presentation of the Brazilian energy scene, the methodology of "The Nature of Landscape – Energy" and teaching material;
- establishment of a technical cooperation agreement between the electrical energy concession-holders and the education area;
- identification of schools that will participation in the activities (competence in the area of education);
- definition of the involvement of school directors (competence in the area of education);
- definition of the teachers who will participate in the course (3 professors from each school, in each program, who will lead the class. In each school, at least 9 teachers should receive upgrading in order to make possible "interdisciplinarity");
- holding a course for the professors (12 hours class time), and collecting the registry of the school.
- establishment of the process of monitoring and evaluation, using specific software for this purpose.

The teaching material is offered free of charge to the schools, to the attention of their directors, through a letter of commitment, and remains available to professors and students, in sufficient quantity for three groups of 45 students to work simultaneously.

4.2.1.2 - Current Situation

"PROCEL in Schools" is, currently being expanded to the entire country. Initially the expansion activities were focused on public schools, because of the ease of creating technical cooperation agreements with the Secretariats of Education, at both the state and municipal levels. Private schools should officially enter the program "PROCEL in Schools" upon the signing of an agreement for technical cooperation between Eletrobrás/PROCEL and the Interstate Federation of Private Schools (FIEP). Already 24 states of the Federation and the Federal District participate in the Program.

"PROCEL in Schools" also participates in meetings, seminars and other events outside the area of education, as another way of using the methodological resources to create public awareness.

In addition, MEC has indicated the need to expand the range of information about energy waste reduction that goes to teachers, using its SCHOOL TV to teach at basic and technical education levels.

To meet this demand, "PROCEL in Schools" is working on the content of the methodology "The Nature of Landscape – Energy", to develop the televised courses jointly with the Roberto Marinho Foundation, which will have guaranteed play on TV Futura, a cable TV channel.

Table 26 - Results of PROCEL in Schools

	Students Trained
1989-1994	800,000
1995-1997	791,375
Total	1,591,375
Total energy saved	84 kWh/year/student[82]
1997	33.5 million kWh/year
1989-1997	133.67 million kWh/year – accumulated

4.2.1.3 – Prospect for the Program

Ongoing implementation of "PROCEL in Schools" techniques in secondary schools

This program includes the following activities:

- use of a course of "Energy Efficiency" appropriate for secondary school technical students, with 40 hours of course work, to cover the areas of Eletrotechnology and Electronics, and Mechanical and Civil Engineering.

[82] Verified by monitoring the electricity bills of families of the students for some months after completion of the course.

- provide appropriate teaching material for students and teachers, so that they can carry out their work with reliable reference sources;
- permanently cover the areas cited of all the Federal Technical Schools and Federal Centers of Technological Education (CEFETs);
- transform to teacher into a central element in the expansion of pilot projects, with responsibility for transmitting to students the issues related to fighting energy waste;
- train other teachers in the principal technical schools and CEFETs of Brazil so they can continue and expand the work of implementing the course “Energy Efficiency” in these schools.

The program is also involved in the development of support materials for each area and the organization of content for the course “Environment and Energy Waste”.

Implementation continues of “PROCEL in institutions” of higher education

PROCEL’s work with institutions of higher education began with a pilot project in UFRJ in 1995, which consisted of offering undergraduate students in electrical, electronic, mechanical and production engineering programs a course in “Conservation and Efficient Use of Energy”, with 60 hours of class time.

4.2.2 - “CONPET IN SCHOOLS”

"CONPET in Schools” is an education project that forms part of the National Program for Rationalization of the Use of Petroleum Derivatives and Natural Gas (CONPET). It was created in order to transmit to teachers more information and knowledge about petroleum, its derivatives and natural gas, as well as concepts involving the rational use of these energy sources, along with expanding the universe of knowledge of students, raising awareness of the importance of issues related to society, nature and the preservation of natural resources and the environment, stimulating them to be a defender of the rational use of these resources and in particular petroleum derivatives and natural gas. The program is broad and involves students from elementary and secondary schools in the public and private school systems.

4.2.2.1 - Methodology

The methodology, successfully used since 1992, consists of working with the professor and not directly with students, which along with being more efficient, makes the process permanent.

Thus the professor is offered a upgrading program about petroleum, its derivatives and natural gas, in order to generate awareness and engagement with the project, and to facilitate the development of the issue in the classroom. The course is offered to a specific group of professors from each school, who participate voluntarily, and are responsible for multiplying the knowledge received to the other professors and for the interdisciplinary coordination of the issue.

4.2.2.2 - Implementation

The project is implemented according to the following principal stages:

- definition of schools involved, number of students and teachers;
- meeting with directors to inform them about CONPET;
- presentation of the project in a talk to directors and professors;

- visit to a Petrobras facility to learn about the operations of a petroleum industry, with talks and showing of films;
- upgrading course of 16 hours for professors addressing rationalization of the use of petroleum products and natural gas with a theoretical and practical approach to the issues, with classroom experiments;
- provision of school kits with support material necessary for the implementation and monitoring of the project;
- work of professors with students in the production of written assignments and projects in pursuit of energy conservation, wherever possible analyzing everyday real-life situations;
- holding events such as science exhibitions and fairs, with student presentations of posters, murals, models, dramatization, etc.;
- evaluation of the knowledge acquired by students and confirmation of changes in attitudes on the part of the professor;
- awarding of certificate to professors that participated in the project.

4.2.2.3 - Form of Participation

Implementation of the project “CONPET in Schools” is decentralized, participative and open to all teaching institutions in the country, both public and private. The institutions interested in participating should sign an agreement for technical cooperation with CONPET. The results of the program up to 1998 are presented in the table below:

Table 27 – Results of CONPET

State	Municipalities	Schools	Teachers	Students	Kits distributed
Bahia	164	724	1,927	504,800	724
Mato Grosso do Sul	10	110	178	68,100	110
Rio de Janeiro	47	381	982	243,857	381
São Paulo	7	24	63	12,000	24
TOTAL	228	1,239	3,150	828,757	1,239

4.3 – BRAZILIAN CLIMATE CHANGE FORUM

Decree # 3515, of June 20, 2000, created the Brazilian Climate Change Forum (FBMC), which is chaired by the President of the Republic, with the objective of building awareness and mobilizing society about the issue global climate change.

Brazilian non-governmental organizations, the private sector and the academic community have expressed interest in expanding the discussion of the issue, in order to allow a greater integration of the various social actors, increase awareness of society about the challenges that the issue of climate change involves and also about the opportunities it brings, in particular by the potential transfer of resources to the country through the Clean Development Mechanism artigo 12 do Protocolo de Quioto à Convenção-Quadro das Nações Unidas sobre Mudança do Clima.

Thus, the objective of the Brazilian Climate Change Forum is to be a public venue for debates about the issue. The FBMC seeks to build awareness and mobilize society for the discussion and decision-making about the problems resulting from changes to climate caused by greenhouse gases, as well as about the Clean Development Mechanism (CDM).

The Forum has the participation of the Ministers of State for Agriculture and Food Supply; Science and Technology; Development Industry and External Trade; Finance; Environment; Mines and Eenrgy; Planning, Budget and Management; External Relations; Health; Transport; Education; Defense; and the Chief of Staff (Casa Civil) of the Presidency of the Republic [83]; as well as figures and representatives from civil society, to be designated by the President of the Republic, with recognized knowledge, or who are agents with responsibility for climate change. Also invited to join the Forum are the Chairs of the Chamber of Deputies and of the Federal Senate, state Governors and Mayors of the state capitals.

The Forum will maintain a permanent integration with the Interministerial Commission on Climate Change, for the adoption of measures necessary to the implementation of its decisions.

The Forum can create, under the coordination of any participant, issue working groups, either permanent or ad-hoc, which bring together the various economic social and techno-scientific sectors of the country with responsibility for the implementation of measures related to the UN Framework Convention on Climate Change. These issue working groups will have technical support from the following Federal government bodies: National Electrical Energy Agency (ANEEL), National Petroleum Agency (ANP), Brazilian Central Bank (BCB), Brazilian Development Bank (BNDES), Brazilian Securities Commission (CVM), Studies and Projects Funding Body (FINEP), Brazilian Institute for Geography and Statistics (IBGE), Institute for Applied Economic Research (IPEA), National Institute for Space Research (INPE), National Waters Agency (ANA)[84], and other governmental bodies or entities maintained with public resources.

The Forum also intends to stimulate the creation of State Climate Change fora, and will hold public hearings in various regions of the country.

Like the procedures adopted in relation to the Commission, administrative support and the means necessary for carrying out the work of the Forum and the issue working groups will be provided by the Ministry of Science and Technology.

The creation of the Brazilian Climate Change Forum shows that Brazil intends to maintain its position of global leadership in relation to global environmental issues, following the example of the United Nations Conference on Environment and Development, held in Rio de Janeiro, in 1992.

Since its creation, FBMC has organized various activities and disseminated information in various areas related to the issue of global climate change, as can be seen on the site www.forumclimabr.org.br.

4.4 - RAISING AWARENESS OF CLIMATE CHANGE ISSUES IN BRAZIL

4.4.1 - BRAZILIAN CLIMATE CHANGE HOME PAGE ON THE INTERNET

[83] According to the decree of November 14, 2000, which amended Decree # 3515, of June 20, 2000.
[84] Idem

The construction of a site on climate change on the World Wide Web, begun in September of 1995 in the very early days of the Internet in Brazil, was a pioneering, innovative and important idea which has assisted the development of the Brazilian National Communication and contributed to the increase in public awareness of the issue in Brazil. The site (www.mct.gov.br/clima) therefore constitutes an important tool for the implementation of the Brazilian commitments assumed under the Climate Convention.

The importance of this idea was recognized by the Secretariat of the Convention, which developed the program CC:WEB for dissemination of the Brazilian model for other developing countries. Also, the Brazilian site served as the basis for the page of the Secretariat itself.

Reflecting the entire process of preparation of the National Communication, the site brings together and makes available information generated by a wide range of institutions and specialists involved in the preparation of the inventory and documents for the National Communication, including the name and contact information for each specialist involved and responsible for the preparation of each document.

The divulgation by Internet of all this material increases the quality and reliability of the work, ensuring transparency and enabling the participation of specialists not directly involved in the process, but who wish to make comments and criticisms.

The Internet has also enabled permanent contact between specialists (via email), facilitation the collective development of the work, shortening distances, reducing costs and the need for meetings and travel, and also facilitating the interaction between specialists from different sectors, allowing them to share experiences about different approaches.

Thus, the Climate Change Site on the Internet has strengthened the capacity of the coordination agency and helped to decentralize the preparation of the National Communication, enabling the total involvement of all the relevant institutions, independent of their location.

Along with the work related to the preparation of the National Communication, the Site has also become a meeting point, open 24 hours per day, for the discussion of issues related to climate change, and has clearly established a formal channel to bring together and disseminate information.

The site enables important texts to be made available throughout Brazil in the national language, with the entire text of the Convention and the Kyoto Protocol, documents related to the negotiations under the Convention, especially decisions of the Conferences of the Parties, as well as documents, speeches and proposals that reflect the Brazilian position. Along with this, it points to information on other sites on the Internet related to climate change which is considered relevant, with levels of knowledge ranging from information for newcomers to the issue to detailed scientific information (such as the IPCC reports).

Links were made to the home pages of Brazilian and international institutions that lead the public directly to issues related to the area, sparing people from having to go through the complex process of navigating to the institutional home pages. For Brazil there are links that go directly to maps of burning in the Cerrado (within the Embrapa site) and to satellite images of the Amazon forest (within the INPE site). There are also links to environmental issues (for example, Agenda 21, the Montreal Protocol, and the Biodiversity Convention).

Along with being a place where information is disseminated, the home page is also a place where additional information can be obtained, because it provides information the roles and responsibilities of the coordination office, indicates who is who in the office and tells how people can make requests and forward questions. The Internet has proven an effective means for putting the external public in direct contact with the Coordination office, which has responded to questions from students, journalists and professionals from other areas interested in obtaining information about climate change and about the implementation of the Convention in Brazil.

Presented in three languages[85] ? Portuguese, Spanish and English ? the Brazilian climate change site goes beyond the Brazilian public, and has become a point of reference internationally, allowing Brazil to take part in the global debate around climate change.

By February 17th, 2000, there were around 3000 pages available in three languages, as shown in the following table:

Table 28 – Number of Pages on the MCT Homepage

	Portuguese	English	Spanish	Total
Number of Pages	992	952	976	2920
Size	4862.5 KB	4800.9 KB	4702.8 KB	14,366.2 KB

In general, the use of the Internet has contributed to ensuring the quality of work, facilitating environmental awareness, increasing efficiency, permitting a better dissemination of information and a greater impact of the Convention and its implementation in Brazil. This effort, however, has limitations, such as the availability of access to the Internet in Brazil, which is currently restricted to a small part of Brazilian society. But the network is evolving rapidly (with an estimated 11.6 million Brazilian users in 2001, or around 8% of the population), which means the work begun in 1995 has only just begun to bear fruit.

4.4.2 - PORTUGUESE VERSION OF THE OFFICIAL DOCUMENTS OF THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE AND OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

As explained above, one of the greatest difficulties encountered in expanding awareness of issues related to climate change in Brazil is the scarcity of written material available in Portuguese. Obviously, overcoming this difficulty requires time and resources.

Thus, following a process of establishing priorities, the translation and publication in Portuguese of the official text of the Convention was a natural choice as the first step in disseminating the issue of climate change in Brazil. In 1996 the text was translated and published in Brazil by the Ministry of Science and Technology and the Minister of Foreign Relations. With the support of the Permanent Secretariat of the Convention, the text was published by the Information Unit on Climate Change (UNEP/IUC), with an initial print run of 3000 copies.

In the year 2000, with the creation of the Climate Change Program of the Federal Government, the text of the Kyoto Protocol was translated and published in Portuguese by the Ministry of Science and Technology and the Ministry of Foreign Relations. With the support of the United Nations Development Program (UNDP), the text was published with an initial print run of 3000 copies.

[85] In 2002, an agreement was signed with the Interministerial Climate Change Mission (*Mission Interministérielle de l´Effet de Serre*) of the French Government to finance the French language version of the *homepage* Global Change Coordination Office.

Also translated were the report of the “Second IPCC Assessment – Climate Change 1995” and the publication “Climate Change 1995 – The Science of Climate Change”, containing a summary for policy-makers and a technical summary of the report of the IPCC Working Group I.

The Portuguese translation of these documents is available in electronic format on the site of the Global Change Research Coordination Office (www.mct.gov.br/clima). This translated version is the key instrument in generating public awareness and understanding of the issue not only in Brazil, but also in other countries that have Portuguese as their mother tongue (Portugal, Angola, Mozambique, Guinea-Bissau, Cabo Verde, São Tomé and Príncipe, East Timor).

4.4.3 – RESEARCH IN AWARENESS ABOUT CLIMATE CHANGE

The Climate Awareness Program (CAP) was created by the United Nations Environment Program (UNEP) to provide assistance to all the Parties not listed in Annex I of the Climate Convention in accordance with article 4.1 (i), in which all Parties have committed to “Promote and cooperate in education, training and public awareness related to climate change and encourage the widest participation in this process, including that of non-governmental organizations”, and in the implementation of article 6 of the Convention, which established that, in carrying out their commitments under article 4.1 (i), the parties shall “promote and facilitate … the development and implementation of educational and public awareness programs on climate change and its effects”. It also calls on the Parties to “Cooperate in and promote, at the international level and, where appropriate, using existing bodies … the development and exchange of educational and public awareness material on climate change and its effects.” However, progress has not been made towards the idea of this program.

Although the program has not been implemented, between March and July of 1998 the Global Change Research Coordination Office of the Ministry of Science and Technology carried out research to analyze and identify the particular circumstances and necessities of Brazil.

The research examined the questions of the context where awareness of climate change should occur, what the target public should be, the most effective media or channels for reaching them, and the possible partners of CAP.

The principal issues raised in the research were:

Level of awareness about climate change, with an analysis of four questions:

It was revealed that there was an excellent level of awareness about climate change among the interviewees, being below only the level of awareness about climate variation/extreme events and HIV/AIDS. The high level of awareness about the Climate Change Convention was surprising, and was even higher that the level of awareness about the issue of global warming itself.

It was found that the four questions considered most important affecting quality of life in Brazil are the poor distribution of income, unemployment, increasing crime and violence, and illegal drug use.

The research results confirm the idea that climate change is not seen as a priority issue by interviewers, in light of the greater priority given to social issues in the current situation of the country.

The responses indicate a good level of general knowledge, despite the confusion between destruction of the ozone layer and issues related to climate change.

There is a clear political division of opinions: half of the interviewees were opposed and the other half was in favor of emissions reduction commitments for developing countries. But both sides recognize that economic development can be achieved simultaneously with environmental protection.

For the question of who the target public should be in any awareness-raising program, it was shown that a higher priority was attributed to business leaders and government employees, followed by journalists and civic leaders. It should be noted also that schoolteachers had an average that was close to the groups given the highest priority. Students, whether at the university level of secondary school level, were considered as the lowest priority target public for an awareness program.

The most important issues related to climate change in Brazil are, in order of decreasing importance:

Energy Sector

All interviewees mentioned the energy sector as being one of the most important issues related to climate change, recognizing the consequences of our electricity matrix — mostly hydro — for national water resources and the effects of mitigation measures on the development of the energy sector.

Forests

The relevance of this question derives principally from the Brazilian contribution to greenhouse gas emissions resulting from deforestation in the Amazon, rather than from fossil fuel consumption. The issue of deforestation is not only of concern to many Brazilians, but also an important political issue because of international pressure in international forums.

Extreme Climatic Events

Concerns were also raised about the effects of climate change on extreme climatic effects, especially floods and droughts. Concerns were expressed in the interviews about the effects of climate change on top of the Brazilian climatic conditions, which represent the greatest relative interannual variability in the world.

Biodiversity

Biodiversity was also identified as one of the most important issues, since one of the principal characteristics of the country is its great diversity of natural resources. Therefore, mention was made of the need to adopt agricultural and forestry practices that do not generate negative climatic impacts and that preserve biomass and biological diversity in Brazil, with an emphasis on the need for these practices to be compatible with environment preservation.

Water Resources

This question is intimately related to issues in the energy sector, since the Brazilian electricity matrix consists basically of hydroelectricity. Along with this, there has been a growing awareness about the seriousness of the “global water crisis” and its effects of day-to-day life of all citizens. Another issue raised was the increased temperature caused by the El Niño phenomenon and its effects, such as increased flooding in the South of Brazil and droughts in the Northeast.

Desertification

As mentioned by one interviewee, more than 1 million km^2 of Brazilian territory is undergoing a process of desertification and another 100,000 km^2 is in serious condition. Another stated that desertification resulting from long summers and droughts could also increase in the Northeast region of Brazil.

4.4.4 - OTHER ACTIVITIES

4.4.4.1 - Publications

With the objective of expanding the amount of material about climate change in Portuguese, between 1997 and 1999, the Global Change Research Coordination Office, with the support of partners, carried out the following activities:

- Publication of the results of the Workshop “Exchange of Latin American Experiences with Preparation of National Communications”, held in Itaipu from September 30 to October 2, 1997;
- Publication of the report “Inventário Nacional de Emissões de Metano pelo Manejo de Resíduos”, in partnership with the Government of the State of São Paulo, Environmental Secretariat, CETESB, PNUD, US Country Studies and MCT, 1998;
- Publication of the Proceedings of the Workshop “Global Climate Change and Brazilian Agriculture”, held in Campinas, São Paulo, 16 - 17 of June, 1999;
- Publication of the book “Energy Efficiency – Integrating Uses and Reducing Waste”, in partnership with the National Electrical Energy Agency (ANEEL), the National Petroleum Agency - ANP and the Ministry of Science and Technology - MCT, 1999;
- Publication of the book “The State of Water in Brazil” (1999): Perspectives on Management of and Information about Water Resources”, in partnership with the National Electrical Energy Agency (ANEEL), the Ministry of Mines and Energy (MME), the Ministry of Environment (MMA) and the Ministry of Science and Technology (MCT), 1999;
- publication of 900 copies of the Primer “The Greenhouse Effect and the Convention on Climate Change”, in partnership with the National Development Bank (BNDES), 1999.

4.4.4.2 - Seminars and Debates

Between 1997 and 2000, around 150 events were held in Brazil related to climate change, including two IPCC events (about article 2 of the Convention, held in Fortaleza in 1994; e about “Good Practice in Inventory Preparation – Emissions from Waste”, held in São Paulo, in 1999). At first these events were primarily held at the initiative of agencies linked to the Federal Government. However, the partnership between universities and research institutes, established in the quest to overcome the methodological difficulties found in the survey for the Brazilian inventory of emissions, has stimulated interest of these bodies in sponsoring events on the issue. Also, the process of developing rules for the Clean Development Mechanism has led to great interest on the part of corporate leaders and sectoral association, which have also held seminars, courses and debates on the issue.

4.4.4.3 - Magazines and Newspapers

The Brazilian media has been gradually becoming more attentive to the issue of climate change, and the number of articles in newspapers and magazines on the issue has increased considerable. The national press has covered the issue more attentively since the negotiations for the Kyoto Protocol, especially as a result of the presentation by the Brazilian delegation of the Elements of a Protocol for the United Nations Framework Convention on Climate Change, better known as the “Brazilian Proposal”, in response to the Berlin Mandate. The process of developing rules for the Clean

Development Mechanism, which originated in the Brazilian Proposal, and the implications of this instrument in the Brazilian political and economic scenario, has led to increasing interest on the part of the media.

Table 29– Number of articles in magazines and large circulation newspapers in Brazil mentioning the problem of climate change.

Year	1995	1996	1997	1998	1999	2000
N^{o}. of citations	11	20	300	240	306	473

The complexity and technical character of the issues related to climate change are a barrier to journalists, who have difficulty in synthesizing information for the format of newspaper and magazine articles, which require a simple and direct language. However, some journalists who specialize in environmental issues and the editorial space given to some Brazilian specialists and scientists in the print media have helped considerably in raising public awareness about the issue.

5 – EFFECTS OF CLIMATE CHANGE ON MARINE AND TERRESTRIAL ECOSYSTEMS

The importance of climate variability does not just result from its effects as a physical phenomenon, but especially because of its social, economic and environmental consequences. Therefore, these issues deserve much more attention than they have received to date.

Because of the limited available resources, both human and financial, in the early stages implementing the Convention in Brazil, the Brazilian government adopted the strategy of placing emphasis on the studies for the preparation of the Brazilian inventory of net anthropogenic greenhouse gases. The limited literature about vulnerability and adaptation to the effects of climate change in Brazil were analyzed here. In the year 2000, with the inclusion of the climate change issue in the Government's 2000-2003 multi-year plan, studies were begun about vulnerability to climate change in relation to health and coral bleaching.

The present capital is an attempt to understand the direct and indirect interactions between climate and society in Brazil. Some case studies of climate change impacts were identified and presented as examples of areas that require further research. Thus, some studies have identified the adverse effects of the drought in the Northeast, as well as in other regions of the country. The agricultural sector is of course the most directly affected by the drought, but other sectors, such as electrical generation, are also affected. Floods also represent a serious problem in various regions, including the metropolitan region of Rio de Janeiro. Frost causes great concern in the South and Southeast regions, and has caused extensive economic losses in previous years. Together, the phenomena of drought, floods and frost have caused losses of millions of dollars, and more importantly have been responsible for a considerable number of deaths.

Brazil's vulnerability to adverse impacts and possible adaptation measures to climate change include vulnerability of coastal zones because of rising sea levels, vulnerability in the area of health, especially related to the expansion of malaria and dengue, and impacts on the electrical sector, because of the predominance of hydroelectric generation.

A global increase in sea levels because of the greenhouse effect and increased urbanization in coastal areas must be addressed by municipal, state and federal authorities, and a preventative approach must be implemented in selecting sites for urban expansion and siting of industries. An evaluation of possible mitigation measures will be important to avoid the high costs of protecting built up areas and improving coastal structures to deal with a given increase in sea level.

Global climate changes could have a broad potential for impacts on public health. Some of these impacts could result directly from heat waves and change in rainfall regimes, with resulting flooding and drought. Transmission of various infectious diseases is particularly sensitive to climatic changes, especially those transmitted by mosquitoes, such as malaria for example. Other health impacts could be secondary to the impacts of climate on social and ecological systems, and could include changes in food production, displacement of populations and economic problems. But in general the effects of global changes in the area of health are associated with particular illnesses. In Brazil, the Amazon region is one of the areas most vulnerable to these problems, because its natural environment is more conducive the increase of diseases, with reproduction of vectors and parasites benefiting from the climatic conditions of high temperatures and humidity, as well as the great availability of water.

The climate vulnerability of the Brazilian electrical sector is due to the variations in the energy demand cycle in the large urban areas of the country, the effects of climatic phenomena on the

Brazilian hydrological cycle, and thus on hydroelectric facilities, as well as any temperature increase resulting from global climate change.

However, a notable feature of the climate change issue in Brazil is the lack of reliable projections of the possible future climates in the country, over a horizon of 100 years, using the emission scenarios of the Intergovernmental Panel on Climate Change (IPCC). Brazil is a vast country, with great regional differences, and includes Amazonia, the semi-arid Northeast, the Center West, the grasslands of the South, and the Pantanal. Each specific region could have different characteristic future climates. Current knowledge of the regional dimensions of global climate change, however, is still very fragmented.

These studies require, however, the development of long term climate change models with sufficient spatial resolution for regional analysis, which will enable the creation of scenarios of possible future climate change with different concentrations of carbon dioxide in the atmosphere, and analysis of the impacts of climate change on Brazil.

5.1 - SEMI-ARID REGION

5.1.1 – PROJECTIONS FOR SEASONAL AND INTERANNUAL CLIMATES AND APPLICATIONS FOR SUSTAINABLE DEVELOPMENT

5.1.1.1 - The Problem and its Global Nature

O El Niño Southern Oscillation (ENSO) is the dominant influence on interannual climatic variability on a planetary scale. It has a global impact, associated with the large-scale dislocation of tropical circulation. Many tropical areas, including Brazil, are directly affected by the droughts and reduced rainfall linked to the warm phase of ENSO, and in an analogous manner in the cold phase. The consequences include various types of losses, as well as famines, deaths and destruction of housing.

In the northeast of Brazil, where many severe droughts are linked to the occurrence of ENSO, statistical and dynamic predictions are expected and successfully used to reduce the negative impacts of these extreme events.

The government of Ceará, for example, through agricultural activities and conservation of water resources, has shown that it is possible to avoid a large population shift when conditions are provided for practicing reasonable subsistence agriculture, as a harmonic way of stimulating agricultural production, including the selection of more drought resistant seed stock.

This example makes it clear that a well-considered strategy should be adopted for producing climatic information and making it available to users, thereby contributing to the economic and social value of using this information in decision-making processes.

Forecasting techniques can clearly have a positive impact on quality of life in a range of areas, such as in increasing food production in agriculture (selection and allocation of seeds), and aquaculture, in forest management and control of rivers (plans for restriction and use of water, control of flow), and hydroelectric generation and distribution.

5.1.2 - SALT PRODUCTION

The Northeast region of Brazil is an ideal location for salt production, because of the long coastline, many hours of sun per year, rain restricted to a well-defined season, calm seas and constant winds, and is the largest Brazilian producer of salt.

Climatic conditions have an important role in salt production. Salt production is by nature carried out in the dry periods, and provides a counter-cyclical opportunity for workers unskilled during the dry winters, and even in dry summers, when the rains fail to appear.

The salt industry is very sensitive to climate variations, although the degree of sensitivity is greater in facilities using low technology than in more modern plants. Numerical data show a negative correlation between rainfall and salt production. Thus, in contrast with agriculture, salt benefits from drought.

In terms of why some reasons, such as Ceará, are more sensitive to climatic variability than others, one must look for factors that influence salt productivity. The history of salt production in Rio Grande do Norte is different from that of Ceará. In Ceará, production was based on local capital and on entrepreneurial capacity, in Rio Grande do Norte the modernization of production was based on capital and an entrepreneurial spirit brought from outside from Brazil, and thus there was higher level of investments and technology. The state's high degree of modernization of systems of extraction and handling of salt gave the industry a greater resilience in the face of climatic variations.

5.2 - COASTAL ZONE

5.2.1 - EFFECTS OF SEA LEVEL RISE

There is increasing evidence of coastline erosion in different areas of the Brazilian coast. However most of the geo-morphological studies have been limited to inherently unstable and dynamic areas, such as inlets and sand bars at the mouth of rivers and in areas affected by construction projects. These cases cannot be considered evidence of erosion due sea level rise, because the lack of sediment supply, increased storm intensity, local tectonic movements and human interference can contribute to erosion.

The absence of measurements of sea level over a longer time horizon, and of topographic and cartographic records, make it difficult to situate current changes of a coastline in a long term perspective. But at any rate, preliminary conclusions point to the need to begin a broad study of the potential impacts of increased sea level in Brazil.

Despite the limits of available information, Brazil has participated in the GLOSS Program of the Intergovernmental Oceanographic Commission (IOC-UNESCO), locally coordinated by the Hydrography and Navigation Directorate (DHN) of the Brazilian Navy and involves a range of governmental bodies, universities and private port companies. Ten marigraphs have been installed in Brazil, including three stations on oceanic islands. All are linked to the Brazilian geodesic network. In addition, a network of ocean stations in ports that would support GLOSS stations are being studied, and therefore more precise data about the relative sea level will be available to Brazil.

5.2.1.1 – Potential Consequences of Sea Level Rise

North Region

Problems of salinization have not been reported to date, but the large-scale destruction of coastal mangrove swamps has been reported in the North of Brazil, and sea cliffs in an active process of erosion have been observed.

For the entire region, rising sea levels would increase significantly the penetration of tides into the rivers. Flooding along river valleys would be confined by the adjacent higher areas. Depending on the amount of sediment, low alluvial areas, such as in Marajó Island at the mouth of the Amazon River, could be flooded. However, significant economic consequences are not expected, since population densities are generally low and already face periodic flooding of rivers.

Northeast Region

In many areas, rocky cliffs will restrict the impacts of any effect of a large rise in sea level. Mangrove swamps, located in low areas of coastal plains, in estuaries, around coastal lagoons, and in agricultural areas in temporarily flooded river valleys, will be affected. More serious problems will appear in coastal cities such as Recife, Aracaju and Maceió, where urbanization has expanded to low areas and flooding already occurs, especially when strong rains coincide with spring tides. Drainage problems and flooding will affect the low areas of coastal plains around the Bays of São Marcos and Todos os Santos.

The flow of rivers in the region is usually very small, except during the rainy season. Most estuaries are subject only tidal currents. With a rise in sea level, flooding of the river valleys would extend the reach of the tides, which would increase the capacity of these canals formed by tides to trap sediments, thus influencing the balance of sediments along the coast.

Groundwater is a common source of drinking water for many coastal communities. The increase in population and in sea level have significant implications for this resource and could cause saline intrusion. Further, excessive removal of groundwater can cause landslides.

Southeast Region

The range of geographic formations of the coastal zone in this region (coastal mountains, small beaches, rocky shores, lagoons, bays, estuaries) will be affected differently by a rise in sea level. Some sites already display signs of erosion, despite having very little human interference. In other sites, intensive extraction of sand from the dunes, beaches and tidal channels has contributed to a deficit in the sediment balance, making these areas more vulnerable to rising sea levels.

South Region

There are process of erosion and of accumulation under way on the coast of Paraná. In Santa Catarina, exposure of peat at the base of coastal escarpments, in contact with the berm of the beach, indicates long-term trend of retreat. Erosion of the shores of Lagoa dos Patos is also interpreted as an indication of relative increase in sea level. Because of the dominant winds coming off the ocean, a zone of dunes has developed from sand transported inland from the beach.

Saline intrusion in coastal lagoons would have local impacts on fishing; and in the case of Lagoa dos Patos, where water from the lagoon is used for irrigation, the problem would cause greater concerns.

Other Implications

Ports play a significant role in domestic and international commerce in Brazil, and would be directly affected by changes in sea level. Changing sea levels would bring serious consequences both for port installations (for example, breakwaters, mooring buoys, dykes) and for port operations (for example, time between dredging, size of oscillations in anchorage, frequency of flooding, etc.).

With a rise of um meter in sea level, several ports would be flooded or their freeboard (height above high tide level) would be less than 0.5 meter. It is estimated that operations in all ports would be adversely affected and some type of improvements would likely be necessary. Given the location of the ports and their economic importance, it appears evident that the North and Northeast regions are more vulnerable than the South and Southeast regions.

Other effects should also be considered. Higher sea levels allow waves to reach the coast with a greater height, because of the reduction of friction with the sea bottom. The force of waves is proportional to the second or third power of the height of the wave, meaning that an increase of 10%

in the height of the wave increases the force on pillars by 20%, and increases by 30% the weight of stone blocks used in construction of breakwaters.

Changes in sediment transport and deposition patterns also would interfere with port operations, with problems of saline intrusion. An increase in the rate of sand transport along the coast should be expected as a result of larger waves.

Another problem related to the greenhouse effect in the change in atmospheric circulation and a possible increase in storms. Increases in wave height have already been described in the North Atlantic. Similar changes in the South Atlantic would be cause for concern for the off-shore oil industry, which supplies the majority of oil consumed in Brazil, as well as for all coastal structures.

It is crucial that more detailed studies be carried out of the possible effects and responses to realistic scenarios of sea level rise along the coast of Brazil. These studies should include evaluations of the effects caused by this event, descriptions of economic activities that will likely be affected, and a careful monitoring of physical changes.

5.3 - CORAL BLEACHING

Coral reefs are the most diverse, complex and productive of coastal marine ecosystems. They provide food and are the principal source of economic resources for hundreds of thousands of people who live in tropical regions of our planet.

In recent decades there has been growing concern, especially in the scientific community, about the importance of reefs to humanity and about the threats to which they are exposed, and there is a general consensus about the necessity to minimize their deterioration.

It is estimated that within thirty to forty years, around 70% of the reef areas of the world will be completely degraded, primarily as a result of global climate changes and depredation of their natural resources from human activities.

Reef ecosystems are extremely sensitive to small variations in ocean water temperature, and are thus excellent indicators of global climatic changes, as a type of living thermometer of the “health” of the oceans. A phenomenon known as *bleaching* of corals appears to be largely caused by variations in environmental conditions, very likely induced by sudden changes in global ocean temperatures, and this phenomenon has caused extensive death of corals in much of the reef area of the globe.

The bleaching process occurs because of the “loss”, by corals, of photosynthesizing algae in their tissue, which provide vital cooperation of benefit to both organisms. These algae, along with giving color to coral, produce organic components which serve as food, and in return the coral provide shelter to the algae and provide chemical elements essential to their survival. Environmental disturbances can interrupt this delicate symbiosis, causing dissociation between the algae and coral. In this case, the coral loses its color, displaying its calcareous skeleton, which was originally white.

Although coral bleaching has been observed in Brazil for some time, systemic studies about its causes were not published until the summer of 1993-94, when an extensive bleaching phenomenon was reported for the coral species *Mussismilia hispida* and *Madracis decactis* on the coast of the state of São Paulo, related to an abnormal increase in ocean water temperatures.

In Abrolhos, two bleaching events connect the phenomenon to an increase in the temperature of surface waters: the first during a temperature anomaly in the summer of 1994, when 51 to 88% of the communities of the genus *Mussismilia* were affected, and the second related to the strong El Niño event that began at the end of 1997 in the Pacific ocean and also caused an increase in water temperature along the coast of Brazil. During this event another "hot spot" was reported on the north coast of the state of Bahia, and in both locations the water temperature was around 1°C above the annual average for these locations. On the north coast of Bahia three species of coral, *Agaricia agaricites*, *Mussismilia hispida* and *Siderastrea stellata*, had between 20 and 80% of their communities affected. This bleaching process lasted for around six months, and after one year all the communities had recovered. During the Abrolhos event it was observed that 10 to 90% of the communities of around 9 coral species were partially or totally bleached.

Not only in Brazil, but in various parts of the world, the phenomenon of coral bleaching appears to coincide with warming of the oceans during El Niño events, demonstrating the small variations in surface water temperatures can cause changes in climatic patterns which directly affect tropical ecosystems, especially coral reefs. There are also controversies between climatologists over whether the frequency of El Niño and extreme climate events reflect a natural process in the ocean/atmosphere system or whether they result from global climate change.

The incidence and severity of coral bleaching will cause substantial changes in the structure of communities of the reef ecosystem, which need to be scientifically understood in order to minimize the deterioration of the state of the oceans and its implications for life on our planet.

As a result of this concern, under the Climate Change Program of the Government Multi-year Plan (called Avança Brasil), an agreement was signed between MCT, the Federal University of Bahia (through its Geophysics and Geology Research Center) and the Foundation for Research and Extension Support (FAPEX) for conducting a study of global climate change and coral bleaching in Brazil.

Thus, a project is already under way to scientifically evaluate the effects of increased ocean water temperature – related to global climate change – on photosymbiotic organisms of coral, whose loss causes bleaching, as well as the capacity of these corals to tolerate and/or acclimatize to these sudden environmental changes.

The knowledge generated in this project will produce data that will enable a better understanding of processes responsible for the changes observed in the reef biota of Brazil, especially in coastal reef areas, which are more shallow and thus more susceptible to variations in temperature of surface water. Through this work, we intend to improve the methodology for studying coral bleaching, to support projects involving management of reefs with coral bleaching and/or with severe damage.

5.4 - FLOODS

5.4.1 - THE CITY OF RIO DE JANEIRO

The problem of flooding in Rio de Janeiro goes back centuries, and results from improper land use in the region, and especially from the lack of consideration of the environment. A sustainable long term strategy is necessary to significantly reduce the risks to the population of Rio de Janeiro resulting from weather-related events.

Unplanned expansion of human settlements and the lack of investments in basic infrastructure — such as drainage systems, waste disposal and sewage facilities, as well as roads and construction projects — are responsible for the impacts of extreme weather events. Little remains today of the original vegetation cover (Atlantic Forest). In its original state, the heavy vegetation functioned as an excellent defense against erosion and landslides.

The municipality of Rio de Janeiro has a high population density and its urbanization level is one of the highest in Brazil. Only a very small part of the population, less than 5%, lives in rural areas. Most of the municipalities in the metropolitan region are completely urbanized. The settlements on the mountainsides and on the shores of the rivers and canals are characteristic of development in the Metropolitan Region of Rio de Janeiro in recent decades. Among the unregulated forms of land use, the expansion of favelas is one of the most insidious. The rural exodus, which began in the early 20th century, resulted in a large number of poor, who because of the high cost of land and the lack of public transport, had little option but to settle in occupy vacant land in areas subject to flooding or to seek land in distant districts. The result is the deterioration of the environment and the creation of great difficulties for governments to provide basic urban services.

5.4.2 - FLOODING IN THE PANTANAL

In contrast with other areas, such as Rio de Janeiro, where flooding results principally from improper land use practices and results in immense social, economic and environmental costs, in the Pantanal the floods are a natural part of environmental processes, and play an important role in the ecological balance of the region.

Human actions that result in loss of natural cover, such as uncontrolled burning in the high lands of the Paraguay River watershed, cause accelerated soil erosion, depleting the soils and reducing water retention, increasing velocity of water flow in the tributaries and the flow of sediments capable of damaging the ecological flow of the region.

Alterations in the highest land of the Paraguay River watershed could have significant consequences for the Pantanal. According to IBAMA, the destruction of a large area of original vegetation cover can cause disturbances to physical processes (water and heat balances, climate, soil structure, winds), and in the biological sphere (destruction of various life forms), with unpredictable consequences for human habitation.

Water levels in the Paraguay river rose above 4 meters 60% of the time in the 20th century. Thus floods in the Pantanal are part of the daily life of the region, where ecosystems alternate constantly between terrestrial and aquatic. There are three principal types of floods in the Pantanal:

- Ordinary: minor, reaching 3-4 meters;
- Intermediate or Extraordinary: regular, frequent, reaching 4 to 5.5 meters; if there are areas for its discharge, they create natural reservoirs, are beneficial and do not cause economic or social problems; and
- Exceptional: these floods reach 5.5 to 6 meters and are rare, with serious social and economic consequences: they submerge pasture, reduce the area of dry land and cause serious problems because of delays in drainage of water and the mechanisms of evapo-transpiration.

Thus it can be concluded that the conditions of ecosystem balance of the Pantanal are based on intermediate flooding. They are responsible for the deposition in flooded areas of fertile alluvial material, which after various uses is carried to the Paraguay River. The floods are also an important factor in the renewal of plant cover, principally in clear fields, depressions, inlets, savannas and edge of forests, and is responsible for the renewal of flora and fauna typical of the Pantanal.

5.4.2.1 - Economic and Social Impacts

While the ecosystem is rejuvenated by the floods, the economy suffers from the reduction in cattle raising, the principal activity of the region, because of reduction in pasture area. As a result, cattle collect around the flooded areas and frequently enter the flooded areas in search of forage. Soon, the highest land is converted to pasture, while other land remains flooded because of the slow drainage. As a result, there is an imbalance between the cattle herd, pasture and available dry land.

Exceptional floods (above 6 meters) always cause unpredictable economic losses, because they are generally accompanied by cold fronts that later increase the number of deaths in the herd, along with the losses caused by damage to ranch infrastructure.

When the floods occur, much of the workforce is laid off because there is little work to be done and the cattle owners have financial difficulties. Also, the human populations living close to the riverbanks who live on subsistence fishing and farming are displaced by the high waters and seek shelter in nearby cities.

5.5 - FROST

5.5.1 - COFFEE PLANTATIONS

Coffee is a small tree which grows continually and requires a limited variation in temperature, with an average of 16°C to 23°C. The effect of temperatures outside this range depend on the degree and duration of the deviation, as well as other factors such as soil humidity, wind, rain, etc.

High temperatures reduce plant growth and cause premature o development and o maturing of the fruit, with a resulting loss in quality. If a heat wave occurs during the flowering period of the trees, there will be a drop in yield. Under intense and direct light, photosynthesis begins to drop above 24°C and reaches zero at 34°C.

Cold weather can also considerably reduce growth of the coffee tree. Below 12°C, growth is completely inhibited, but the greatest losses occur below 3°C, the point at which the leaf tissue freezes internally. The mere presence of ice on a coffee tree doesn’t necessarily cause serious damage, but it is the internal freezing of tissue that must be avoided at any cost, when frost affects the plantations.

Obviously the extent of the damage caused by the cold will depend only on intensity: temperatures below 2°C close to the soil will block growth of stems of young trees, which normally leads to the death of affected tissue.

Thus, coffee production is affected by frost and the extent of the damage depends on the severity of the event.

5.5.2 - ORANGE PLANTATIONS

Citric fruits originated in sub-tropical areas and are sensitive to temperature extremes, which affect the rate of growth of the plant and development of the fruit. Some authors place the optimum temperatures between 22 and 23°C. Thus, as in coffee production, 12°C is the limit temperature below which the plant begins a zero growth period. At the other extreme, above 36°C plant activity begins to reduce, reaching the minimum at 42°C.

Generally, high temperatures burn leaves and fruit. The effect on leaves is caused by the destruction of chlorophyll, blocking photosynthesis and thus the metabolism and nutrition of the plant. A visible effect in equatorial regions is the discoloring of the skin of the fruit. Since there is no cold season, the fruit maintains it green color after maturing, which causes problems for the sale of fruit.

For citric fruits destined for production of juice concentrates, the principal result of high temperatures is formation of sugar and alterations in the sugar/acidity ratio. In the absence of a cold season, ripening occurs at high temperatures, which favors the formation of sugar at the expense of acidity. Where irrigation is available, citric fruits can be grown in arid or even desert regions.

Low temperatures also damage the leaves, fruit and foliage. The extent of the damage depends not only on the intensity of the winter, but also on its duration. Below 4°C, leaves and stems begin to suffer; a frost of 2°C lasting two days can cause serious consequences. Between 0.8 and 2.8°C, the fruit begins to show signs of damage. Low temperatures dehydrate the cells because water fills the intercellular spaces when it freezes. Ice causes the coagulation and impermeability of cell walls, followed by their death.

Since most of the juice is exported, global market prices are another important determining factor. It generally cannot be said that frost has positive effects, but when they significantly reduce supply, they result in higher prices. However, this has never occurred in Brazil in relation to orange production, but it has certainly been the case with frosts in the United States. Some severe frosts there have caused extensive losses and a large drop in production. And the loss of one country means the gains of another: imports of concentrated orange juice from Brazil increased exponentially in direct relation to frosts in the U. S. and the expansion of the orange industry in Brazil.

5.6 - HEALTH

Under the Climate Change Program, in the Government’s Multi-year Plan (called *Avança Brasil*), there are provisions for studies of vulnerability and adaptation to the impacts of climate changes, coordinated by the Ministry of Science and Technology (MCT).

An agreement has been signed between MCT, the Fundação Oswaldo Cruz (FIOCRUZ) through the Program of Environmental Global Changes and Health (PMAGS), and the Brazilian Graduate Association for Collective Health (ABRASCO) for the development of an analysis of vulnerability of the Brazilian population to climate change impacts.

Brazil, because of its geographic location and size, is subject to significant climatic variation, which lead to environmental changes, which favor the emergence of endemic infectious diseases which are sensitive to climate, such as malaria, dengue, cholera, leishmaniosis (tegumentary leishmaniosis and visceral leishmaniosis), leptospirosis, hantavirus, and others. The mechanisms of climate variables may be direct, such as the creation of humidity favorable to the development and dispersion of infectious agents and vectors, or indirect, such as human migration processes caused by drought, stimulating the spatial redistribution of endemics and an increase in social vulnerability of communities.

Infectious endemic diseases are responsible for high morbidity and mortality, important aspects of the vulnerability of populations.

In Brazil, extreme climatic events (storms, floods and droughts) have significant public health impacts, through causing a rise in infectious diseases or by claiming victims through accidents.

Future scenarios related to climate changes suggest a greater instability of phenomena linked to climate variability, making prediction more difficult, which reduces protection for the population.

The agreement, described above, has the general objective of conducting a retrospective study of socio-environmental vulnerability of the population when subject to extreme climatic events and to endemics sensitive to climatic oscillations. An objective of the agreement is to develop a Geographic Information System (GIS), which will enable preventing critical situations which increase the risk of morbidity and mortality from diseases selected for the study.

The research being developed covers all of Brazil, although the large territory and the heterogeneous distribution of diseases require a study which takes into account the realities and peculiarities of each region of the country. Five endemic infectious diseases were selected ? malaria, dengue, cholera, leishmaniosis, and leptospirosis ? being those which are considered to be most influenced by climatic events. Such diseases are also analyzed in the context of each region with a higher level of endemicity, and accidents resulting from extreme climatic events are being analyzed in each region (droughts, floods, storms, etc.), where there is a historic record of their occurrence.

5.7 – ELETRICAL SECTOR

Quantitative predictions of hydrological effects of climatic alterations are essential to understand and resolve the potential water resource problems related to supply for domestic and industrial use, electricity generation, agriculture, transport and leisure, as well as for planning and management of water resource systems and environmental protection.

Climatic changes will affect the planning, construction and operations of projects involving water resources. Because of the long lifetime, these projects will be subject to climatic conditions for which they were not planned. The vulnerability of a system increases to the extent that its capacity for adaptation decreases, and when the system is not flexible. The vulnerability of socioeconomic and natural systems depends on economic circumstances and institutional infrastructure. This suggests that systems are typically more vulnerable in developing countries, where economic and institutional conditions are less favorable.

In the area of energy, Brazil is highly vulnerable to climatic changes, given the importance of hydroelectric generation in the country’s energy matrix. Even considering the prospects for expanding Brazilian thermoelectric capacity, the country’s electrical generation system will continue to be strongly dependent on water availability for the production of base-load energy, and therefore for ensuring the demand is met.

Implementing research and monitoring, through cooperation between Brazilian and international institutions, is essential to improve the climatic projections on a regional scale, and take into account the response of natural and socioeconomic systems to climatic variations and improve the knowledge of the effectiveness, costs and benefits of strategies for adapting to these changes.

In December of 1988, ANEEL, MCT and UNDP signed a Protocol of Intentions establishing technical cooperation for implementation of activities related to research on climate change related to the Brazilian electrical sector, with the objective of carrying out activities involving the greenhouse gas emissions inventory, climatic vulnerability of the Brazilian electrical sector, mitigation measures for reducing the risks of global climate change, and public awareness of climate change.

The work involving the greenhouse gas inventory is pursuing improvements in the methodologies for measuring emissions from hydroelectric reservoirs and thermoelectric plants, and the establishment of systematic ongoing measurements from electrical concession-holders. This knowledge represents an important element in outlining new scenarios for the electrical sector in the face of global climatic changes and the prospects for expansion of thermal generation.

5.8 - AGRICULTURE

5.8.1 - VULNERABILITY OF BRAZILIAN AGRICULTURE GLOBAL CLIMATIC CHANGE

The agro-industrial sector represents around 7.7% of Brazil's GDP[86] and employs around 18 million people[87], which demonstrates the importance of the primary sector in the absorption of rural labour. Therefore, given the social and economic importance of agricultural, special attention is justified for studies about the effects of climate change on the agricultural sector. However, there have been few studies in this area in Brazil. Nonetheless, three can be cited.

Using a General Circulation Model (GCM), one such study, in 1994[88], presented projections about the potential effects of climate change on Brazilian agriculture, focusing on 13 different sites in Brazil, and wheat, corn and soy crops. The sites were selected based on agro-climate studies, representing the principal Brazilian agricultural climate regions: subtropical, high tropical, tropical regions, semiarid and equatorial/subequatorial. Latitudes range from 31°47'S to near the equator (1°28'S), longitudes from 60°01'W to 39°06'W and altitudes range from 13 to 955 m. Although this study has not addressed all the crops of economic interest to Brazil, it did address those with the greatest sales, covering around 27 million hectares of planted fields.

A sensitivity analysis was conducted on each site to assess the effect of gradual changes in temperature (0, +2^{o}C and +4^{o}C), rainfall (0, +20%, -20%) and in atmospheric concentrations of CO_2 (550ppm) on the production and physiology of agricultural crops.

The simulators used in this study were Goddard Institute for Space Studies - GISS , Geophysical Fluid Dynamic Laboratory - GFDL ; United Kingdom Meteorological Office - UKMO , and the simulators of crop growth, developed by IBSNAT, were CERES-Wheat version 2.10 for wheat; CERES Mayze for corn; Soybean crop growth simulation model - SOYGRO for soy.

86 IBGE, 2000.
87 Agricultural Census, 1996.
88 SIQUEIRA, O. J.F de; FARIAS, J. R. B.; SANS, L. M. A. Potential effects of global climate change for Brazilian agriculture: applied simulation studies for wheat, maize and soybeans, 1994.

The three GCMs project increased temperatures, precipitation changes and small variations in solar radiation. Sensitivity analysis studies were carried out later in order to assess the effect of climatic alterations on the crops analyzed. The results obtained are presented below:

- **Temperature increase:** annual average temperatures will increase by between +2^{o}C and +6^{o}C, but there are significant differences between the projections of the three scenarios. In general, the greatest increase is in to the scenario of the UKMO model. The sites in the Center and South regions have the greatest temperature increases in the months of March to November, which is the growth period for wheat. For the sites in the Northeast, the UKMO scenarios project high temperatures in winter (June to August).

- **Rainfall:** there is considerable variations in projections of precipitation, especially for sites more to the south of Brazil. For most of these, projected annual precipitation increased over current observed levels. The scenarios of the GFDL project increased precipitation for the South in the period of September to November and for the Center-south region in the period of March to May. Precipitation projected by the GFDL and UKMO models for December were less than current observed levels, suggesting increased problems related to drought for summer crops. Reductions in annual precipitation were projected for the sites analyzed in the North and Northeast regions, where the scenarios of the UKMO model project reductions of around 10-15% in precipitation.

- **Physiological effect of CO_2:** the physiological effects of 555 ppm of CO_2 for wheat in a scenario of +4^{o}C include an increase in productivity, compared to the scenario of +4^{o}C alone, but do not completely compensate the negative effects of higher temperatures in wheat fields. For corn, the physiological effects of 555 ppm of CO_2 on grain productivity are lower than wheat, as expected because of the lower response of corn, a C_4 crop, to higher concentrations of CO_2. For the soy crop, the SOYGRO model simulated significant increases in production (average of 22%), except for the Northeast region, where production was lower even given the doubled concentrations of CO_2. The more positive results projected for soy result from the beneficial physiological effects of CO_2 concentrations.

- **Wheat productivity:** dropped in all the sites analyzed, although the size of reduction varies with scenario and region. The region most vulnerable to future climatic changes was the Central region (reductions of 24% and 46% in production for the GFDL and UKMO models, respectively) and the Center-South region (43% GISS scenario). The increase in temperature resulted in significant reductions in the length of the growing season and in productivity of grains. An increase of +4^{o}C resulted in a reduction in the length of the growing season of the crop of around 15% and a reduction of around 40-50% in grain productivity. With the physiological effect of 555 ppm of CO_2 in this same scenario, wheat productivity increased, but the effect did not completely compensate the negative impacts of temperature rise on productivity. The South region apparently proved less vulnerable to climatic alterations, with average productivity losses projected to be 22%.

- **Productivity of soybean:** the effects of climatic alterations on soybean were less than on other crops analyzed in the GCM scenarios. Based only on these scenarios, there would be reductions in productivity of grains (of between 5% and 31%) and in crop biomass through almost all regions. With the physiological effect of CO_2 on productivity, the SOYGRO crop growth model showed significant increases in productivity (average gain of 22%). These results were consistent in all regions, with the exception of the Northeast region, where productivity diminished, even when the physiological effects of CO_2 were taken into account. An increase of 2^{o}C in temperature, with the physiological effect of doubled CO_2 concentrations, resulted in small increases in productivity. Also, the increase in temperature did not significantly affect the length of the growing season for soybean. These results suggest that production of Brazilian soybean may not be severely affected by the effects of climatic alterations, especially considering the beneficial physiological effects of doubling CO_2 concentrations.

- **Productivity of corn**: for corn, all the scenarios of the GCM models project reductions in biomass production, in grain productivity and in the length of the growing season, when compared with current climate. The effect of climatic alterations in season duration and in crop productivity was a result of temperature increases projected by the GCMs. The largest decrease in productivity was in the Northeast region (26% in the GISS model scenario), while reductions in the South and Center South regions were all less than 20%. The impact of increasing temperatures on grain productivity by region ranged from around -20% in the Center South region to -28% in the Northeast region. This effect reduced the length of the crop growing season by 15% on average, but the largest effect was registered in more southern latitudes. There were no apparent effects on productivity of grains from increased precipitation, except in the Northeast region. Low precipitation could be beneficial for corn productivity in the North region, but not in the Northeast. In terms of the physiological effects of 555 ppm of CO_2, reductions in corn production were less than reductions in wheat production, as could be expected because of the low response of corn to increased CO_2 concentrations. The largest reductions in crop productivity, with scenarios taking into account the physiological effect of CO_2, were found for the South and Center South regions in the GFDL and UKMO model scenarios (ranging from 11% to 20%). For this same scenario, using the GISS model, the greatest reductions were found for the North region (24%).

Based on the results presented here, this study estimated the effects of climatic alterations on national production of these crops, aggregating the results obtained in the regions and weighting them for the cultivated areas in each region. The impact on wheat production would be large (reductions of 33%, 18% and 34% for scenarios from the GISS, GFDL and UKMO models, respectively). Corn production in Brazil would also drop (11%, 11% and 16% GISS, GFDL and UKMO scenarios, respectively). On the other hand, Brazilian productivity estimates for soybean rose by 26%, 23% and 18% for the GISS, GFDL and UKMO scenarios, respectively.

Different impacts on the regions were projected in these scenarios, with the Northeast region being especially vulnerable to decreased corn production and the Central and Center South region being vulnerable to reductions of wheat. The South region would be vulnerable to reductions of wheat and corn and the North region would be vulnerable to reductions of corn.

5.8.2 - Adaptation Strategies for Climatic Change

This same study also projected alternative scenarios, through the general circulation models, in order to analyze adaptation strategies based on technologies such as the use of irrigation and new cultivars, changes in planting dates, and nitrogen fertilizers. For Brazil, it was predicted that these techniques would help to increase productivity of crops affected by climate changes, such as wheat and corn, but would not be sufficient to compensate for all the losses projected by the climate change scenarios generated.

The projection made for a more heat-resistant cultivar presented promising results in terms of the potential for adaptation to global warming, but the prospects for practical implementation of this new cultivar still need to be tested and evaluated through genetic improvement programs. For soybean in the Northeast, increased production is foreseen with the use of irrigation and nitrogen fertilizers, to compensate for any impact of climate change.

The principal limitations of the study lie in the fact that the simulators used were not validated for all regions analyzed, and that the technology and land use were treated as constants, even knowing that they will probably be modified in the future. Thus, new studies are needed to assess the real implications of the direct physiological effects of CO_2 on crop development and productivity.

Other studies carried out in 1996 and 1997[89], estimated the impact of global climate change on Brazilian agriculture using a Ricardian model. The model evaluates the influence of variables such as production, labour, fertilizers, constructions, roads, scientific research, adoption of technology, rural extension programs and variables such as climate (temperature, rainfall, solar radiation, etc.) and soil conditions (type of soil, slope, texture, etc.) on land productivity, and thus on land prices. From this it is possible to estimate the impacts of adaptations to climatic alterations on production and yield of land. According to the authors, the net impact of climate change would be negative for Brazilian agriculture, especially for the Center West region, where the cerrado is dominant, while the South region will benefit moderately from warming.

A study carried out in 1996[90], using various climatic scenarios and projections based on a GCM, estimated that the impact of climate change on the Brazilian economy would be significant, with extensive damage to the agriculture, forestry and energy sectors. The study concluded that because the Brazilian climate is already hot and the sectors sensitive to climate alterations are predominate in the country, the Brazilian economy would be one of the most affected countries in the world[91].

5.9 - DISASTER PREPAREDNESS

The continuous monitoring of weather conditions by radar, satellites, telemetric stations and lightning detectors is essential to be able to issue alerts, involving various meteorological phenomena such as heavy rainfall, high winds, lightning, etc. This information is valuable both to the general population and to decision-makers, and has implications for the sectors of public safety, water resources, agriculture, environment, electrical sector, oil exploration, transport, industry and commerce, civil construction, tourism, leisure and sports, health and the safety sector.

The Meteorology System of the State of Rio de Janeiro (SIMERJ), to be established within a period 4 (four) years from the time the resources are made available, seeks to adopt a structure capable of offering support to authorities, society and the private sector in decision-making, in order to minimize the harmful effects of weather and climate and to take advantage of their beneficial effects. This system will provide services which are not provided by currently available meteorological services in the state.

The intention is to regionalize meteorological services, with the participation of agencies working in the state of Rio de Janeiro, to complement traditional meteorological services, devoted to observation in space and time, with the use of telemetric networks and remote sensing (radar and satellites). Also, there will be telecommunications and computer equipment to enable weather monitoring and forecasting in a very short term (less than 24 hours) using, inclusive, meso-scale numerical analytic and weather prediction models.

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[89] ALVES, D.C.O; EVENSON, R.E. Global warming impacts on Brazilian agriculture: estimates of the Ricardian model, 1996. SANGUI, A., Alves, D.C., EVENSON, R., MENDELSOH, R. Global warming impacts on Brazilian agriculture: estimates of the Ricardian model, 1997.

[90] MENDELSOHN, R. Estimating the market impacts of global warming in Brazil, 1996.

[91] The IPCC Third Assessment Report (2001) showed some advances in relation to the climate scenarios generated by global and regional models. The IPCC predictions for Brazil showed, in general, an increase in temperature by 2080 of from 1°C (low emissions scenario) to more than 6°C for the north of Brazil. In terms of precipitation, the level of uncertainty is still greater, because the various simulations present divergent data, with some simulations indicating an increase in precipitation while others indicate reduction.

With implementation of the system, the state of Rio de Janeiro will be able to take preventative civil defense actions, such as the issuance of alerts regarding floods, heavy rainfall, high winds, hail, lightening strikes, floods and landslides, especially in high-risk areas of metropolitan and mountainous regions.

The state will be in a position to establish partnerships with the private sector and state-owned corporations for operation and maintenance of the system, offering useful information to the oil exploration , industry, commerce and services sectors, to support the expansion of these activities, generating jobs and revenue for the public coffers.

Similar programs are being developed in the states of Paraná (Paraná Meteorological System Simepar), Minas Gerais (Minas Gerais Meteorology and Water Resources System - Simego) and Goiás (Goiás Meteorological and Water Resources System - Simego), in which climatic monitoring serves to support planning of actions to minimize impacts of adverse climatic conditions (prolonged drought, extreme temperatures, etc.).

5.10 - REGIONAL MODELING OF GLOBAL CLIMATE CHANGE

In many regions of Brazil, there is still no clear signal that climate change is already occurring, especially in relation to average air temperature and precipitation patterns. However, some changes have been observed in the regional atmospheric circulation of the Atlantic sector that suggest systematic changes in precipitation in the Amazon and the Northeast and Southeast regions of Brazil. For example, (a) the subtropical Atlantic anticyclone has intensified, which caused increased precipitation in the North of Argentina and possibly in the south of Brazil during the last 30 years, (b) moisture transport from the tropical North Atlantic to the Amazon Basin and Brazilian Northeast regions has intensified since 1950 and led to a systematic increase (although systematically insignificant) in precipitation[92]. Changes such as these, mentioned as interdecadal climatic variations (generally from natural sources), have also been detected in data from rivers and in precipitation in other regions of Brazil. It is still not know of these negative long term trends are natural manifestations of climate variability or are caused by human activities.

The projections of climate change scenarios for the 21st century were derived from various global climate models used by the IPCC and were discussed by scientists in regards to Brazil[93]. The fact that global climate models use different physical representations of processes, with a relatively low resolution grid, introduces a certain degree of uncertainty in these future climate change scenarios. This uncertainty is extremely important in the evaluation of vulnerabilities and impacts of climate change, as well as in the implementation of adaptation and mitigation measures. For example, for the Amazon Basin, some models produce climates with higher rainfall and others relatively drier climates. For the Northeast of Brazil, the great majority of models suggest increased precipitation.

In using data from climate models for assessment of impacts and vulnerability, some questions should be considered: the problem of scale, the uncertainties in the use of climate change scenarios and the possible effects of global warming on some processes. For example, the fact that projections from the models suggest a warming and reduction of humidity in the Amazon region would imply an increase in respiration, the closing of stoma and a possible deterioration of the forest, which would become more susceptible to fires. Along with this, there would be more intense and frequent periods of low moisture during the rainy season.

[92] IPCC, 2001.
[93] Hulme and Sheard, 1999; Marengo, 2002.

In fact, most of the uncertainties in the model projections for the climate change scenarios can be connected with the problem of spatial scale and the representation of extreme climatic events on higher spatial scales than those produced by most of the global climate models. The problem of spatial scale is also crucial, since extreme events (waves of low moisture, heat and cold waves, storms, etc.) can be identified only with daily data, and not with the monthly or seasonal data produced by most of the IPCC global models. Of course there is also the problem of representation of the physical process by parameterization of the different models and the correct representation of the current climate by the climate models. Thus there is a need for downscaling methods that can be applied to the climate change scenarios based on the global climate models, in order to give more detailed projections of climate, by state, valleys or regions, with a high spatial resolution than that provided by a global climate model. This would be of great use for studies of climate change impacts on the management and operation of water resources, on natural ecosystems, on agricultural activities and even in health and transmission of diseases. Of course before conducting and downscaling activities, there should be a clear understanding of:

- the correct representation of the current climate, both for the global model and for the regional climate model (known as control runs);
- the identification of regions where predictions or simulations of global climate models can be considered more predictable, suggesting a greater ability of the models in these regions. The Northeast of Brazil and the North of the Amazon region present more predictability than the Southeast of Brazil[94].

Thus, it is of fundamental importance to develop climate modeling capacity in Brazil, through analyses of global and regional climate models and for current and future climate change scenarios.

5.10.1 – STRATEGIES AND EXPERIMENTS WITH MODELS TO BE CARRIED OUT AT CPTEC

CPTEC has developed a climate modeling capacity at the global and regional levels, which is currently used to forecast weather and seasonal climates. CPTEC has also developed a regional climate model (ETA/CPTEC) which could be easily applied to South America to generate detailed climatic predictions, including for climate change (see section 3.5). This activity has been carried out under the Federal Government Multiyear Plan for 2000-03, under the Climatic Change Program (see section 7.3).

The original regional ETA model was implemented at the National Center for Environmental Prediction (NCEP) and is widely used in weather forecasts in various climate centers throughout the world. The ETA/CPTEC model, whose domain is South America, was adopted as CPTEC's official regional model.

It is intended to make regional climatic predictions available to groups from South America so that climate change scenarios can be developed in national research centers.

The regional climate models present a much higher resolution than the global climate model, and thus provide climatic information with useful local details, including realistic predictions of extreme events. The predictions made using regional climate models thus lead to substantially better assessments of vulnerability of each country in relation to climate changes and how the Brazil can adapt to them.

[94] Koster *et al.*, 2000; Cavalcanti *et al.*, 2002; Marengo *et al.*, 2002.

The different IPCC climate change scenarios are available from the Data Distribution Centre (DDC) of the IPCC, currently located at the Climate Research Unit of the University of East Anglia, in Norwich, UK. This also involves the development and refinement of the regional atmospheric model ETA/CPTEC, with a horizontal resolution of up to 40 km. The work will be carried out by CPTEC, in collaboration with other research groups linked to the IPCC, such as the Tyndall Centre for Climate Research, the Hadley Centre for Climate Prediction and Research, the Center for Ecology and Hydrology and the Climate Research Unit of the University of East Anglia, all located in the United Kingdom. While CPTEC will be the principal user of the model results (downscaled climate change scenarios), this activity will also have the collaboration and interaction of some of the projects financed in Latin America under Scenarios Development and Application in Assessment of Impacts, Adaptation and Vulnerability of the AIACC (*Assessment of Impacts and Adaptation to Climate Change*).

The climate scenarios provided by the IPCC-DDC with different levels of emissions and socioeconomic development (SRES scenarios) will be used for South America. This will help to deal with the uncertainties produced by the different models in the simulation of future climates under the same forcing (SRES scenarios).

5.10.2 – NEED FOR REGIONAL *DOWNSCALING*

The scenarios for the 21st century provided by the different climate models (from IPCC-DDC) do not reflect the details of a watershed or a region. These models provide climate projections at a grid scale as large as 300 km of latitude and longitude, which is considerably larger than that necessary to study impacts and vulnerability, especially those that involve hydrological processes. The growing need for climate change scenarios with a greater spatial and temporal resolution demands the implementation of different methods for downscaling (dynamic, statistical). Ideally, these methods also reflect the physical mechanisms and processes of the watershed and should capture the regional aspects of large scale climate.

The technique of downscaling is used to "interpolate" from a subgrid scale with less resolution to one with greater resolution, suitable for mesoscale processes, such as those at the level of a drainage basin. The technique of downscaling consists of the projection of large scale information to a regional scale. This "translation" of a global to a regional scale and from annual to daily time scales would also increase the degree of uncertainty of the climate change projections. For example, while a climate model may have some success in reproducing the observed precipitation patterns, it is likely to be less successful in reproducing the daily variability, especially in relation to higher order statistics, such as standard deviation and extreme values. Thus, while it may appear reasonable to adopt an interpolated temperature scenario based on the grid points of a global climate model for a specific location, the interpolated time series could be considered unsuitable for current climates, and thus generate uncertainties in the climate change scenarios.

For precipitation, the arguments in favor of downscaling are reinforced by the way precipitation is simulated in a grid of a low resolution climate model. Precipitation is simulated in a grid as an average for the entire area and is distributed uniformly. Thus, it is not appropriate to compare values generated by a model with observations at the station level. The problems with validation of frequencies and intensities of daily precipitation also raise some questions related to the level of confidence in climate change scenarios of the global climate models, especially for extreme precipitation events.

Two methods have been proposed for downscaling: dynamic and statistical. Dynamic downscaling is based on the use of regional climate models, while statistical downscaling is based on the functions of statistical transference[95]. Experiments with the use of global climate models have been carried out on various regions of the planet[96], and the most important issue, the regionalization of these climate change scenarios, is still being developed. Some experiments, such as PRECIS 2000 (Providing Regional Climates for Impacts Studies), an initiative of the Hadley Centre for Climate Prediction and Research, could be useful in deriving regional climate change scenarios. This includes the use of the Hadley Center's coupled model HadCM3 with the HadRM3 (Centro Hadley regional model), which has a 50 km horizontal resolution, 19 vertical levels and 4 soil levels. This regional model includes a broad representation of the physical processes in the atmosphere and on the earth's surface, and also includes a sulfur cycle. However, there is no broad analysis of current climate based on HadRM3, which is necessary to assess the model's ability and the predictability of climate in various regions of South America, as well as to determine the degree of uncertainty in the regional predictions of future climates on the continent.

5.10.3 – CPTEC'S STRATEGY FOR MODELING REGIONAL CLIMATE AND FOR PREDICTING CLIMATE FOR THE 21ST CENTURY

CPTEC's climate modeling strategy includes global climate models and regional climate models nested in a global climate model (dynamic downscaling).

For downscaling of global climate change scenarios to be developed at CPTEC, the regional model to be used is ETA/CPTEC, nested in version 3 of the Hadley Center's coupled global climate model (HadCM3H, a special version of HadCM3 with a higher horizontal resolution). A 300 year run of HadCM3H is being made available at CPTEC. The preference for the ETA/CPTEC regional model over the Hadley Centre's HadRM3 regional model results from the fact that CPTEC has knowledge and experience with the characteristics and structure of the ETA/CPTEC model, related to the use of this regional model in studies and experiments with sensitivity, simulations and predictions.

The modeling strategy includes running the ETA/CPTEC regional model with the IPCC climate change scenarios, based on the Hadley Centre's Global Coupled Model (HadCM3) developed in 1998. The ETA/CPTEC model will be improved with some modifications and the adaptation of its radiative scheme, so that it can include variable levels of radiative forcing from greenhouse gases and aerosols (CO_2, CH_4, S_2O, etc.), thus preparing the system to generate regional scenarios. In addition to the concentrations of greenhouse gases in the IPCC scenarios, the model will be capable of accounting for aerosols and other particulates and gases emitted to the atmosphere from burning of biomass and forest fires in the Amazon during the dry season, which, as documented, affects the regional energy balance and thus circulation and precipitation as well.

The HadCM3 is preferred principally because of the collaboration between CPTEC and the Hadley Centre, and its accurate representation of current climates in South America. The Hadley Centre made possible the use of the results of the special run of the HadCM3H model, implemented by the Hadley Centre under the PRECIS initiative. This run was 300 years, with a horizontal resolution of 1.25º x 1.875º of latitude-longitude and the daily products available every 6 hours, with Sea Surface Temperature (SST) anomalies provided by HadCM3's oceanic component. The HadCM3H model produces only daily results, which are insufficient to run the regional model. HadCM3H does not have the TRIFFID iterative vegetation scheme, available on the HadCM3 model. The 3H version runs were carried out for the A2 and B2 scenarios, and included a representation of the sulfur cycle. New scenarios (A1 and B1) will be available until the end of 2002. Testing is currently being carried on coupling of the ETA/CPTEC and HadCM3H models. It is expected that by the second half of 2002 we

[95] Giorgi and Mearns, 1991.
[96] Marengo, 2002; Hulme and Sheard, 1999.

will have a 10 year climatology from the ETA/CPTEC regional model, using the lateral conditions of the CPTEC/COLA model.

By mid-2003, results are expected from the model for time ranges centered on 2020, 2050 and 2080, with the climate change scenarios of HadCM3H downscaled with ETA/CPTEC. The regional model will be run with horizontal resolutions of 40 to 80 km and 38 vertical levels, with a six hour time step. The ETA/CPTEC model is being improved through incorporation of a new radiative scheme that includes the effects of smoke and aerosols resulting from burning of biomass in the Amazon. Smoke and aerosols are not currently included in the SRES.

The SRES climate change scenarios will be *downscaled* to 40 km with the use of both the ETA/CPTEC model and the HadCM3 global model. The regional climate change scenarios, together with any model results (paleoclimatic model runs) and various sets of observational data will be made available on the CPTEC web site and on mirror sites established by the Ministry of Science and Technology and other interested institutions. CPTEC will provide results of models and specialists for the analysis of these regional level climate change scenarios, in Brazil and South America. CPTEC's analysis will be carried out in the context of climate change scenarios after downscaling, observed climatic trends and the interpretation of paleoclimatic indicators, used as analogies of what could happen in the future as a result of climate feedbacks and mechanisms. The information provided by CPTEC will be used by other sectors of government and by society to assess impacts and vulnerability and the implementation of adaptation and mitigation measures by the respective decision-makers at the executive level of state and federal governments.

6 - FORMATION OF NATIONAL AND REGIONAL CAPACITY

Brazil has special needs in terms of the institutional structure to deal with issues related to climate change.

The development of human resources is one of the principal objectives related to the formation of national and regional capacity, since this issue is a new area of study and there are few specialized programs on the issue in developing countries.

This chapter describes Brazilian capacity-building initiatives related to the climate change, in particular the Center for Weather forecasting and Climate Studies (INPE/CPTEC), the participation of Brazilian scientists in the IPCC process and the Antarctica Program, and at the regional level, the creation of the Inter-American Institute for Global Change Research (IAI), an intergovernmental organization dedicated to research, with the goal of developing scientific capacity to understand the integrated impact of present and future global changes on the environment of the American continent, with its headquarters in Brazil.

6.1 - INTER-AMERICAN INSTITUTE FOR GLOBAL CHANGE RESEARCH (IAI)

6.1.1 - OBJECTIVES AND PRINCIPAL ACTIVITIES

The phenomenon of global change was identified at the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in 1992, as one of the greatest challenges to be faced in the near future. Since then, there has been a clear awareness that this is a trans-border issue and must be addressed scientifically as a global and regional problem, along with pursuing measures towards mitigation and alleviation at the national level.

With this concern in mind, the Inter-American Institute for Global Change Research (IAI) was created on May 13th, 1992, in Montevideo, Uruguay, to work at the level of the Americas. The Institute is an intergovernmental organization dedicated to research, with the goal of developing the capacity of understanding the integrated impact of present and future global change on regional and continental environments in the Americas and to promote collaborative research and informed action at all levels.

Guided by the principals of scientific excellence and international cooperation, and with a broad exchange of scientific data about global changes, the principal objectives of the Institute are:

- to promote and facilitate regional and international cooperation for interdisciplinary research about aspects of global change;
- to carry out, on a regional scale, research that cannot be conducted by one country or institution individually;
- to priorize study of aspects of global changes with regional importance;
- to contribute to the dissemination of information, education and technical and scientific capacity;
- to promote the free exchange of scientific information.

Thus, the IAI's work is carried through four basic activities:

- contributing to the advance of scientific knowledge on the continent, through research, education and technology transfer, and defining a scientific agenda with well defined priorities.

- supporting the International Conventions and Protocols (Climate Change, Biodiversity, Ozone), contributing to clarify the scientific issues and their policy implications related to these instruments, in order to support national interests.

- supporting broad international cooperation, contributing to international climate change related programs — World Climate Research Program (WCRP), International Geosphere-Biosphere Program (IGBP), International Human Dimensions of Global Environmental Change Program (IHDP) — promoting information policies for that ensure free access to data;

- serving the interests of IAI countries, through providing scientific information which serves the interests of federal, state and local governments, the private sector and the public in general.

6.1.2 - SCIENTIFIC AGENDA

For the IAI, the great scientific challenges are climate variations, ranging from seasonal to interannual; climatic changes in the coming decades; ultraviolet radiation and the reduction of stratospheric ozone; changes in land cover and in marine and terrestrial ecosystems; and the understanding of the complex behavior of the earth system and its various components. The Institute's other challenges include the management of large amounts of data about climate changes, communication of research results regarding these changes, education of a new generation of scientists from an appropriate environmental perspective, and the commitment to progressively understand the earth system.

Given these concerns and objectives, IAI maintains a dynamic scientific agenda, which concentrates on issues of regional interest determined by the Scientific Advisory Committee - SAC and approved by the Conference of the Parties (CoP). In light of the IAI's scientific agenda, the principal topics of investigation and related areas of interest to the Institute are:

Climate Variability in the Americas

The focus of this theme is the documentation of climate variability in the Americas and its links to changes in natural systems and societal impacts in those countries. The goals are to understand the ocean-land-atmosphere interactions and the key processes (either natural or anthropogenic) that cause climatic variability on time-scales of seasons to decades (for example, ENSO, hurricanes, frequency of drought and floods). Another research objective is to assess the impacts of climatic factors on economic sectors of the region (agriculture, fishing, water resources and public health).

Comparative Studies of Ecosystem, Biodiversity, Land Use and Water Resources in the Americas

Changes in climate, land use and vegetation cover are interconnected processes that affect the working of natural ecosystems and the availability and a quality of natural resources for the use and benefit of communities in the Americas. Thus, o IAI encourages comparative studies and analyses of natural and anthropogenic systems from the tropics to temperate zones and high latitudes, including terrestrial, coastal and oceanic systems, in order to establish the interactions at a global and regional level, as well as assess the consequences of global changes in these ecosystems.

Changes in the Composition of the Atmosphere, Oceans and Fresh Waters

The focus of this theme is on documenting and understanding processes that modify the chemical composition of the atmosphere, inland waters and oceans in a manner that affects productivity and human welfare in the countries of the Americas.

Integrated Assessment, Human Dimensions (socioeconomic impacts of global changes) and Applications and Use of Information in Public and/or Private Policies

This area encourages multidisciplinary projects which integrate natural and social science themes that include a human dimension component and on the application of research results to public and private policies for the benefit of the societies and economies of IAI member countries.

6.1.3 - TRAINING ACTIVITIES

Training and education of future scientists are fundamental for the ongoing advance of research on global changes in the Americas. Thus, the IAI has an important role in training students to carry out research than can contribute to resolving environmental problems in their countries, and contribute to the development of the Institute's scientific agenda. The IAI offers training and education to students through scholarships and supports training and education activities through its scientific program.

In Brazil, the National Scientific and Technological Development Council (CNPq) offers a total of 20 scholarships for Doctorate or Post-Doctorate studies in a program for training graduate students offered in conjunction with IAI, through an institutional agreement between the Institution and CNPq. To complement this, in June 1998, IAI and CNPq signed a memorandum of understanding which specifies fields and activities of common interest which could orient future cooperation activities between the two institutions.

Some of the Brazilian universities that offer Doctorate or Post-Doctorate programs in areas related to the scientific agenda of IAI are:

- University of Campinas (UNICAMP)
- Paulista State University (UNESP)
- Federal University of Vitória (UFV)
- Fluminense Federal University (UFF)
- Federal Rural University of Rio de Janeiro (UFRRJ)
- Federal University of Rio de Janeiro (UFRJ)
- University of São Paulo (USP)
- University of Rio Grande do Sul (UFRGS)
- National Institute of Space Research (INPE)
- National Institute for Research in the Amazon (INPA)

6.1.4 - FUNDING

IAI has been carrying out its institution-building program with funding from the GEF and implemented by the WMO. The objectives of this project, called "Regional Cooperation Activities for Support for Global Change Research in IAI countries", are as follows:

- expand and improve the scientific and technological capacity of human resources relevant to global change research in IAI member countries;
- create an acceptable and uniform capacity for data processing in member countries and develop a system for exchanging data in the Americas;
- develop standardized methodologies for collecting and processing basic data relevant to global change research.

Along with the US$3 million from GEF, the government of Brazil has given significant support to the project through a donation of software programs, including the Geographic Information and Image Processing System - SPRING and Meteorological data visualization and processing software - METVIEW, to all countries participating in the project.

6.2 - INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

In principal, IPCC is made up of experts chosen from among competent scientists throughout the world. In practice, however, most of the experts who participate in the assessment reports do Panel come from developed countries.

The participating of developing country scientists is proportionally very small. As a result, the participation of Brazilian scientists in the Working Groups[97] for the Assessment Reports is also small.

Only six Brazilian scientists participated in the IPCC First Assessment report, from 1990, with 4 in Working Group I (WG I) and 2 in Working Group II. For the IPCC Second Assessment Report, in 1995, 5 Brazilians participated (3 in Working Group I and 2 in WG II), 6 as collaborators (1 in WG I, 2 in WG II and 3 in WG III) and 6 as reviewers (1 in WG I, 2 in WG II and 3 in WG III). For the IPCC Third Assessment Report[98], 12 Brazilians scientists contributed as authors (3 in Working Group I, 3 in WG II and 6 in WG III), 1 as collaborators (WG II) and 10 as reviewers (2 in WG I, 3 in WG II and 5 in WG III).

One of the objectives of the national training programs in terms of issues related to climate change is to increase the number of Brazilian scientists who can carry out research related to the issue and contribute to a better understanding of related issues. The participation of these scientists is of great importance, especially because they have a more specific understanding of processes (such as, for example, those related to the Amazon Region) and technologies (such as use of alcohol as motor vehicle fuel) important to developing countries.

6.3 - CENTER FOR WEATHER FORECASTING AND CLIMATE STUDIES (CPTEC/INPE)

6.3.1 - PRINCIPAL RESEARCH AREAS

High quality of weather forecasting is essential to the planning and good performance of various economic activities, especially in agriculture. Also, precise weather forecasts also have impacts on social programs, facilitating decision-making in the areas of civil defense, electricity generation, and management of water resources, as well as contributing to the areas of transport, supply, tourism and leisure.

CPTEC/INPE is equipped with supercomputers SX-3/12R and SX-4/8A, capable of processing up to 3.2 billion and 16 billion floating decimal point arithmetic operations per second, respectively. They

[97] Working Group I assesses the scientific aspects of climate systems and climate change; Working Group II assesses the scientific, technical, environmental, economic and social aspects of vulnerability to climate change, along with the negative and positive consequences for ecological systems, socioeconomic sectors and human health; Working Group III assesses the scientific, technical, environmental, economic and social aspects of mitigating climate change and, through a multidisciplinary group, assesses the methodological aspects of crosscutting issues the Task Force works with the preparation of greenhouse gas inventories.

[98] Released in 2001.

have the capacity to use numeric models for the simulation of weather and climate, integrating atmospheric and oceanic information[99].

CPTEC's computing system is fed with information from METEOSAT and GOES satellites, from the WMO data network, national networks under the responsibility of INMET, under the Ministry of Agriculture, DEPV, in the Ministry of Aeronautics, DHN, in the Ministry of the Navy, state meteorology centers and other international centers. The satellites SCD-1 and 2, which collect environmental data, also plays an important role in collection the information necessary to INPE's meteorological research. An observation network meteorological and hydrological Data Collection Platforms (PCDs) were implemented in 1996 throughout the country. The PCDs are operated jointly by CPTEC and ANEEL, and transmit meteorological and hydrological information in real time to a center operated by CPTEC, through SCD-1 and 2. All this information enables CPTEC to provide reliable weather forecasts for the entire country.

The principal areas of research carried out by CPTEC are:

Anglo-Brazilian Amazonian Climate Observation Study (ABRACOS): the objective of ABRACOS, a collaboration between the Brazilian Cooperation Agency (ABC) and the UK Overseas Development Administration, is to monitor the climate of Amazônia and improve our understanding of the consequences of deforestation, along with providing data to validate the GCM model and its sub-models for the Amazon forest and pasture after deforestation. The ABRACOS experiment ended in 1997, but the flux towers and other scientific installations still operate, serving as a base for research projects currently being carried out in the Amazon, such as LBA.

Research in the Climate Area - Climate: the objective of Research in the Climate Area is to carry out observational studies and experimental climate simulations and predictions through the use of a numerical of global circulation models, as well as regional models. These activities also include the monitoring and prediction of phenomenon such as El Niño and La Niña, on an interannual scale, and cold or heat waves on an interseasonal scale. New areas of climate research were developed. Some of this research analyzes the global characteristics of the atmosphere, climate variability at various temporal scales, and effects of climate anomalies on South America and more particularly, on Brazil.

Applications for Weather Satellites - Satellites: the principal objective is to research, develop, install and disseminate methods for analyzing weather satellite data, studying atmospheric and land surface properties and variables and generating information about weather, climate and the environment. Some of the products derived from satellites include data about fog, burning, vegetation index, TOVS probes, solar radiation, winds and ocean temperature.

Weather Research Area - Weather: has the objective of conducting systematic observation of phenomenon related to weather prediction, such as fog, atmospheric pressure, relative humidity, rainfall indexes, etc. The global model used is the CPTEC/COLA with a resolution of 200 km (T062) and 100 km (T126), as well as the ETA/CPTEC regional model with resolution of 40 and 80 km.

Updating the Representation of Vegetation in the CPTEC/INPE Numerical Models - (ProVeg): although continental surface modeling can increase the capacity to understand its interaction with the atmosphere, the inaccurate or insufficient representation of continental surface conditions and processes could have a negative impact on weather prediction and climate studies. Thus, ProVeg is an initiative that seeks to improve the representation of the spatial variability of vegetation in the climate

[99] The SX-3 model will be replaced by the new supercomputer SX-6, which should enter into operations in 2002. The SX-6 will be capable of processing up to 768 billion floating decimal point arithmetic operations per second, when the two implementation phases are completed. With this new supercomputer, CPTEC will enter a new era of research on climate and climate changes, since it will be possible to run global and regional climate models to generate climatic scenarios for the 21st century.

and weather forecasting models, through adaptation of a more detailed database and with parameters that more appropriately represent the physical properties of soils and the types of vegetation on Brazilian territory.

Laboratório de Instrumentação e Calibração Meteorológica - LIM: is supported by the Research Support Foundation of the State of São Paulo (FAPESP) and has the objective of supporting research under way in the area of meteorology (especially in micrometeorology and soil-plant-atmosphere interaction) throughout the country and especially in the Amazon region, given the start of field activities of the LBA project in January of 1999.

Project - Physical Processes in Regional Models and Improved Quality of Weather Predictions in South America: refinement of weather prediction for South America, through modern techniques of representing the physical processes adapted to the atmospheric conditions of the region, using the ETA/CPTEC regional model.

Brazilian Regional Atmospheric Modeling System (BRAMS): a CPTEC project, financed by FINEP, to carry out regional weather predictions for Latin America and Portuguese speaking countries, using the RAMS regional model.

Public education in Secondary Schools (ENSINOP): creation of an interactive multimedia program, resident either on a CDROM or on the Internet.

CPTEC/INPE also carry out special forecasting and monitoring projects[100]**:**

Program for Real Time Climate Monitoring in the Northeast Region (PROCLIMA): a joint initiative of SUDENE and the Ministry of National Integration to monitor the rainy season in the Northeast region. PROCLIMA is implemented by CPTEC and by states of the Northeast Region, Minas Gerais and Espírito Santo, through government centers and laboratories participating in the Weather, Climate and Water Resources Monitoring Program. The Program monitors trends in daily, weekly and monthly precipitation levels. The meteorological variables permit the calculation of the daily distribution of precipitation and evapotranspiration over the entire region, information which, when appropriately combined with Embrapa's soil data, allow estimation of soil moisture content. This system aims at supporting decision-making in agricultural activities. The system also has a database of socioeconomic data which includes 1998 IBGE demographic census data, the 1995 agriculture and livestock census, as well as numbers of those enrolled in make-work projects surveyed by SUDENE.

Project Burn: presents the latest fires detected in the most recent images from the NOAA satellites. The data are updated operationally various times per day, all year round. The options indicated in the top and left side of the Portal permit access to dozens of related products, such as maps of fire risks, monthly distribution of burning, incidence of fires by state, days without precipitation, accumulated precipitation, a powerful geographic base for visualizing locations of fires, etc.

Modeling of Waves: The third generation global model of ocean waves (WAM) produces two daily forecasts, based on the forcing of wind fields produced by CPTEC's global atmospheric model. The model generates forecasts of wave height and direction.

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[100] CPTEC/INPE also participated in the hydrometeorological monitoring and prediction by the Climate Prediction Research Group as support during the energy crisis of 2001, where monitoring was conducted on the situation of the reservoirs of the Southeast in the Watersheds of the Rio São Francisco, Grande, Paranapanema, Tietê and Tocantins, as well as weather and climate predictions for the watersheds, with emphasis on the drought of 2001. This was done in response to a direct request of the Energy Crisis Management Committee of the Federal Government, in 2001. The work of the group continues and was extended to all Brazil's watersheds.

Climate Change: calls for activities and research on climate trends n Brazil and the implementation of a research group for preparing climatic scenarios, using the experience of participation of CPTEC researchers in the IPCC, as well as collaboration with researchers from the Hadley Centre, the Tyndall Centre, and the University of East Anglia in the UK. It is expected that a regional modeling capacity will be implemented at CPTEC to develop regional climatic scenarios based on the IPCC predictions, using the technique of dynamic downscaling, where the Hadley Centre's HadCM3 coupled global model will be aligned with the ETA/CPTEC regional model, allowing the implementation of regional climate predictions for Brazil and South America, with a resolution of up to 40 km (see section 5.10).

7 – INTEGRATION OF CLIMATE CHANGE ISSUES IN MEDIUM AND LONG TERM PLANNING

Brazil's environmental legislation is among the most advanced in the world, although there are still administrative and institutional difficulties in its implementation.

Awareness of medium and long term environment issues is essential to sustainable development, a principal that is set out in the Rio Declaration and which is one of the foundations of Agenda 21. Both documents are outcomes of the UN Conference on Environment and Development (UNCED), held in Brazil in 1992. Domestically, in the process of drafting the Brazilian Agenda 21, an attempt was made to establish strategies for pursuing sustainable development in Brazil, with recommendations for actions, actors, partnerships, methodologies and institutional mechanisms necessary for its implementation and monitoring.

In terms of national policies for medium and long term planning, for the first time in the Government Multi-year Plan (PPA 2000-2003), known as "Avança Brasil", there is a specific program on climate change to produce scientific information related to greenhouse gas emissions and to support the development of a policy for actions in this area.

The programs described in this chapter, in most cases, do not have the direct objective of reducing greenhouse gas emissions, but will have impacts on emissions from different sources. One of the most important factors is that not just the federal level is involved, since some initiatives also require the commitment of states and municipalities.

At the federal level, the National Program for Air Quality Control (PRONAR) seeks to control air quality by establishing national emission limits; the Control Program for Air Pollution from Automotive Vehicles (PROCONVE) has the same objective, but deals specifically with air pollution by automotive vehicles. Although these programs are aimed at fighting local pollution and not directly at climate change, they involve similar institutional and legislative aspects and could, in the future, enable the creation of similar instruments and legislation to address greenhouse gas emissions from human activities.

Another important issue addressed in this work involves the measures adopted by the Brazilian government – aware of the importance of Amazônia for the future of the country – to combat deforestation in the region. The legal, administrative and economic measures that have been adopted, as well as the strategy for political actions, are analyzed here.

The Project for Monitoring and Control of Deforestation and Fires (PRODES) is the largest forest monitoring project in the world, providing estimates of deforestation; and the Program for Prevention and Control of Burning and Forest Fires in the Arc of Deforestation Fires Program (PROARCO) is aimed at predicting and controlling burning and forest fires in the Arc of Deforestation. Also, there is a large number of Conservation Areas in Brazil to protect and conserve samples of existing flora and fauna, in accordance with Article 4.1 (d) of the UN Framework Convention on Climate Change, which requires Parties to "promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems."

At the state level, the State Program for Global Climate Change of the State of São Paulo - PROCLIMA demonstrate the commitment assumed by the state of São Paulo in emissions reductions and control of atmospheric pollution. Em at the municipal level, the explicit commitment to reduction of greenhouse gases was assumed by the cities of Niterói, Volta Redonda, Goiânia, Porto Alegre and Rio de Janeiro under the campaign Cities for Climate Protection - CCP.

Finally, financial and fiscal measures (Green Protocol, Ecological ICMS Tax, etc.) are analyzed, which have begun to show significant results for the reduction of environmental degradation and the promotion of sustainable development.

7.1 - BRAZILIAN ENVIRONMENTAL LEGISLATION

Since colonial times, Brazil has had specific regulations for protection of its territory and wealth, which were already found in the colonial laws of Afonsinas, Manoelinas and the Philippines, and were thus in force in Portugal at the time of discovery (1500).

The oldest Brazilian legal document addressing the environment is the Waters Code (decree nº 24,643, of July 10, 1934), which defined the right of ownership and exploitation of water resources for water supply, irrigation, navigation, industrial uses and electrical generation. Thus, since the 1930s there have been various legal instruments which establish the rights and duties of society in relation to specific environmental areas.

A very important law in the history of Brazilian environmental legislation is # 4771, from September 15, 1965, known as the Forestry Code, which recognized existing forests on Brazilian territory and other forms of vegetation as public goods, imposing limits on the right to property. It also established minimum criteria for the permanent preservation of areas and for the creation of parks and biological reserves.

Since the 1970s, with the United Nations Environmental Conference held in Stockholm in 1972, there has been growing concern in Brazil regarding issues of environmental protection.

In 1973, a Special Environmental Secretariat (SEMA) was created under the Ministry of the Interior, which was the first official Brazilian body devoted to the rational use of natural resources and environmental preservation. With the creation of this body, legal regulations were expanded significantly.

Law # 6803-80, which defines the basic rules for industrial zoning in critical pollution areas, introduced the idea of Environmental Impact Assessment (EIA). One of the elements of the environmental impact assessment process is the Environmental Impact Study (EIA), for which regulations were introduced later, and which was mentioned in the 1988 Federal Constitution. This requires that a multidisciplinary team carry out technical and scientific work to systematically analyze the consequences of implanting a project in the environment, through EIA methods and techniques for predicting the environmental impacts. The result of the study is the Environmental Impact Report, which is accessible to the public and funded by the project proponent.

In 1981, the first generic law was created to systematize the existing specific laws, with the publication of Law nº 9638, which provides for a National Environmental Policy, its objectives and mechanisms of formulation and application. This law, which establishes environmental licensing as an instrument of this policy, addresses connections between economic development and environmental preservation, and direct or indirect administrative bodies from the three levels of government. The law also created the National Environmental System SISNAMA) and the National Environmental Council (CONAMA), whose responsibilities include establishing regulations and standards related to the control of environmental quality.

Another important advance related to protection of the “diffuse rights” involves Law # 7347/85, which governs public civil actions involving responsibility for damage caused to the environment.

The 1988 Constitution represents a significant advance for the environmental area, in that it dedicates a special chapter to the environment and includes its defense among the principals of the economic order, seeking to reconcile promotion of socio-economic growth with the need for environmental protection and preservation.

Thus, Art. 225 of Chapter VI, dealing with the environment, establishes that: "All have the right to an ecologically balanced environment, a good of common use of the people and essential to a healthy quality of life, imposing on the public authorities and the collective the duty to defend and preserve it for the present and future generations." Thus the environment is characterized as an inherent right of each individual and of all of society, with the public authorities and the collective, without distinction, having the duty of preserving it and ensuring environmental balance. Paragraph 1 of this Article identifies the responsibilities of the public authorities, which include:

- preservation and restoration of essential ecological processes and promotion of ecological management of species and ecosystems;

- preservation of the diversity and integrity of the genetic heritage of the country, and inspection of entities dedicated to research and manipulation of genetic materials;

- definition in all the units of the Federation of territories to be specially protected;

- requirement of prior environmental impact study for the installation of a project or activity which is a potential cause of significant environmental degradation;

- control of production, sale and use of techniques, methods and substances which pose a risk to life, quality of life, or the environment;

- promotion of environmental education and public awareness for environmental preservation;

- protection of fauna and flora, with those practices that put at risk its ecological function, cause species extinction, or submit animals to cruelty being prohibited, under the law.

Along with the measures and provisions which are the responsibility of the public authorities, the 1988 Federal Constitution imposes behavior on those who can directly or indirectly cause damage to the environment: requirement that those who exploit mineral resources restore degraded areas; need to create federal legislation governing siting of nuclear power plants; non-availability for development or occupation of unoccupied government lands or lands acquired by states through formal demarcation processes, in cases where this is necessary for the protection of natural ecosystems.

Furthermore, Paragraph 4 of the same article of the Constitution declares the Brazilian Amazon Forest, the Atlantic Forest, the Coastal Forest, the Pantanal in the state of Mato Grosso and the Coastal Zone to be national heritage areas, with their use being subject to the law, under conditions that ensure environmental preservation.

Although the Constitution gives special attention to preventative activities, it also makes reference to punitive measures. Paragraph 3 of Article 225 provides for penal and administrative sanctions for individual or corporate lawbreakers, whose conduct or activities are considered damaging to the environment, independently of the obligation to make restoration of the damage caused.

In 1989, Law # 7735, of February 22, created the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA), with the purpose of implementing and enforcing the national policies for environment, preservation, conservation and rational use, inspection, promotion and control of natural resources. This body was constituted through merging four Brazilian organizations working in the environmental area: Environmental Secretariat (SEMA); Rubber Superintendency (SUDHEVEA); Fishing Superintendency (SUDEPE), and the Brazilian Institute for Forestry Development (IBDF).

In 1996 there was an important amendment to the Forestry Code, through provisional measure # 1511, from July 26, which revises Art. 44 of Law # 4771, from September 15, 1965, providing for the prohibition of increase in conversion of forested areas to agricultural areas in the North region and the northern part of the Center West region. The new text of Article 44 of the Forestry Code provides that in these regions clearing is only allowable if tree cover remains on at least 50% of the area of each property. Furthermore, according to the provisional measure, in the properties where the tree cover consists of forest physiognomy, clearing will not be permitted in at least 80% of these forest typologies (see section 7.6.2.1). This provisional measure has since been revised.

Another important legal advance is the Environmental Crimes Law, which represents a change in the system of sanctions in the current legislation. Until then, the legal arrangement has only established monetary sanctions for crimes against flora. The law passed on February 12, 1998, # 9605 (Environmental Crimes Law), provides for penal and administrative sanctions for conduct and activities which damage the environment, such as for example, setting a penalty of 1 to 3 years in prison followed by a fine to the author of crimes against flora, including for cutting trees on legal reserves or in forests with a specially protected status. This law consolidates environmental legislation, with typification of environmental crimes and infractions and with their respective penalties duly stipulated.

In 2000, the project of the National System of Conservation Units was approved by the Senate, received Presidential sanction and became Law nº 9985, which brought the concept of conservation area up to date, introducing social issues and uses for other ends. The importance of the establishment of a National System of Conservation Areas is in the definition, uniformization and consolidation of criteria for the establishment and management of these Areas, thereby enabling a better management of Brazilian environmental heritage.

Brazilian legislation addressing defense of the environment is made of numerous dispersed laws. This phenomenon, as in almost all areas of law, results from, among other factors, the different political and institutional contexts that have characterized the recent history of Brazil.

With the goal of consolidating the legislation in the most important branches of Brazilian law, the Steering Committee of the Chamber of Deputies created a Working Group for the Consolidation of Brazilian Legislation, which will also work towards consolidating Brazil's environmental legislation.

In summary, it is recognized that the Brazilian environmental legislation is one of the most advanced in the world, with clear legal guidelines for pursuing sustainable development, in spite of the institutional and administrative difficulties posed to its broad implementation.

7.2 - BRAZILIAN AGENDA 21

7.2.1 - AGENDA 21

The United Nations Conference on Environment and Development (Rio-92) was an historic event, representing a planetary effort to establish new directions for development based on environmental protection, social justice and economic efficiency. Five documents resulted from this conference: the Rio Declaration on Environment and Development, a Agenda 21, the Statement of Principals on

Forest Management, the United Nations Convention on Biodiversity, and the United Nations Framework Convention on Climate Change.

The Rio Declaration includes a set of guidelines adopted by consensus by leaders from all over the world, to ensure the sustainability of development in the coming century. Sustainable development should be understood as "development that meets the needs of the present, without compromising the ability of future generations to meet their own needs"[101].

Accordingly, Agenda 21 indicates the strategies for pursuing sustainable development, suggesting actions, actors, partnerships, methodologies and institutional mechanisms necessary for its implementation and monitoring.

The focus of discussion in the formulation of Agenda 21 was not only global strategies, but rather there was an attempt to focus simultaneously on the global and local. The strategies outlined in Agenda 21 for solving problems combine decentralized cooperation and local action, through implementation of policies and programs that mobilize at the same time local, national, regional and international institutions.

Given the importance of each society establishing their own priorities, the signatory countries to the agreements emerging from the United Nations Conference on Environment and Development assumed the commitment to development and implement their respective national programs for Agenda 21.

7.2.2 - COMMISSION ON SUSTAINABLE DEVELOPMENT POLICIES AND NATIONAL AGENDA 21 (CPDS)

The approach used by several countries for constructing their national Agenda 21 emphasizes partnerships between the different levels of government, the private sector and organized civil society. In more than 70 countries, national sustainable development councils or committees linked directly to the head of government have been created to manage, implement and monitor the Agenda 21, usually with the participation of civil society.

In Brazil at the beginning of 1997, a new national committee was created for sustainable development and linked to the Chamber of Natural Resource Policies of the Government Council. This new institutional arrangement has the goal of bringing together, under the President of the Republic, the coordination of various bodies and governmental agencies committed directly to the Brazilian Agenda 21.

Thus, through a Decree of February 26, 1997, a Sustainable Development and National Agenda 21 Policies Commission (CPDS) was created under the Chamber of Natural Resource Policies. The purpose of the Commission is to propose strategies for sustainable development, and the coordination, development and implementation of Agenda 21.

The CPDS is chaired by a representative of the MMA and consists of one representative of each of the bodies of the different sectoral activities of the government: Minister of Planning and Budget, MRE, MCT, the then Secretariat of Strategic Issues of the Presidency of the Republic (SAE), and the Secretariat of the Chamber of Sectoral Policies.

[101] This definition was used in the document *Our Common Future*, 1987, known as the Brundtland Report, prepared by the World Commission on environment and Development, created by the United Nations and chaired by the then Prime Minister of Norway, Gro Harlem Brundtland.

Along with the government bodies related directly to environment and development issues, it is intended that the CPDS have parity, with five representatives of organized civil society.

According to Article 2 of the decree creating it, the CPDS has the following powers and responsibilities:

- propose to the Chamber strategies, instruments and recommendations oriented to sustainable development in Brazil;
- develop and submit for approval of the Chamber the National Agenda 21.
- coordinate and monitor the implementation of the National Agenda 21.

7.2.3 - AGENDA 21 AND THE MULTI-YEAR PLAN (2000-03)

In the first meeting of the CPDS and the National Agenda 21, the then Minister of Planning, announced that both the Program "Brazil in Action" and the PPA 2000 would be created in accordance with the criteria of sustainability of Agenda 21, to be prepared with civil society participation.

Considering Agenda 21 as the basis for preparation of the government's PPA (2000-03) is an important advance towards incorporating the concept of sustainable development into Brazil's public policies. Thus, the National Agenda 21 has come to be seen as a strategic instrument, through which a bridge can be built between the current model of development and that desired.

7.2.4 - PREPARATION OF THE NATIONAL AGENDA 21

The first steps towards the preparation of the National Agenda 21 were taken in 1995. At that time, the MMA carried out studies and held a series of meetings with a range of governmental and non-governmental actors seeking input in defining a methodology to be used, and outlining the status of initiatives for sustainable development in Brazil.

This included the following activities:

- Preparatory Workshop for Brazil's Agenda 21, held in Brasilia in April of 1996, bringing together representatives of governmental and private institutions, NGOs and universities;

- National consultation on "Sustainable Development: 100 Brazilian experiences", held between October 1996 and February 1997, with registration by issue and the dissemination of 183 projects throughout the country;

- The Seminar "Agenda 21 – The Concrete Utopia", held in Rio de Janeiro in March of 1997, simultaneously with Rio+5, with discussions about strategic issues and priorities for the National Agenda 21;

- National Study of "What Brazilians think about the environment, development and sustainability", carried out with the Museum of Astronomy and Related Sciences - MAST, the Institute for Studies of Religion (ISER) and the Brazilian Institute of Public Opinion and Statistics (IBOPE), which surveyed the opinions of around 2000 people throughout the country.

- Document "The Path of the Brazilian Agenda 21 – principals and actions 1992-97", prepared with the support of the initiatives described above.

These intensive discussions provided important inputs to CPDS in establish a methodology for developing the Brazilian Agenda 21, which defines the priority positions and issues for the country.

It was decided to organize the Brazilian Agenda 21 in three primary sections: an introduction, which gives an overview of the country at the beginning of the 21st century; a section devoted to the six areas identified as priorities (sustainable cities, sustainable agriculture, infrastructure and regional integration, management of natural resources, reduction of social inequalities, and science and technology and sustainable development); and a final part about the means of implementing the strategies established for each theme. It should be stressed that the methodology adopted should reflect the interconnections of the priority issues and the interdependence between the environmental, economic, social and institutional areas.

Since the National Agenda 21 is not intended to be just another government document, but rather the product of a consensus between the different sectors of Brazilian society, the MMA began a tendering process for hiring consultants to organize the discussion process and preparation of the reference documents on the issues considered priorities for the National Agenda 21.

The consortium of consultants which was successful in the bidding process carried out their work using participatory methods, through workshops and seminars open to the public, seeking to involve all sectors of society related to the issues at hand.

The results of the work carried out be consultants were organized and synthesized, in order to form the first version of the Brazilian Agenda 21. This version was discussed and reviewed with the participation of a range of sectors of society. For this, the strategy proposed by CPDS was based on the organization of state-level discussions, with recommendations emerging at regional meetings.

On June 8, 2000, during Environment Week, the CPDS delivered to the President of the Republic the results of the work carried out to date, which were included in the document "Brazilian Agenda 21 – Bases for Discussion". At that time, the continuation of the process of developing the agenda through holding state-level debates was announced. Upon completion of the state-level discussions, a regional meeting was held in each region of the country, where the reports from the states were analyzed with the objective of preparing a document that expresses the outcomes for the region.

The process of developing the Brazilian Agenda 21 can be followed on the homepage of the Ministry of Environment (www.mma.gov.br)[102].

7.3 - BRAZILIAN CLIMATE CHANGE RESEARCH PROGRAM (MCT)

An example of the increasing importance of issues related to climate change was the inclusion of a Climate Change Program in the federal government's Multi-Year Plan (PPA 2000-03), with the allocation of Federal budgetary resources. The Program's objective is to develop scientific information related to greenhouse gas emissions to support the definition of a policy for activities related to climate change. The measure identified for achieving that objective is to increase the number of institutions with the capacity to address the climate change issue. When the program began, there were 27

[102] The launch of the Brazilian Agenda 21 took place in July of 2002, finalizing the preparation phase and marking the beginning of the implementation phase. The Brazilian Agenda 21 consists of two documents: "Agenda 21 Brasileira - Ações Prioritárias", which established the preferential paths to the construction of Brazilian sustainability, and "Agenda 21 Brasileira – Resultado da Consulta Nacional", product of the discussions held throughout Brazil.

institutions directly involved with the issue, and it is expected that at the end of the PPA, 49 institutions with the appropriate capacity will be directly involved.

The Climate Change Program included 6 actions:

Action 1 - Carrying out studies about vulnerability and adaptation to the impacts of climate change.
Action 2 - Development of forecasting models to monitor climatic changes.
Action 3 - Preparation of the National Inventory of Anthropogenic Greenhouse Gas Emissions.
Action 4 - Implementation of a monitoring system for greenhouse gas emissions.
Action 5 – Greenhouse effect information system.
Action 6 – Research on climate change mitigation.

When the Program was in the early stages of development, activities were carried out to promote work in this area, coordinated by Funding Agency for Studies and Projects - FINEP , with resources from the National Fund for Development of Science and Technology (FNDCT). In terms of research, it is intended to develop a stimulus program for research jointly with CNPq for the studies needed for the inventory, based on the areas where there is a lack of knowledge in Brazil, identified during the development of the inventory.

Information about the projects developed within the Climate Change Program and their outcomes can be found at the site of the Global Change Coordination Office of the Ministry of Science and Technology (MCT) (www.mct.gov.br/clima).

7.4 - NATIONAL AIR QUALITY CONTROL PROGRAM - PRONAR

In recent decades, the levels of atmospheric pollution in urban areas of Brazil increased considerably, along with the economic and industrial growth of the country. For this reason, control programs for urban industrial pollution have been developed in several regions, as well as other programs that seek to reduce emissions of pollutants from the principal pollution sources. Within these sources, automotive vehicles have become the greatest concern in large metropolitan regions.

At the same time, there is awareness of the importance of the creation of a national program that addresses the fixed sources of atmospheric pollution. Given that most states do not provide local source emission standards, there was a need for establishing regulations and atmospheric monitoring activities.

Thus, through CONAMA Resolution nº 5, from June 15, 1989, the National Air Quality Control Program (PRONAR) was created, in order to provide guidance and control for atmospheric pollution in Brazil, involving regulatory strategies such as the establishment of national standards for air quality and source emissions, the implementation of a policy for prevention of the deterioration of air quality, the implementation of a national air monitoring network, and the development of inventories of priority sources and atmospheric pollutants.

The basic strategy of PRONAR, according to this resolution, is to establish national limits for emissions, by type of source and priority pollutants, with the use of air quality standards held in reserve as a complementary control action. In order to implement this, short, medium and long term goals were established as a basis for the allocation of resources and decisions about actions.

The first legal provision under PRONAR was CONAMA Resolution # 3, of June 28, 1990, which established new national air quality standards:

Table 30- National Air Quality Standards – CONAMA Resolution nº 3, from 28/06/1990

Pollutant	Duration of sampling	Primary Standard μg/m^3	Secondary Standard μg/m^3	Measurement Method
Total Suspended Particulates - TSP	24 hours* AGM**	240 80	150 60	High Volume Sampler
Smoke	24 hours* AAM***	150 60	100 40	Reflectance
Inhalable Particles	24 hours* AAM	150 50	150 50	Inertial Separation/ Filtration
Sulfur dioxide	24 hours* **AAM**	365 80	100 40	Pararosaline
Carbon monoxide	1 hour* 8 hours*	40,000 (35 ppm) 10,000 (9 ppm)	40,000 (35 ppm) 10,000 (9 ppm)	Non-dispersive Infrared
Ozone	1 hour*	160	160	Chemiluminescence
Nitrogen Dioxide	1 hour AAM	320 100	190 100	Chemiluminescence

(*) Should not be exceeded more than once per year
(**) Annual Geometric Mean (AGM)
(***) Annual Arithmetic Mean (AAM)

Another advance in this resolution was the establishment, at the national level, of criteria for preparation of an emergency plan for severe air pollution incidents, which previously existed only in the State of São Paulo.

Table 31- Criteria for severe air pollution incidents – CONAMA Resolution nº 3, from 28/06/1990

Parameters	Levels		
	ATTENTION	ALERT	EMERGENCY
TSP* (μg/m^3) - 24 h.	375	625	875
Smoke (μg/m^3) - 24 h.	250	420	500
Inhalable Particulates (μg/m^3) - 24 h.	250	420	500
Sulfur dioxide (μg/m^3) - 24 h.	800	1.600	2100
Carbon monoxide (ppm) – 8 h.	15	30	40
Ozone (μg/m^3) - 1 h.	400	800	1000
Nitrogen dioxide (μg/m^3) - 1 h.	1130	2260	3000
SO_2 X TSP* (μg/m^3)x(μg/m^3) – 24 h.	65.000	261,000	393,000

(*) Total Suspended Particulates - TSP

However, the State Air Pollution Control Programs were not developed and implemented as planned. This fact, along with some administrative characteristics of the program, rendered unviable the medium term goals such as implementation of the national air quality monitoring network and production of a national inventory of sources and emissions. Thus, most of the goals established in Resolution nº 5, of June 15, 1989, were not achieved. Currently, IBAMA has plans to reactivate this program.

It is also expected that the "Law of Environmental Crimes" (Law # 9605, of February 12, 1998), which should provide greater agility in punishing polluters, will give the program new strength. Section III of the chapter on environmental crimes specifies crimes related to pollution and other environmental crimes. Another advance under this law is the definition of responsibilities of corporations – including penal responsibility – and allows the responsibility to be also placed on individuals as the author or co-author of the infraction.

The implementation of mechanisms for the control of environmental quality, such as ISO 14000, can also significantly support air quality control, with the direct involvement of the private sector. The important thing, however, is to strengthen the institutional structure and implement the provisions of PRONAR so that this program becomes an effective instrument for the control of environmental pollution.

7.5 - MOTOR VEHICLE AIR POLLUTION CONTROL PROGRAM - PROCONVE

7.5.1 - HISTORY OF PROCONVE

In Brazil, highway transportation accounts for 96.1% of passenger transport. Growing urban pollution, deficiencies in public policies regarding mass transport and the recovery of economic growth have caused a dramatic increase in private transportation. The national fleet of automobiles and light duty vehicles increased from 10,325,000 in 1990 to 12,726,000 in 1995[103], resulting in increased pollutant emissions from motor vehicles.

The main pollutants emitted by motor vehicles are carbon monoxide (CO), nitrous oxides (NO_x), hydrocarbons (HC), particulate matter (PM), aldehydes (CHO), sulfur oxides (SO_x), and lead (Pb) compounds[104]. There are also emissions of carbon dioxide (CO_2), which although not considered a typical pollutant because of its low toxicity, should also be taken into account because of its contribution to the greenhouse effect.

On May 6, 1986, resolution nº 18 of CONAMA created the Motor Vehicle Air Pollution Control Program (PROCONVE) with the purpose of mitigating pollutant emission levels from motor vehicles, improving the technical characteristics of liquid fuels used by the national fleet of motor vehicles and reducing atmospheric emissions. This resolution established the basic guidelines of the Program and stipulated the first emission limits. On October 28, 1993, Law nº 8723 assigned responsibilities for taking the necessary steps to reduce vehicle pollution emission levels.

The Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) is responsible for the national coordination of the program. CETESB is co-responsible for its implementation, operation and technical updating, through an agreement to provide technical advice and support.

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[103] The scrappage rate is already calculated. Cf. USP Report "Emissão de Gases de Efeito Estufa Brasil 1990-1994" prepared for the Ministry of Science and Technology.
[104] However, limits for sulfur oxide ((SO_x) emissions and of lead (Pb) compounds are not regulated in Brazil.

The technical aspect of the program is very important, since its main objective is to reduce atmospheric contamination by establishing maximum emission limits, inducing technological advances on the part of manufacturers and requiring that both vehicles and engines comply with the limits established. Compliance is measured by means of standard tests in dynamometers, using a reference fuel. PROCONVE also calls for certification of prototypes and keeping of statistics of production vehicles; authorization from IBAMA for the use of alternative fuels; the impounding or repair of vehicles and engines that are found not to be in accordance with production or design standards; prohibition of sale of vehicle models that have not been approved; and establishment of “Inspection and Maintenance Programs for Vehicles in Use”, called “I/M Programs”.

Approval of prototypes is the foundation of PROCONVE, inducing manufacturers to use design principles that ensure a low pollution potential in new vehicles and a low deterioration rate for emissions throughout their useful life. Emission limits and other PROCONVE requirements apply both to domestic and imported vehicles/engines.

To implement the program, vehicles were classified in three categories, each with a specific timetable: light passenger vehicles, with a total mass of up to 3,856 kg (automobiles); 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 a total mass of above 3,856 kg (buses and trucks).

Box 3 – Elimination of Tetraethyl Lead

At the beginning of PROCONVE, to be able to achieve the specified emission levels, it was seen as necessary to use catalytic converters on automobile exhaust systems and electronic fuel injection to replace carburetors. Since the tetraethyl lead added to gasoline rendered catalyzers inoperative in a short time, this additive was clearly incompatible with the new technological resources for emissions reductions. Thus, efforts of Petrobras resulted in the elimination of tetraethyl lead in gasoline in 1989, and Brazil became the first country in the world to completely eliminate this toxic additive from its fuel matrix. O aditivo usado como substituto do chumbo tetraetila passou a ser o álcool anidro, que tem vantagens significativas, principalmente ambientais.

7.5.2 - SCHEDULE FOR IMPLEMENTATION OF PROCONVE

7.5.2.1 - Light Passenger Vehicles

With regard to light passenger cars, emission control was divided into three phases, according to the provisions of Resolution nº 18/86, with the first two already completed. Phase I, from 1988 to 1991, de forma gradual, 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, under way since 1997, is characterized by inducing the manufacturer/importer to employ state-of-the-art technologies available for mixture formation and electronic control of the engine, setting emission limits (table 32) equivalent to those in force in the United States[105], although with different time frames; on whose experience the program was based.

[105] The targets for Brazil in 1992 were the same as the targets for the U.S.A. in 1983. The targets set in 1997 were the same as for the U.S.A. in the same period. Today, only California has more rigorous emission limits, because of their large number of vehicles.

Table 32 - Light Passenger Vehicles - since 01/01/1997

POLLUTANTS	LIMITS
Carbon monoxide (CO g/km)	2.0
Hydrocarbons (HC g/km)	0.3
Nitrogen Oxides (NO_x g/km)	0.6
Particulate material (PM** g/km)	0.05
Aldehydes (CHO* g/km)	0.03
Evaporative emission (g/test)	6.0
Crankcase gas emissions	None

(*) except for vehicles with diesel engines.
(*) except for vehicles with Otto cycle engines.

7.5.2.2 - Light Commercial Vehicles

CONAMA resolution nº 15 of December 13, 1995, marked the beginning of concern for light duty vehicles, including vans and pick-ups. With the significant increase in the number of such vehicles in Brazil, maximum emission limits have also been set for them (table 33).

Table 33 - Light duty vehicles - reference test mass of over 1700 kg since 01/01/1998

POLLUTANTS	LIMITS	
	Vehicles with specific mass of up to 1700 kg	Vehicles with specific mass of above 1700 kg
Carbon Monoxide (CO g/km)	2,0	6,2
Hydrocarbons (HC g/km)	0,3	0,5
Nitrogen Oxides (NOx g/km)	0,6	1,4
Particulate material (PM** g/km)	0,128	0,16
Aldehydes (CHO* g/km)	0,03	0,06

(*) except for vehicles with diesel engines.
(*) except for vehicles with Otto cycle engines.

7.5.2.3 - Heavy Vehicles

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

CONAMA resolution nº 18/86 took the first steps to control diesel vehicle emissions in 1993, by means of resolution nº 8 of August 31, which updated PROCONVE to include heavy vehicles manufactured and sold in Brazil, regardless of the type of fuel used. As Diesel powered vehicles comprise the vast majority of heavy vehicles, maximum emission limits were established for diesel vehicles, as described in table 34 below.

Table 34 - Heavy Vehicles

	CO (g/kW)	HC (g/kWh)	NO_x (g/kWh)	Smoke(k) [1]	Particulates (g/kWh) [1]
PHASE I	—	—	—	2.5	—
PHASE II	11.2	2.45	14.4	2.5	—
PHASE III	4.9	1.23	9.0	2.5	0.7/0.4 [2]

PHASE IV	4.0	1.1	7.0	—	0.15

(1) applicable only for diesel motors.
(2) 0.7 g/kWh, for engines of up to 85 kW and 0.4 g/kWh for engines of more than 85 kW.

As for Otto cycle vehicles, a progressive scale was established so that diesel powered vehicle categories would comply with the emission limits. It was established that on March 10, 1994, all diesel engines produced for the models chosen by their manufacturer (as the responsible party) representing at least 80% of its production must meet the Phase II limits, with the remaining models meeting Phase I limits, as set out in Table 38. As of January 10, 1996, the same applies to Phase III, with the remaining models required to meet the Phase II limits, and the same principal would be applied as of January 10, 2000 for Phase IV, with the remaining models meeting Phase III limits. Only from January 1, 2002 onwards will all heavy vehicle engines be required to meet the Phase IV limits. For urban buses the dates established for Phases III and IV were moved up by two years.

While for light vehicles U.S. legislation was used as the basis, for heavy vehicles European legislation was used. The Brazilian Phase IV corresponds to European Phase II, which started in Europe in 1996, which was replaced in 2000-01 by the Euro Phase III .

Since 2002 there have been two types of diesel oil, common and metropolitan, the latter being distributed in the large metropolitan areas as defined by CONAMA/IBAMA. Thus diesel oils are thus classified as types A and B in metropolitan areas and types C and D in other cities: diesel oil A having 0.10% sulfur, diesel B 0.20%, diesel C 0.35% and diesel D 0.50%. Changes are planned for the years 2005 and 2009 (see section 7.5.3.1).

Having made important achievements, the objective of PROCONVE is to administer and where appropriate update the existing legislation[106]. Discussions to this end are under way with the sectoral trade associations, in order to by 2005 update emission limits to allow light vehicles to meet the current U.S. limits, and heavy vehicles to meet current European limits.

The success of the program can be seen in Tables 32 and 35, which show that, thanks to PROCONVE, there was a dramatic reduction of average emission factors for light passenger vehicles from 1980 to 2000.

Since the schedule established by CONAMA Resolutions related to PROCONVE are being strictly followed, at almost no cost to the government, and is achieving its targets satisfactorily, the program is considered, even abroad, one of the best programs for controlling emissions from mobile sources in developing countries. Moreover, it is certainly one of the most successful environmental programs ever implemented in the country.

Table 35 - Average Emission Factors of Light Passenger Cars [1]

YEAR/ MODEL	FUEL	POLLUTANT				
		CO (g/km)	HC (g/km)	NO_x (g/km)	CHO (g/km)	Evaporative Emissions from Fuel (g/test)
Pre-1980	Gasoline	54	4,7	1,2	0,05	na
1980-83	Gasoline C Alcohol	33 18	3 1,6	1,4 1	0,05 0,16	na na

[106] In addition, it is worthwhile citing CONAMA resolution # 297, from February 26, 2002, which establishes gaseous emission limits for motorcycles and similar vehicles, starting in January 1, 2003, with limits equivalent to the current European ones for motorcycles, called Euro I. CONAMA Resolution # 291, from October 25, 2001, regulates the elements for conversion of vehicles to natural gas; and Resolution # 282, from September 12, 2001, establishes the requirements for catalytic converters for the replacement parts market.

1984-85	Gasoline C Alcohol	28 16,9	2,4 1,6	1,6 1,2	0,05 0,18	23 10
1986-87	Gasoline C Alcohol	22 16	2 1,6	1,9 1,8	0,04 0,11	23 10
1988	Gasoline C Alcohol	18,5 13,3	1,7 1,7	1,8 1,4	0,04 0,11	23 10
1989	Gasoline C Alcohol	15,2 12,8	1,6 1,6	1,6 1,1	0,04 0,11	23 10
1990	Gasoline C Alcohol	13,3 10,8	1,4 1,3	1,4 1,2	0,04 0,11	2,7 1,8
1991	Gasoline C Alcohol	11,5 8,4	1,3 1,1	1,3 1	0,04 0,11	2,7 1,8
1992	Gasoline C Alcohol	6,2 3,6	0,6 0,6	0,6 0,5	0,013 0,035	2 0,9
1993	Gasoline C Alcohol	6,3 4,2	0,6 0,7	0,8 0,6	0,022 0,040	1,7 1,1
1994	Gasoline C Alcohol	6 4,6	0,6 0,7	0,7 0,7	0,036 0,042	1,6 0,9
1995	Gasoline C Alcohol	4,7 4,6	0,6 0,7	0,6 0,7	0,025 0,042	1,6 0,9
1996	Gasoline C Alcohol	3,8 3,9	0,4 0,6	0,5 0,7	0,019 0,040	1,2 0,8
1997	Gasoline C Alcohol	1,2 0,9	0,2 0,3	0,3 0,3	0,007 0,0012	1 1,1
1998	Gasoline C Alcohol	0,79 0,67	0,14 0,19	0,23 0,24	0,004 0,0014	0,81 1,33
1999	Gasoline C Alcohol	0,74 0,6	0,14 0,17	0,23 0,22	0,004 0,013	0,79 1,64
2000	Gasoline C Alcohol	0,73 0,63	0,13 0,18	0,21 0,21	0,004 0,014	0,73 1,35

Source: CETESB, 2001.
Notes: (1) Weighted averages for each model-year by amount of production
na – not available.
Gasoline C – 78% gasoline plus 22% anhydrous alcohol (v/v)
RCHO – formaldehyde+acetylide

7.5.3 - OTHER CONSIDERATIONS

7.5.3.1 - Sulfur Content

CONAMA, resolution nº 226, from August 20, 1997, addresses technical specifications for commercial diesel oil. This resolution establishes a schedule for the reduction of sulfur content in diesel fuel.

In light of the considerations presented above, the number of vehicles circulating in different regions of the country and their environmental necessities, different sulfur contents are stipulated for diesel sold in the metropolitan regions of large cities (set out in that resolution) and in the rest of the country.

Since January of 1998, the maximum sulfur content in Brazilian diesel fuel is 0.5%. Starting in January 2000, diesel fuel sold in metropolitan regions of large cities (São Paulo, Santos, Cubatão, Rio de Janeiro, Salvador, Aracaju, Recife, Fortaleza, Porto Alegre, Curitiba, São José dos Campos, Campinas, Belo Horizonte and Belém) has a maximum sulfur content of 0.2% in accordance with a diesel fuel improvement program.

CONAMA's intention is that, starting in January of 2005, common and metropolitan automotive diesel oil, respectively, have the following minimum specifications: sulfur content (max.) of 500 ppm and 2000 ppm; T 85% - 360° C for common, T 90% - 360° C for metropolitan; density – 0.82 to 0.86 and 0.82 to 0.87; cetane number - 45 and 42. Starting in January 1st, 2009, metropolitan and common automotive diesel oil should have, respectively a maximum sulfur content of 50 ppm and 500 ppm.

7.5.3.2 – Vehicle Maintenance and Inspection

The maximum emission limits stipulated in the CONAMA resolutions must be guaranteed in writing by manufacturers, for at least 80,000 km for Otto Cycle[107] engines and 160,000 km for diesel engines, or for five years of use, whichever comes first. In order maintain this guarantee, the owner must be able to prove that the preventive maintenance recommended in the vehicle owners manual has been properly carried out.

However, the implementation of PROCONVE led to the conclusion that it was no use imposing rigid pollution and noise limits on manufacturers, if after being sold the vehicle did not undergo the proper maintenance, since this ensures the continuity of the desired emission levels. Thus emerged the need to implement programs for inspection of vehicles in use, as a way to ensure that their owner carries out at least the maintenance procedures called for by the manufacturer and within the periods set by the regulators for these inspections. The developed countries with air pollution control programs also reached the same conclusion.

Despite this need, there was no instrument for ensuring that users took the appropriate stepts to maintain the emission limits for vehicle pollutants. Thus in 1993, CONAMA created and passed regulations for "Inspection and Maintenance Programs for Vehicles in Use". These programs were to be implemented by the State and Municipal Environmental Executive Agencies (OEMA), according to the general guidelines and regulations established at the federal level, in light of the real necessities and special characteristics of each state.

There was, however, no compulsory linkage between these programs and the annual vehicle licensing, which is the responsibility of the State Transit Departments (DETRANs), and was seen as the only way to ensure that the vehicle in circulation undergoes a pollution emission inspection. It was then that, in 1995, the National Transit Council (CONTRAN) created this linkage through regulation, as well as created the vehicle safety inspection, through Resolution nº 908/95, to be implemented in 1998.

The approval of the new Brazilian Transit Code (CTB) (by Law no. 9503 of September 23, 1997) established this linkage in law, with its application mandatory for all DETRANs in the annual vehicle licensing process, where the inspection of pollutant gas emission and noise had already been implemented. The Transit Code also instituted mandatory vehicle safety inspection and a new CONTRAN which in its first meeting revoked the 1995 resolution, in order to regulation the area at a later date. At that point controversies emerged and all the technical, political and economic discussions

[107] For which should be determined the Emissions Deterioration Factors, through tests on accumulation of mileage, according to Resolution # 14, of December 13, 1995.

of the past returned to the fore, but this time with a greater number of interested parties. The media coverage of the new Transit Code attracted the attention of many people who had not until then been following the issue. Various events were held to collect input for the vehicle inspection regulations – issues such as “centralized or decentralized”, “individual concessions or by lot”, “federal or state concessions”, etc., were addressed, and finally CONTRAN passed regulations through Resolution nº 84/98.

Over the period 1993-97, some OEMAs and DETRANs worked towards implementing the vehicle emissions and safety inspections in their states/municipalities. Some attempts failed in the process of internal political negotiations, others suffered setbacks because of the revocation of Resolution nº 908/95 and others worked out well. Successful experiences such as that of the municipality of São Paulo, which implemented the I/M for the public service fleet (taxis, school and collective transport), should be congratulated because the enterprising spirit overcame a wide range of problems. Another effort with a positive outcome was that of the State of Rio de Janeiro, which was marked by its innovative character, simplicity and efficiency. There, the government resolved that it would implant the vehicle inspections itself, and gave the execution of this task to DETRAN.

DETRAN, used the innovative approach of calling on the Superior Center for Government Studies of the Federal University of Rio de Janeiro (UERJ) to develop and implement the “Annual Vehicle Licensing Project”. Starting from the principal of decentralization of licensing activities, this project installed a telephone call center and 23 service stations to serve the public, distributed over the Rio de Janeiro Metropolitan Region.

Each service station consists of three modules with the functions of executing the inspection of polluting gases and the visual safety inspection. The quality of the service, carried out by students from the University, hired as interns at the service stations and in the call center. Auditing of the system is carried out by State Foundation for Engineering and the Environment (FEEMA).

While the rest of the country was discussing the procedure to be adopted, Rio de Janeiro implemented a system that made sense to everyone. DETRAN improved the quality of services provided and increased its revenue by around 85%. Furthermore, a UERJ was contracted by DETRAN to manage the system, FEEMA is responsible for the network of air quality monitoring stations (in 1998 there were 3 states implemented, with plans for another 8 stations) to carry other the audit, university student interns receive scholarships to work 6 hours per day, and finally the population using the system is satisfied with the quality and efficiency of the services received, even having to pay more for it.

The controversy around how to implement vehicle inspections did not end with the publication of CONTRAN resolution no. 84/98. This resolution created a centralized system in the Federal Government for approvals for providing vehicle safety inspection services, while CONAMA, in 1993, had already chosen a decentralized system whereby the OEMAs would grant approvals for provision of inspection services for polluting gases and noise. It is the case that few OEMAs have since given importance to the implementation of emission inspection services in their states.

The approval of pollutant emissions and noise inspection provided for in Art. 104 of Law no. 9503, of September 23, 1997, which instituted the Brazilian Transit Code (CTB), is required for the licensing of automotive vehicles, in the municipalities covered by the Pollution Control Plan for Vehicles in Use (PCPV), pursuant to Art. 131, Para. 3 of CTB. CONAMA Resolution # 256, of June 30, 1999, establishes that state and municipal environmental agencies will have responsibility for implementing the measures necessary for implementing inspection of pollutant emissions and noise levels, as called for in the CTB.

Art. 2 of this resolution provides for a term of 18 months from the date of its publication, which occurred on July 22, 1999, for States and municipalities to comply with the provisions of CONAMA resolutions, especially those of # 7, of August 31, 1993 and # 18, of December 13, 1995, developing, approving and publishing the respective Pollution Control Plans for Vehicles in Use (PCPV), and implanting the Inspection and Maintenance I/M Programs as defined in the PCPV.

The I/M Programs created to comply with the CONAMA resolutions must be implemented in an harmonious manner by States and their municipalities. The State environmental agency, in cooperation with the municipal environmental bodies involved, have responsibility for preparing the respective PCPVs and for executing the I/M Programs. Municipalities with a total fleet of at least three million vehicles can implant their own I/M programs, through a specific agreement with the state.

But what is really important, and this should be the only objective of inspections, is to ensure that the owner understands and accepts the concept of correct maintenance of their vehicle, on which depends their safety and that of others, and on which also depends the quality of the air that everyone breaths. Awareness of this duty is the principal goal. Thus the inspection services should be cheap, efficient and of excellent quality in order to win over the citizen vehicle owner, and not put across the idea that the inspection is just another obligation. In this regard, the positive experiences should not be ignored.

The I/M Programs, although addressing local pollution, could prepare the population to be concerned about greenhouse gases in the future.

7.6 - MEASURES TO COMBAT DEFORESTATION IN THE AMAZON REGION

7.6.1 - PRINCIPAL CAUSES OF DEFORESTATION

7.6.1.1 - Large-scale Development Projects

Social, economic and political inequalities between the different regions of Brazil, along with the stratification of Brazilian society, led to the implementation of development projects in frontier regions, whose goals was more focused on the country’s necessities than on the meeting the legitimate development interests of these frontier areas.

Low land prices the resulting expectation of future gains, facilitated access to natural resources, the perception that resources of inexhaustible, as well as the provision of tax and credit incentives by governments, were factors that attracted the private sector, with no concern for bringing improved technologies that could ensure the competitiveness and sustainability to resource exploitation.

The deforestation caused by these activities expanded started in the 1970s, with the introduction of programs for agricultural settlement in the Northern region, supported by the National Integration Program (PIN), the Program for Land Redistribution and Agro-industry Incentives for the North and

Northeast (PROTERRA)[108] and the Program for Livestock and Agro-mineral Poles in the Amazon (POLAMAZÔNIA)[109].

In general, the objectives of large development projects in the Amazon focus on increasing production and extraction of natural resources, principally minerals and timber; on the creation of an industrial center devoted to assembly of electronic equipment and cutting of precious stones; support for livestock raising; and the occupation of remote areas to ensure sovereignty over the territory. Over the past three decades, there has been little investment in attracting private companies capable of creating competitive and innovative productive structures for technologies in the Northern region.

The large cattle ranches, agricultural settlement projects and the majority of development mega-projects supported by the federal government in the region have proven unsustainable in the medium term, and have provided very low levels of social benefits and high environmental impacts.

The existence of credit policies that offer lower real interest rates for loans for agricultural activities than for non-agricultural sectors, guaranteed minimum prices for agricultural producers, flexible rules for land title rights for squatters, low property taxes, and fiscal incentives for investments in approved undertakings in the region, have had a great impact on deforestation in the region. It is worth noting that many of these policies have been scaled back or eliminated in recent years.

Even generation and distribution of electricity in the region, which is essential to enable development projects, has been a factor in regional imbalances. The principal objective in the construction of hydroelectric projects in the Northern region has been to supply some urban centers and to promote energy intensive economic activities through providing electricity at subsidized prices.

Highly centralized decision-making between 1960 and 1990, including with the participation of the Amazon Development Superintendency (SUDAM), about infrastructure and development projects by the federal government, in the name of “actions for development and integration of the Northern region”, did not take into account the environmental, cultural and socioeconomic realities of the regions.

This period in fact contributed little to the development of the region, due to the low technological level of the principal activities in the Amazon and its low level of social development. At the end of this period the share of the Northern region in Brazil’s GDP, of less than 5%, is much lower than the real potential of the region.

7.6.1.2 - Characteristics of Economic Activities in the Amazon

There is a competition between as primary resource extraction and forests in the Amazon region, because of the need for land area for production. In recent decades, agriculture has greatly expanded, which can be related to deforestation rates.

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[108] PIN and PROTERRA were part of the national integration policy of the North and Northeast regions, established in the First National Development Plan (1972-74). PIN involves principally the construction of the TransAmazon highway (a transversal, east-west route interconnecting with the Northeast and a longitudinal, north-south route connecting with the Center and South of the country). It also involved settlement of the adjoining region in association with the private sector, through construction of residential centers. PROTERRA, through land title reform of these regions, called for breaking up the large latifundios and expansion of properties that were to small for economically viable activities, in order to stimulate medium-sized rural companies to change the traditional production systems through appropriate use of land, credit and modern technologies to raise the productivity of the sector.

[109] POLAMAZÔNIA promoted the integrated use of the potential for agricultural and ranching, forestry and mining in projects located in 15 selected areas, distributed throughout the Legal Amazon.

Since 1970 there has been a great expansion of agriculture and especially livestock raising in the Amazon, driven by the growing population pressure in the region. The Amazon region (located principally in the states of the North region, but also in the northern part of the state of Mato Grosso and in the western part of the state of Maranhão) has experienced a sharp increase in the resident population in recent decades, especially in the large cities. In the North region the population grew from 5.9 million in 1980 to around 10 million in 1001, and to around 12.9 million in the year 2000.

This population pressure also one of the factors which can be related to conversion of forests into agricultural lands.

The characteristics of agricultural activities in the Amazon region, including agricultural crops (manioc, sugar cane, corn, potatoes, tobacco, rice, soybean, wheat, etc.) and cattle ranching, require large areas of land. Thus expansion of agriculture and ranching, along with being important factor in deforestation in the region, results in the degradation and abandonment of the areas used because of low soil quality.

For transportation of people and products, in recent years a large number of roads have been built, which is directly related to population density, to agriculture and economic activities, and thus to deforestation.

In the Amazon region the direct effects of mining on deforestation has been very limited, but the massive investments in the mining development poles have lead to a development boom that has brought more wide-ranging impacts on the region.

Another important economic activity in the Amazon, is timber extraction, which is not a recent activity, having been carried out for more than 300 years. However, in the past it was done on a small scale, with the extraction of a few tree species, without causing significant damage to the forest ecosystem. Wood was a byproduct of clearing land for agricultural purposes. Over the last two decades, however, there has been a much more intensive and destructive system of timber extraction, involving clear-cutting, with the use of machinery that allows the extraction of a great number of plant species in a short time period, in an unsustainable manner, weakening the entire forest ecosystem.

Brazil is the world’s largest producer of tropical wood, and is also a great consumer. The country also has a large share in the international timber trade, as the second largest exporter of sawn tropical lumber.

To meet the demand for tropical wood, across the Amazon region there are 3000 timber companies, both Brazilian and foreign-owned. These companies extract more than 30 million cubic meters of logs from the region per year. Much of this total involves the unsustainable exploitation of native forests. This results in impacts such as erosion and depletion of species of higher commercial value.

Another factor that should be considered in assessing the economic activities of the Amazon is that wood, as well as other forest products (nuts, rubber, etc.) has a low market value. Thus, its destructive extraction practices, along with depleting the natural resources of the region, do not contribute to improving the incomes of the local population, establishing a vicious circle between poverty and environmental degradation.

It is understood that the sustainability of forests, including their environmental, economic and social aspects, is essential to the continuity of life on the planet. It is thus necessary to establish criteria and methods for the exploitation of forest resources based on an equilibrium between regeneration and production. Sustainable forest management could be viable alternative for achieving this goal.

Sustainable forest management is defined in Art. 2 of Decree nº 1282, from October 19, 1994, as "the administration to obtain economic and social benefits, while respecting the maintenance mechanisms of the ecosystem which is the object of management."[110] It was thus perceived that the forest management plans should be guided by concern for conservation of natural resources and forest structure and functions, maintenance of biological diversity and the socioeconomic development of the region.

Art. 1 of this same decree also stipulates that "exploitation of original forests of the Amazon basin addressed by Art. 15 of Law nº 4771, of September 15th, 1965 (Forestry Code), and other forms of natural arboreal vegetation, will only be permitted in the form of sustainable forest management, according to the general principals and technical underpinnings established in this decree."

It was thus intended to regulate exploitation of forests and other forms of arboreal vegetation for alternative land use in Amazonia. This decree further established forest restocking as a requirement, following specific technical criteria, by the individual or company that exploits, uses, transforms or consumes forestry raw material.

The principal restraints on sustainable forest management are economic, social, technical and institutional. The greatest problems identified are the low profitability of forest management, in some case, resulting principally from competition from wood extracted illegally, and the trend towards conversion of natural forest areas into areas for agricultural production.

In addition, although the country has broad experience with silviculture and biotechnology techniques with subtropical plantations, such innovative management techniques are restricted to the South and Southeast, and have still not been extended to the forest resources of the Amazon. Furthermore, there are few technical training centers and qualified workers for such activities in the region.

One of the principal problems of implementation of forestry management in tropical areas is the high tree species (sp) diversity: while management plans in temperate areas are designed to support 30 sp/ha, in moist tropical forests they must be designed to support around 400 sp/ha. This species diversity implies a lower density of individuals of a given species, which means that forestry management is less productive than if it were designed for a few species.

The inefficient use of forest resources in the Brazilian Amazon has two causes: (i) market failures in the lack of definition of property rights that, combined with the abundance of land, forests, mineral resources, etc., lead to their underutilization; and (ii) institutional failures and difficulties in regulating property rights, with the need to strengthen the institutional structure of the region, that is, increase the technical and administrative capacity for research, regulation and monitoring, and to enforce laws at the local and national levels.

7.6.1.3 - Land Title Distribution and Macroeconomic Issues

Directly related to the problem of primary activities in the Amazon is the problem of land title distribution. Brazil has a serious problem of land distribution, with large landowners with more than 10,000 hectares representing more than 40% of productive land. Because of this unequal distribution,

[110] This article conforms to Art. 4.1.d of the U.N. Framework Convention on Climate Change, which calls for all Parties, in accordance with their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, to "promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems."

thousands of families lack access to land, which in recent decades has led to enormous political pressure to carry out agrarian reform, resulting in the search for new frontiers for agricultural expansion.

The relative weight of properties with an area of 10,000 ha or greater is much higher in the Northern region. The percentage of rural property in holdings with 10,000 ha or more was 35.88% in the North region in 1966, climbing to 56.34% in 1978, and 47.35% in 1992[111].

The 1988 Federal Constitution sought to establish the foundations for carrying out such changes. The Constitution establishes that property will serve its social function (Art. 5, clause XXIII) and provides again in Art. 184 that "The Union has the power to expropriate for social interests, for purposes of agrarian reform, rural properties that are not fulfilling their social function". Although the rule containing the principal of the social function of property came into force immediately, like all constitutional principals, the issue still raises questions. Article 188 of the Constitution further provides that "the destination of public and uninhabited land will be made compatible with agricultural policy and with the national plan for agrarian reform".

Thus, in the Amazon region, especially in the decade of the 1980s and the beginning of the 1990s, there was a policy of awarding of land title and privatization of public land with forest cover. In addition, the fact of having a large forested area on a private property facilitated its classification as unproductive for the purposes of agrarian reform. Although this distortion has been under review in recent years, 80% of the lands destined for agrarian reform are located in the region of the Legal Amazon.

This evaluation is necessary to understand the relation between the rate of deforestation in the region, the structure of land ownership, and macroeconomic issues. In Brazil, the rate of deforestation is influenced by a range of factors, including population pressures, economic crises, and political instability.

The deepening of economic crises tends to lead to reductions in rates of deforestation. This occurs because interest rates on the financial market increase and there is a reduction in availability of public and private resources for investments, which leads to a decline in investments in agriculture and in other activities that require the conversion of natural habitats. In the macroeconomic sphere, the Real Plan has, over the last two decades, established a balance between economic development and stabilization of the national economy was achieved.

Deforestation is inversely proportional to economic stability, to the extent that the exercise of property rights is conditioned by the implementation of agrarian reform under the Constitution. When the land title regime era challenged by changes in the system of coalitions of power at the national, regional or local level, landowners clear forests from their properties in order to demonstrate that their ranches were productive lands, and thus cannot be expropriated for the purposes of agrarian reform. Agrarian reform in Brazil had its best performance starting in 1995, through a set of federal government initiatives[112], pressured by a surprising social movement – the Landless Peasants Movement.

Both of these dynamics are evident in the current situation in Brazil, with favors deforestation and thus a growing loss of the ecosystem, of species and of biodiversity. In Brazil these forces have resulted in an increase in the rate of deforestation to a historic record in the 1994-95 period: 29,130 km^2 of the Amazon Forest was cut down in only one year. This is an increase of 38% over the annual average

[111] INCRA, Atlas Fundiário Brasileiro, 1996.
[112] Between 1995 and 2001, more than 588,000 families were settled and 5639 settlement projects were created, which represents more than 2.5 times the number of families settled in the 30 years prior to 1995. In this period, almost 20 million hectares of land were obtained, 50% of which through expropriation, as punishment for non-compliance with the social function of property as set out in the Federal Constitution, and more through acquisitions and land credit programs.

gross deforestation rate observed in the period 1978-89, which was 21,130 km^2. According to INPE, the greatest deforestation rates are consistently observed in the states of Mato Grosso, Pará, and Rondônia, accounting for more than half the average rate of gross deforestation each year in the Legal Amazon.

In addition, illegal activities involving extraction of high-value timber in Amazonia accounted for 80% of the sector's total profit in Brazil[113]. The illegal operation[114] of foreign-owned sawmills occurs because of the lack of capacity of IBAMA to supervise the implementation of forest management plans and carry out appropriate inspection of an area two times larger than France and Spain combined (2.3 million km^2).

7.6.2 - MEASURES TO COMBAT DEFORESTATION

7.6.2.1 - Legal Measures

A report prepared by the then Secretariat of Strategic Issues (SAE)[115] and the gross annual deforestation rate published by INPE provide data that creates awareness in governments and compels them to adopt actions to reverse this trend[116]. In July of 1996, the government established the *Amazon Package*, which called for two emergency actions.

The first emergency action was established through Presidential Decree nº 1963, of July 25, 1996, which suspended new authorizations for forest exploitation and established a two year moratorium on issuance of licenses for exploitation of two species: Mahogany (*Swietenia macrophylla*) and Virola (*Virola surinamensis*). In June of 1998, the government renewed the moratorium for another two years. This issue has also been addressed in discussions under the Amazon Cooperation Treaty - ACT, in the context of the objectives of the regional policy for mahogany.

The second action was Provisional Measure nº 1511, of July 26, 1996, which among other measures revises of Art. 44 of Law nº 4771 of September 15th, 1965 (see section 7.1). According to this provisional measure, in the Northern region and the northern part of the Center-West region, along with the restrictions contained in the Forestry Code, clear cutting of forest is only permitted where a minimum of fifty percent of each property still has forest cover. In properties where tree cover is made up of forest vegetation, clear cutting will be prohibited in at least 80% of these forest types. Furthermore, three basic activities were established to reduce the rate of deforestation: 1) prohibition on new conversions of forested areas to agricultural systems; 2) provision that the use of forest areas on the Legal Amazon will only be permitted when implemented through a process of sustainable forest management; and 3) subjecting the implementation of economic activities to the recommendations in the Ecological-Economic Zoning, in any area where the zoning has been concluded at a scale of at least 1:250,000. The provisional measure has been rewritten since them.

[113] According to the official report prepared and published by SAE (Secretariat of Strategic Issues) in mid-1997. The report prepared by SAE/Presidency of the Republic was useful in quantifying a situation that had already been diagnosed by IBAMA and NGOs such as the Worldwide Fund for Nature (WWF).

[114] The illegal operation was discovered because 22 foreign-owned sawmills declared that they had 508,000 hectares and that they were exploiting only 186,000 hectares. However, with this data, ecologists calculated that they could only extract 6 million cubic meters of high-value wood, while in fact they were declaring production of 30 million cubic meters. A more rigorous inspection carried out by SAE (see previous footnote) showed that just 8 sawmills had 1.9 million hectares of forest, which is four times greater than the total area declared by the 22 companies together.

[115] See footnote 99.

[116] The report prepared by the Secretary for Strategic Issues was published in 1997, but the research, described above, served to support legal actions in 1996.

Another important legal instrument for controlling deforestation is the Law of Environmental Crimes, nº 9605, sanctioned on February 12, 1998, addressed above. This law consolidates environmental legislation, with typification of environmental crimes and infractions and with their respective penalties duly stipulated. Thus, compliance with the Forest Code is not restricted to economic aspects; it will have more serious consequences for individuals and companies. Regulations under this law a currently being created.

7.6.2.2 - Administrative Measures

Despite the importance of these emergency measures, the effectiveness of the "Amazon Package" and the success of the Environmental Crimes Law are dependent on improvements in the system of monitoring and enforcement in the Amazon region (audits, decentralization, human and institutional capacity-building, computerization, education, etc.).

It is fundamental to develop a more effective system of enforcement for deforestation in the Amazon region, which involves actions seeking to guide the exploitation and use of natural resources towards a basis of legality, through the use of legal instruments. Enforcement is an important tool for preservation, with the goal of coordinating, executing and bringing about the execution of government decisions and regulations.

A new scheme for enforcement based on audits in large sawmills has been implemented by IBAMA, which is thought to be more effective that an increase in the number of on-site IBAMA officials. The prior scheme has proven to be inefficient over the long term. The isolation of government officials working in the forest has been an obstacle to effective action. The auditing approach may not be 100% effective, but it appears to be the only operational alternative for the immense and uninhabited area of the Amazon region.

In the first week of implementation of the auditing scheme, IBAMA reevaluated 400 management plans, which led to the immediate suspension of 16% of the concessions awarded to sawmills. The President of IBAMA stated that at the end of the process of reevaluation of the management plans, around 84% of the concessions previously authorized by the body could be revoked.

Another important element in combating environmental degradation is the growing technical capacity of the country. Monitoring of the Amazon Forest carried out by INPE allows IBAMA to implement a system of identification and monitoring of the dynamics of deforestation that expands the effectiveness of the use of the various legal instruments available to control human activities in the region.

The quality of IBAMA's inspection and enforcement activities increases with the use of new technologies such as remote sensing, satellite images, georeferenced localization and aero transported sensors, since now actions are planned ahead of time and directed to the sites of unauthorized deforestation.

The annual publication of deforestation (see section 7.7) data and its availability on the Internet, starting in February of 1999, are crucial measures in guiding the planning of political actions and are important instruments available to the federal government and to Brazilian society.

7.6.2.3 - Economic Measures

The objective of all these regulations, monitoring measures, programs and technological innovations is to pursue a paradigm change in the model of economic exploitation of the Amazon Forest.

Among the economic measures that could improve the implementation of the *Amazon Package* (7.12.2) is the Green Protocol and the incentives for sustainable management in special areas protected for indirect use, known as the National Forests (FLONAs).

The Green Protocol is a declaration of principals signed by the Brazilian public banks to ensure that the development projects financed by public investments are environmentally sustainable and in accordance with environmental legislation.

Art. 14 of Law nº 6938 de 1981 (which addresses National Environmental Policy), in its introduction and paragraphs II and III, states that notwithstanding the penalties set out in federal, state and municipal legislation, the non-compliance with measures necessary to the preservation or correction of inconveniences and damages from degradation of environmental quality will subject the transgressors to the loss or restriction of fiscal incentives and benefits offered by the State, and to the loss or suspension of access to lines of credit in official lending agencies.

The system of public financing has been one of the contributors to environmental degradation and to unsustainable conversion of natural habitats. Thus, changes to financial policies and practices is a fundamental step towards promoting development and environmental conservation. The impacts of the Green Protocol should be clearly assessed, but if environmental concerns were truly institutionalized in financial practices, as called for in the Green Protocol, Brazilian financial institutions could be an effective instrument in bringing about compliance with the legislation and environmental programs. This strategy has achieved relative success in international financial institutions such as the World Bank, which has incorporated environmental concerns into its lines of credit and has created administrative bodies to deal with environmental issues.

Finally, an initiative that brings together relevant concerns with economic incentives and improvement in inspection are the FLONAs. According to Decree nº 1289, of October 27, 1994, national forests are areas under the public domain, inalienable, in part or in whole, constituting goods of the Union, with native or planted vegetation cover, established with the objectives of: 1) management of natural resources, with emphasis on the production of wood or other plant products; 2) ensure the protection of water resources, scenic beauty and historic or archeological sites; 3) stimulate basic and applied scientific research, environmental education and recreation, leisure and tourism activities. The basic principal is the size of the area in the Amazon region that is under the control of the State (currently 21% of the area of the Brazilian Amazon Region belongs to the federal government), reserving it for forestry purposes and ensuring that it is used in a sustainable manner.

The project of FLONAs represent, on the one hand, an attraction to logging companies, who come to depend on the possibility of exploiting resources that are not on their private properties, and can thus delay exploitation of the highest-value wood on their own land. On the other hand, the FLONAs can become areas for research on new forestry management techniques that research institutes and NGOs – such as WWF – have developed, but which cannot be easily disseminated or implemented by companies which resist changing their traditional methods unless they are required to or receive economic benefits for this.

The annulling of forestry concessions that IBAMA had already awarded, together with provisions ensuring that only sustainable forestry activities will be permitted in the future (Art. 3 of provisional measure nº 1511-16), and progress in the creation of FLONAs, should represent a first initiative in the effective implementation of the Amazon Package. Its realization over the long term depend on three basic measures:

- a broad revision of the system of acquisition of land, which still permits private companies (both Brazilian and foreign) to own huge areas of land in Brazil;
- carrying out a survey to assess whether the legal reserves of those properties have been officially maintained – the effective implementation of legal reserves in the region resulted in a significant contribution to conservation of vegetation cover in Brazil;
- the implementation of a broad campaign to inform international consumers of the existence of more than 100 species of tropical trees used commercially – along with mahogany – so that the changes in forest management projects can be stimulated by the international market.

According to IBAMA, there are 59 National Forests, covering more than 16 million hectares in the Amazon Forest. In these areas, the government will be able to conduct better supervision and will be able to allow development of sustainable forestry systems and extractivist activities.

Another important piece of information in the process of development and review of forestry management regulations and instruments which have an economic base is the new Rural Property Tax law of 1996, which encourages forestry management and restocking, and includes forestry policy mechanisms in the calculation of property tax. This decision encourages important initiatives such as the creation of legal reserves and permanent preservation areas, the adoption of forestry management and the expansion of areas considered in the specific program of Private Natural Heritage Reserves (RPPNs) (see 7.8.4).

7.6.3 - POLITICAL ACTION STRATEGY

The formulation and implementation of an action strategy with a national scope and a social dimension requires an innovative approach from the federal government: to listen to all the groups involved with the problem, identify proposals and negotiate solutions in search of consensus, through the development of positive agendas with the states making up the North region.

The development of a positive agenda presupposes that problems such as deforestation and burning will not be resolved only by monitoring and enforcement, but rather through a coordinated effort by all the diverse actors of society, presenting alternatives that generate employment and income, in a sustainable manner, contributing to solutions to economic and environmental crises based on policy guidelines.

In this regard, in 1999 the Environment Ministry created five directives for combating deforestation in the Amazon.[117]

- improve forest monitoring through identification of the economic and social causes that give rise to deforestation and ensure resources to IBAMA and the state environmental bodies, to carry out relevant enforcement actions. The resources of PPG7 for the states of the Amazon region total US$ 60 million, over a four-year period.
- strengthen innovative agro-forestry projects under way in the form of pilot projects in the Amazon, and incorporate the positive results into policies for the region.
- reorient credit mechanisms (which total around US$600 million per year for agriculture in the Amazon) towards projects for the sustainable use of the region's natural resources.
- reconvert degraded areas (around 100 million hectares) to small and medium scale agroforestry activities, avoiding the encroachment of economic activities into the native forest.

[117] According to the inaugural speech of Minister José Sarney Filho upon assuming the position in early 1999.

- strengthen and expand those economic and social projects that ensure the sustainable use of biodiversity and the permanence of populations traditionally adapted to the tropical environment.

Thus a work program was developed, coordinated by the Secretary for the Amazon of the Environment Ministry - MMA, which has the general objective of pursuing environmental management and the sustainable development of the Amazon region. This work program has the following specific objectives:

- promoting decentralized environmental management;
- implementing sustainable development activities as an alternative to deforestation;
- recognizing the value of environmental services provided by the Amazon forest and by extractivist populations.

The traditional populations of the Amazon region, consisting of Indians, riverside dwellers and extractivists, have coexisted with the forest for decades, gaining their livelihoods with very low environmental impacts. This situation has been constantly threatened by the various forms of destructive occupation of the region, often resulting in the exodus of populations to the periphery of cities and/or replacement of forested areas by degraded areas, resulting in high environmental impacts. It is thus necessary to ensure the sustainability of the way of life of the traditional populations that coexist with the forest.

There is thus an attempt to reverse the process of deforestation, based on the pursuit of endogenous solutions for the region. According to this philosophy, a work plan was established by the Secretariat of Amazonia, under MMA, for the period 1999-2003 involving the following programs:

National Forests Program

Created by Decree nº 3420, of April 20, 2000, the National Forests Program has the mission of promoting sustainable forestry development, reconciling exploitation with ecosystem protection, and making forestry policy compatible with other public policies, in order to promote the expansion of internal and external markets and the institutional development of the sector.

Significant progress has been made, especially in programs of: a) expansion of the area of planted forest, benefiting more than 5000 rural landowners in 300 Brazilian municipalities; b) management of native forests in public and private areas, creating around 1,200,000 ha of National Forests; c) incentives for reforestation and improvements to production systems, with the reforestation of 7710 ha in the states of Espírito Santo, Minas Gerais, Goiás, Roraima and Santa Catarina.

Expansion of the Forest Base (FLORESTAR)

According to the structure called for in the PPA 2000-03, three programs were defined: Sustainable Forests; Expansion of the Forest Base (FLORESTAR); and Preventing and Combating Deforestation, Burning and Forest Fires.

For all the programs, partnerships are expected to be established with the private sector – represented by the pulp and paper industries, and the wood, steel and charcoal industry, which consumes forestry raw materials – research and teaching institutions, professionals from the sector, state and municipal governments, other Ministries and federal bodies, international bodies, and environmental and social NGOs.

The objective of FLORESTAR is to increase the supply of forest products and byproducts coming from planted/managed areas, and their target public consists of producers, producers' associations, the wood industry and researchers.

The activities planned for FLORESTAR include carrying out studies for forestry development and for implementation of forestry projects; support for projects involving technical assistance for forest owners, development of forestry technology, forestry extension services and reforestation; and forest restocking.

Ecotourism Development Program for the Legal Amazon – Green Tourism (PROECOTUR)

PROECOTUR was developed with the idea of implementing sustainable development activities in the Amazon as an alternative to deforestation, within the program Avança Brasil, to create tourism development activities in the nine states making up the Legal Amazon.

The objective of the program is to promote the rational and integrated development of ecotourism, through technical, economic and environmental feasibility studies, in order to implement ecotourism infrastructure, and enabling services in the areas of the ecotourism centers. In addition, it was intended to support training and capacity-building for the development of ecotourism activities through institutional strengthening, promoting the articulation and interchange of information between governmental bodies and private sector entities. The program will be divided into two parts: one of seeking out attractions and the other of effective investments. The Brazilian counterpart will be the creation of lines of credit for private capital from the Banco da Amazônia, Banco do Brasil and BNDES.

Brazilian Program of Molecular Ecology for the Sustainable Use of Biodiversity of the Amazon (PROBEM/Amazonia)

PROBEM/Amazonia is also part of the Avança Brazil program. The objective of the program is to contribute to the development of Brazil's bio-industry, specifically in the Amazon region, through the generation of knowledge and transfer of technologies, and through a range of forms of partnerships with research institutes and Brazilian and international companies.

The program in 1999 covered the following activities: 1) a management contract with Organização Social BioAmazônia; 2) an agreement with SUFRAMA for the construction and purchase of equipment of the Amazon Biotechnology Center; 3) operationalization of the PROBEM management structure.

Expansion and Consolidation of a System of Protected Areas

The program has the objective of promoting the creation, implementation and development of protected areas in the Amazon region, based on a macro-zoning of the region, identification of new areas for indirect and direct protection of natural resources, with the objective of meeting the Brazilian commitment of preserving at least 10% of the Brazilian tropical forests.

A cooperation agreement has been signed between MMA and the United Nations Food and Agriculture Organisation (FAO) for preparatory assistance for the project. The management team for the project, made up of MMA, IBAMA and WWF Brazil, is responsible for preparation of the project plan and for articulation with complementary actors such as the PPG7 and the World Bank.

Amazon Solidarity Program

The Amazon Solidarity Program, created based on the *Exposição de Motivos Interministerial* nº 4, from October 15, 1998, seeks to promote the economic and social improvement of the population of the Legal Amazon, especially the rubber-tappers, through specific incentive mechanisms for the multiple use of the Amazon Forest and ensuring that the local population remains on the land, with projects to support extractivism in the Amazon, through coordinated actions by MMA coordinated with interested communities.

7.7 - PROGRAM FOR DEFORESTATION ASSESSMENT IN THE BRAZILIAN LEGAL AMAZONIA (PRODES)

7.7.1 - TECHNICAL ASPECTS

The Program for Deforestation Assessment in the Brazilian Legal Amazon (PRODES) (see http://www.grid.inpe.br/amz/pagina1.html) is the largest forest monitoring project in the world using satellite remote sensing techniques. For many years INPE has been analyzing Landsat satellite images to monitor gross deforestation rates in the Amazon region. Publication of the data shows the continuing commitment of the federal government to transparency in the handling of this information.

The Amazon region covers the states of Acre, Acre, Amapá, Amazonas, Pará, Mato Grosso, Rondônia, Roraima, Tocantins and part of the state of Maranhão, for a total area of approximately 5 million km^2. Of this total, forest vegetation classes cover around 4 million km^2.

Satellite images in colored compositions at a scale of 1:250.000, permit identification of alteration in forest areas down to 6.25 hectares (0.0625 km^2). The Amazon region is covered by 229 of these images that when interpreted visually provide the limits between the area of original forest and other vegetation types. Each survey identifies the newly deforested areas, which are copied unto overlays, and undergo a rigorous analysis. When approved, the overlays are digitalized, and the size and location of each deforested area are computed with the use of a Geographic Information System.

To calculate the size of the altered areas, the digital data are converted into an appropriate format (vectorial), using software developed specially for this purpose. This format also allows the presentation of the deforestation in any geographic division, for example, by large forest classes or municipalities.

Each survey involves approximately 50,000 person-hours, 10,000 machine-hours and several Brazilian companies specializing in remote sensing, subcontracted by the Foundation for Space Science, Applications and Technologies (FUNCATE), linked to INPE. Along with the more than 70 specialists involved directly in the work, there is also a team of 15 INPE professionals who accompany all phases of the project, ensuring a rigorous quality control.

PRODES, along with providing estimates of the size and rate of gross deforestation, also indicates in geographic terms the most critical areas. For example in 1999 more than 78% of the gross deforestation in the Amazon region was concentrated in 44 of the 229 Landsat satellite images. In addition, the PRODES data are overlaid on the RADAM vegetation map of the Brazilian Geography and Statistics Institute (IBGE) to identify the forest types that are undergoing alterations. The distribution of newly deforested areas by size class, also provided in this study, is used by IBAMA as an indicator of the possible causes of deforestation in the Amazon.

7.7.2 - USE OF THE DATA

The information provided by INPE permits IBAMA and the state Environmental agencies to carry out surveys of the causes, dynamics and consequences of the process of deforestation in the Amazon region.

The integrated monitoring strategy carried out by IBAMA is based on the following elements:

- intensive use of airplane based sensors to identify selective cutting of timber;
- adoption of satellite communication systems installed in IBAMA's inspection vehicles for consulting registries, enabling the verification of documentation and the existence of irregularities;
- identification, diffusion and application of technologies for sustainable forest use, seeking to replace environmentally destructive agricultural and forestry practices.

As a result, control is possible through the emission of tax assessment notices, authorizations for transportation of forestry products and inspection reports, along with allowing monitoring of the work of inspectors, since each vehicle is monitored.

7.7.3 - DATA SURVEYED BY PRODES

Deforestation, for the purposes of this work, is understood as the conversion of areas of primary forest types by human actions for agricultural, silvicultural and ranching activities, detected through orbital platforms. The term gross deforestation indicates that the areas in a process of secondary succession or forest regrowth were not included in the calculation of the size and rate of deforestation

Table 36 – Average rate of gross deforestation (km^2/year) from 1978 to 1999

States in Amazon Region	77/88 *	88/89	89/90	90/91	91/92	92/94 **	94/95	95/96	96/97	97/98	98/99
ACRE	620	540	550	380	400	482	1208	433	358	536	441
AMAPÁ	60	130	250	410	36	-	9	-	18	30	-
AMAZONAS	1510	1180	520	980	799	370	2114	1023	589	670	720
MARANHÃO	2450	1420	1100	670	1135	372	1745	1061	409	1012	1230
MATO GROSSO	5140	5960	4020	2840	4674	6220	10391	6543	5271	6466	6963
PARÁ	6990	5750	4890	3780	3787	4284	7845	6135	4139	5829	5111
RONDÔNIA	2340	1430	1670	1110	2265	2595	4730	2432	1986	2041	2358
RORAIMA	290	630	150	420	281	240	220	214	184	223	220
TOCANTINS	1650	730	580	440	409	333	797	320	273	576	216
AMAZÔNIA	21130	17860	13810	11130	13786	14896	29059	18161	13227	17383	17259

Source: INPE, 2001.
* Average for decade.
** Two-year average.

In the period of 1995 to 1997, deforestation increased and later decreased. In 1995 deforestation reached its highest level, at 29,059 km^2, compared to the decade's lowest level, in 1991, of 11,130 km^2. In 1997, the deforestation level registered was 13,037 km^2, the second lowest rate ever registered, confirming a trend towards decrease begun in 1996, when the rate fell by around 40%. However, deforestation increased again in the period 1998 and 1999.

Table 37 - Average rate of gross deforestation (%/year) from 1978 to 1999

States in Amazon Region	77/88 **	88/89	89/90	90/91	91/92	92/94***	94/95	95/96	96/97	97/98	98/99
ACRE	0,42	0,39	0,39	0,28	0,29	0,35	0,86	0,31	0,26	0,40	0,33
AMAPÁ	0,06	0,12	0,23	0,37	0,03	-	0,01	-	0,02	0,03	-
AMAZONAS	0,10	0,08	0,04	0,07	0,06	0,03	0,14	0,07	0,04	0,05	0,05
MARANHÃO	1,79	1,30	1,03	0,63	1,07	0,35	3,21	2,01	0,40	0,99	1,21
MATO GROSSO	1,01	1,31	0,90	0,64	1,05	1,40	2,43	1,56	1,25	1,56	1,71
PARÁ	0,62	0,55	0,47	0,37	0,37	0,42	0,78	0,62	0,41	0,58	0,51
RONDÔNIA	1,11	0,78	0,91	0,62	1,27	1,46	2,75	1,45	1,18	1,23	1,44
RORAIMA	0,18	0,39	0,10	0,27	0,18	0,15	0,14	0,14	0,11	0,14	0,14
TOCANTINS	2,97	2,00	1,61	1,61	1,17	0,95	2,29	0,94	0,81	1,73	0,66
AMAZÔNIA	0,54	0,48	0,37	0,30	0,37	0,40	0,81	0,51	0,37	0,48	0,48

Source: INPE, 2001.
* relative to the area of remaining forest.
** Average for decade.
*** Two-year average.

Overlaying the deforestation maps on vegetation maps of areas that undergoing a process of undesired occupation shows clearly that the advance of deforestation is occurring in a region of vegetation in transition, which corresponds to the advance of the agricultural frontier, principally in the states of Mato Grosso, Pará, Rondônia and Maranhão. The area of gross deforestation in the Amazon region in 1999 was 569,269 km².

Deforestation occurs principally in a strip called the "arc of deforestation". This arc starts in the northeast of the state of Pará, extending south to the western part of the state of Maranhão, then northwest to the state of Tocantins, entering the northeast of the state of Mato Grosso, crossing the north of this state in the direction of Rondônia, crossing it completely in an east-west direction and reaching the east do state of Acre.

Figure 1 –Deforestation observed in 1999

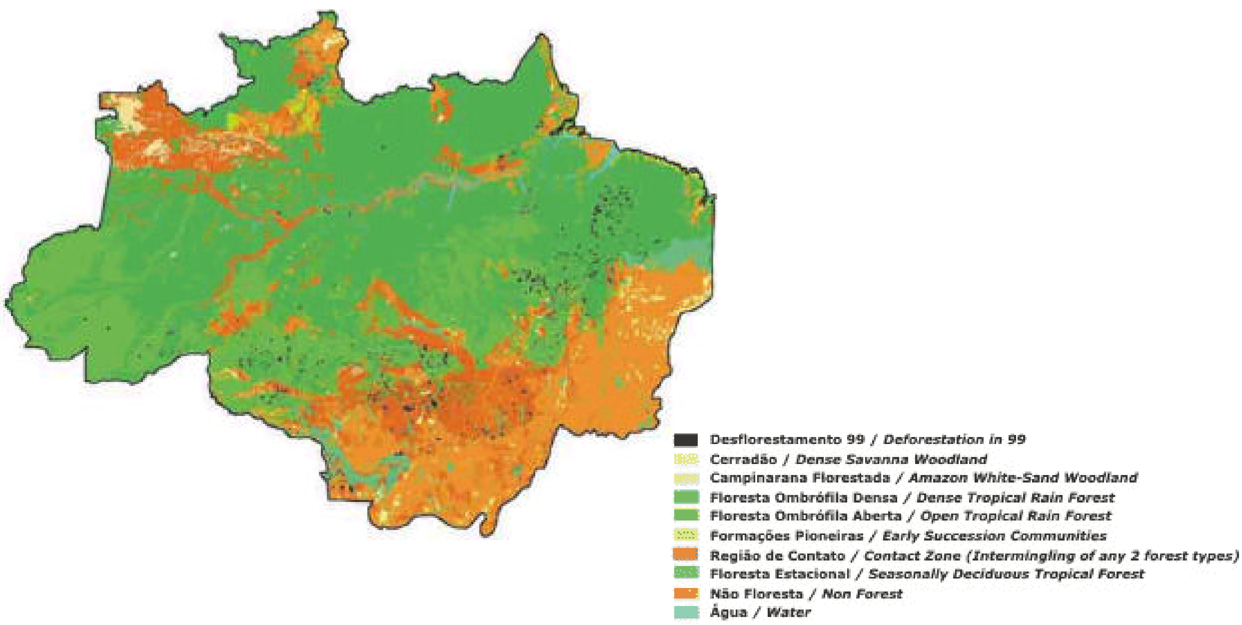


Table 38 - Area of gross deforestation (km^2) from January of 1978 to August of 1999

States in Amazon Region	Jan/78	Apr/88	Aug/89	Aug/90	Aug/91	Aug/92	Aug/94	Aug/95	Aug/96	Aug/97	Aug/98	Aug/99
ACRE	2500	8900	9800	10300	10700	11100	12064	13306	13742	14203	14714	15136
AMAPÁ	200	800	1000	1300	1700	1736	1736	1782	1782	1846	1962	1963
AMAZONAS	1700	19700	21700	22200	23200	23999	24739	26629	27434	28140	28866	29616
MARANHÃO	63900	90800	92300	93400	94100	95235	95979	97761	99338	99789	100590	102326
MATO GROSSO	20000	71500	79600	83600	86500	91174	103614	112150	119141	125023	131808	137610
PARÁ	56400	131500	139300	144200	148000	151787	160355	169007	176138	181225	188372	194619
RONDÔNIA	4200	30000	31800	33500	34600	36865	42055	46152	48648	50529	53275	55274
RORAIMA	100	2700	3600	3800	4200	4481	4961	5124	5361	5563	5791	6112
TOCANTINS	3200	21600	22300	22900	23400	23809	24475	25142	25483	25768	26404	26613
AMAZÔNIA BRASILEIRA*	152200	377500	401400	415200	426400	440186	469978	497055	517069	532086	551782	569269

Source: INPE, 2001.
* including old deforestation.

Figure 8 - Average rate of gross deforestation in the Amazon region (km^2/year).

* relative to the area of remaining forest
** data from 1993 to 1994 refer to estimates of the average rate of gross deforestation for the period of 1992-94
*** the average rate of gross deforestation for 2000 was derived from the 49 TM-Landsat scenes of that year

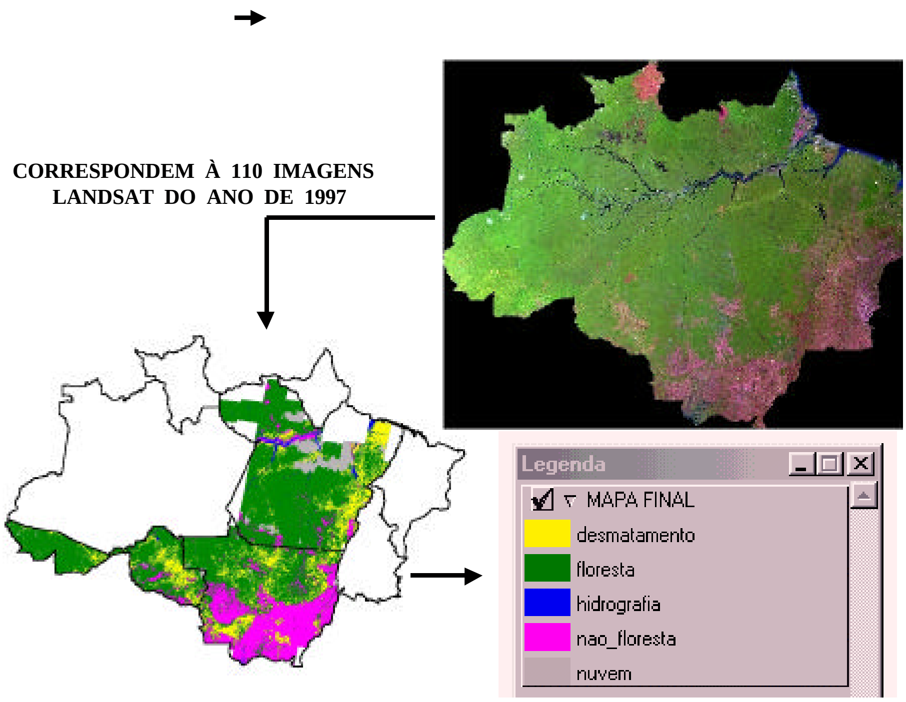
7.7.4 – Computerization of data obtained by PRODES (PRODES DIGITAL)

The methodology developed by INPE enabled the creation of PRODES Digital, whose objective is to automate the operations of PRODES, creating a reliable georeferenced database which is easily manipulated by the user.

This methodology consists of the generation of image fractions derived from the linear spectral mixture models, with the objective of reducing the dimensionality of the data to be processed. Next, shadow image segmentation techniques are used, followed by unsupervised classification by region and matrix editing carried out on the computer screen, to do the mapping of the extent of brute deforestation of the Brazilian Amazon that occurred in 1997. With the development of this methodology it was possible to generate the Digital Amazon Data Bank, which is an expanding source of information for the technical and scientific community and for decision-makers involved in the development of policies, analyses, planning and monitoring of the resources of the Amazon region, with the goal of preservation and/or self-sustaining management.

PRODES Digital enables the presentation of data on gross deforestation in the Brazilian Amazon over a georeferenced cartographic base, containing the spatial distribution of human activities in the region. In addition, it enables the use of gross deforestation data on the Brazilian Amazon for cross-referencing or integration with other information, as well as the implementation of a digital database with a range of information important to the region, and making this available to the user community.

Figure 2 – Map of gross deforestation in the States of Acre, Rondônia, Mato Grosso and Pará for the base year of 1997



7.8 - THE NATIONAL SYSTEM OF CONSERVATION AREAS (SNUC)

7.8.1 - CURRENT SITUATION

Brazil is one of the richest countries in the world in environmental terms: its territory contains approximately 1/3 of the remaining tropical forests and the largest river system on the planet. It also contains the world's largest floodplain (the Pantanal), the savannah with the richest biological diversity (the Cerrado), and more mangroves than any other country. The Brazilian flora represents 22% of the world's flora, with many species of flora and fauna that only exist in Brazil.

But although Brazil has one of the most rigorous bodies of environmental legislation in the world, this has not been effective in combating the destruction of Brazilian flora and fauna in many areas. For this reason, "Conservation Areas" were created, which are spaces devoted specifically to the protection and conservation of samples of each type of existing flora and fauna.

The legislation related to the conservation areas was fragmented and limited. On July 18, 2000, after a long legislative process, Law nº 9985 was approved, which consolidates and formally creates the National System of Nature Conservation Units (SNUC), formed by the entire set of federal, state and municipal conservation areas. Conservation areas can be understood as the "territorial space and its environmental resources, including jurisdictional waters, with relevant natural characteristics, legally instituted by the State, with objectives of conservation and defined boundaries, under a special regime of administration, to which suitable guarantees of protection apply."

SNUC has the following objectives:

- contribute to the maintenance of biological diversity and genetic resources in national territory and jurisdictional waters;
- protect species threatened with extinction at the regional and national levels;
- contribute to the preservation and restoration of diversity of natural ecosystems;
- promote sustainable development based on natural resources;
- promote the use of principals and practices of nature conservation in the development process;
- protect natural and little altered landscapes of clear scenic beauty;
- protect the relevant characteristics of a geological, geomorphological, speleological, archeological, paleological and cultural nature;
- protect and restore water and soil-related resources;
- recover or restore degraded ecosystems;
- provide means and incentives to activities of scientific research, studies environmental monitoring;
- recognize the economic and social value of biological diversity;
- provide infrastructure and support for environmental education and interpretation, recreation in contact with nature, and ecological tourism;
- protect natural resources necessary to the subsistence of traditional populations, respecting and recognizing their knowledge and culture, and providing economic and social support.

Today Brazil has an extensive set of Conservation Areas. The general policy approaches to the creation, recognition and use of Conservation Areas are outlined by the National Environmental Policy (CONAMA), and having as executing bodies IBAMA and the responsible state and municipal bodies.

The Conservation Areas forming part of SNUC are divided into two groups, with specific characteristics: fully protected areas and areas of sustainable use. The basic objective of the fully protected areas is preservation of nature, with only indirect use of their natural resources permitted, with exceptions set out in the law. The group of fully protected areas consists of Ecological Stations (ESECs), Biological Reserves (REBIOs), National Parks (PARNAs), Natural Monuments and

Wildlife Refuges. The areas of sustainable use have the basic objective of making conservation of nature compatible with the sustainable use of part of its natural resources. The environmental protection Areas, Areas of Relevant Ecological Interest (ARIEs), National Forests (FLONAs), Extractive Reserves (RESEXs), Fauna Reserves, Sustainable Development Reserves and Private Natural Heritage Reserves (RPPNs), make up the group of areas of sustainable use.

Not including the indigenous reserves, there are a total of 206 federal conservation areas, with a total area of 44,835,960.84 hectares, or 448,000.35 km^2, covering 5.25% of Brazilian territory.

Table 39 - Federal Conservation Areas by category

Category		nº	Total Area* (há)	% of country **
Full protection	National Parks	47	11,669,883.78	1.37
	Biological Reserves	24	2,984,401.23	0.35
	Ecological Stations	28	3,694,311.67	0.43
Subtotal	Full protection	99	18,348,596.68	2.15
SUSTAINABLE USE	Environmental Protection Areas	28	6,473,193.04	0.76
	National Forests - FLONAs	59	16,075,244.67	1.88
	Areas of Relevant Ecological Interest	17	32,371.24	0.0
	Extractive Reserves	23	3,906,555.22	0.46
Subtotal	Sustainable Use	127	26,487,364.17	3.10
Total	Federal Conservation Areas	226	44,835,960.84	5.25

Source: IBAMA, 2002
* the overlap between CAs were processed by including them in the category of the greatest use restriction.
** based on the digital municipal network of 1996, provided by IBGE; the continental area of Brazil, not including the oceanic islands.

There is a large number of Conservation Areas administered by the states (451 units in 1997), protecting a total area of more than 29.8 million hectares. Some of these units are large, such as the Amanã Sustainable Development Reserve, with 2.35 million hectares. This reserve is linked to the Sustainable Development Reserve of Mamirauá, the Jaú National Park (AM), the Anavilhanas Ecological Station, the Rio Negro State Park and together with these areas, forms a continuous corridor of 8,567,908 ha. This is an area larger than Austria, and is one of the largest protected forest areas in the world.

Table 40 – State Conservation Areas in Brazil by Unit of the Federation

STATE / REGION	FULLY PROTECTED CAs		CAs of SUSTAINABLE USE	
	Area (ha)	Number	Area (ha)	Number
CENTER WEST	**590,448**	**25**	**391,958**	**9**
DF	15,737	7	71,256	4
GO	32,158	5	3,244	2
MS	765	3	-	0
MT	541,788	10	317,458	3
Northeast	**778,474**	**62**	**7,040,692**	**53**

AL	892	2	19,700	2
BA	17,105	9	489,074	21
CE	59	1	33,119	4
MA	748,312	3	6,321,569	7
PB	2,647	4	-	0
PE	8,287	41	24,195	14
RN	1,172	2	1,880	1
SE	-	0	54,413	3
PI	-	0	96,742	1
North	**3,293,759**	**16**	**13,081,345**	**41**
AC	-	0	-	0
AM	2,320,012	4	5,831,191	7
AP	5,811	2	23,000	1
PA	24,897	1	6,009,711	3
RO	942,739	8	1,062,607	27
RR	-	0	-	0
TO	300	1	154,836	3
Southeast	**1,052,045**	**107**	**2,115,792**	**53**
ES	10,334	10	26,729	6
MG	113,765	27	186,897	5
RJ	89,873	14	87,217	10
SP	838,163	56	1,824,949	32
South	**254,327**	**57**	**1,156,402**	**28**
RS	87,645	20	54,058	4
SC	108,524	7	1,100	1
PR	58,158	30	1,101,244	23
TOTAL	**5,969,143**	**267**	**23,796,189**	**184**

Source: Marino, M., 1997
* Brazilian States and Regions

A study by the National Environmental Fund - FNMA, including federal, state and some municipal Conservation Areas, showed that in terms of ecosystems, the Amazon region contains the greatest protected area, although in percentage terms it is the Coastal Zone that has the greatest proportion of its surface covered do biome by Conservation Areas.

Table 41 - Federal Conservation Areas by Biome

Brazilian Biomes	Area of Biome* (ha)	% do total	Full Protection** (ha)	% of total	Sustainable Use** (ha)	% of total
Amazonia	368,896,022.37	43.17	13,568,629.85	3.68	19,846,195.37	5.38
Caatinga	73,683,115.53	8.62	504,938.65	0.69	1,597,553.44	2.17
Southern Plains	17,137,704.54	2.01	50,992.75	0.30	317,015.82	1.85
Cerrado	196,776,092.28	23.03	2,638,266.86	1.34	1,467,786.66	0.75

Coast	5,056,768.47	0.59	322,675.01	6.38	316,060.62	6.25
Caatinga-Amazonia Ecotones	14,458,259.63	1.69	6,659.04	0.05	1,064,640.06	7.36
Cerrado-Amazonia Ecotones	41,400,717.92	4.84	5,678.78	0.01	36,127.02	0.09
Serrado-Caatinga Ecotones	11,510,813.00	1.35	383,732.97	3.33	15,527.72	0.13
Atlantic Forest	110,626,617.41	12.95	790,857.21	0.71	1,823,262.27	1.65
Pantanal	13,684,530.26	1.60	75,494.59	0.55		
Area not mapped	1,310,194.36	0.15				
Totals	854,540,835.77	100	18,347,925.72	2.15	26,484,168.98	3.10

Source: IBAMA, 2002.
* according to mapping carried out by IBAMA/WWF at a scale of 1:5,000,000,000, considering only the continental area.
** the overlap between CAs were processed by including them in the category of the greatest use restriction.

In the municipalities there are also organized systems of protected areas, generally linked to the respective Secretaries of Environment and with allotments in the respective budgets. In addition, many universities and research institutes establish and protect significant areas of Ecological/Forestry Reserves for scientific/experimental purposes, along with conservation. Examples are the 10,000 ha Adolfo Ducke Forest Reserve in Manaus, administered by INPA, and the 1260 ha IBGE RESEC in Brasilia, administered by IBGE.

Some private organizations administer protected areas with the goal of conservation, and with many of them linked to ecological tourism. Mining, energy and forestry companies, especially in the pulp area, also have important reserves created as environmental compensation or devoted to the development of management techniques. Pulp and paper companies, for example, maintain more than 1.000.000 hectares protected in the region of the Atlantic Forest alone. One example of this type of protected area is the Linhares Forest Reserve, of CVRD, with 21,787 ha, one of the largest and most important units in the Atlantic Forest.

Various conservation NGOs maintain important Private Reserves or Ecological Sanctuaries. There are, for example, the 880 ha Caratinga Biological Station, in the east of the state of Minas Gerais, administrated by Fundação Biodiversitas, the 1,716 ha Salto Morato Natural Reserve in the east of the state of Paraná administered by the Boticário Foundation for Nature Conservation (FBPN), and the chain of wildlife sanctuaries The Pro-Nature Foundation (Funatura).

Another advance in recent years has been the creation of Marine RESEXs along the Brazilian coast. These reserves cover only the aquatic aspect, and do not require resolution of the land title problems on the coastal zone (protected by ordinary legislation). Besides these RESEXs, there are federal conservation areas consisting of coastal and oceanic islands, as well as others protecting beaches, dunes, coral reefs, marine feeding grounds, bays, estuaries, saltwater lagoons, swamps, mangrove swamps, sand marshes, and coastal sandy soil vegetation (restinga) and marshes. Despite these marine RESEXs, however, conservation of the biological diversity of the marine and coastal zones is still fragile.

7.8.2 - DIFFICULTIES IN ADMINISTRATION OF CONSERVATION AREAS

Although there is a large number of Conservation Areas, it should be recognized that simply creating them, with the objective of protecting biodiversity, is no guarantee that this will in fact occur. In Brazil, many of these areas face problems of implementation that makes achievement of their purpose unviable. This is a consequence of the insufficiency of resources provided by the government for the maintenance of these areas, resulting in the need for international cooperation programs and co-management with non-governmental organizations.

A study carried out by WWF in 1999 revealed that among the 86 Conservation Areas analyzed, 47 were in a precarious situation, 32 were considered minimally implemented, and only 7 units were classified as reasonably implemented.

The principal problem faced by the strategy of protection of the fully protected Conservation Areas, then classified as for indirect use, has been the small number of IBAMA staff per area – an average of one staff member for each 27,560 hectares. Other limiting factors are the inaccessibility of the areas, lack of means of transport and of equipment. In strategic points, support has been obtained from the Army, state and federal police, municipalities and non-governmental organizations. In the RESEXs and Sustainable Development Reserves, “collaborator inspectors” have been mobilized, and leaders from the communities themselves have been trained and authorized by IBAMA. Inspection of coastal and marine areas has been made more difficult in Brazil because of the lack of a coast guard that is active in the environmental area. However, the Brazilian Navy has often cooperated with IBAMA in this area.

It is expected that Law nº 9985, de 2000, in bringing up to date and consolidating the principles and directives that guide the implementation of public policies related to conservation of *in situ* biological diversity, replacing the existing legislation in the area, will contribute to improving the administration of conservation areas.

According to this law, the bodies responsible for the administration of the conservation areas can receive resources, including visitor fees and donations of any nature, from domestic or international sources, with or without charges, from private or public organizations or individuals that wish to contribute. Furthermore, the management body for the conservation area is responsible for administration of the resources obtained, and these are to be used exclusively in its implementation, management and maintenance. This new development in terms of direct management of resources by the administrators of conservation areas was very warmly received by environmentalists.

The principal priorities established by IBAMA for Conservation Areas for the coming years are:

- institutional strengthening of public and private organizations responsible for protected areas;
- progress in the monitoring of biological diversity in Conservation Areas;
- creation of new areas and effective implementation of those already created;
- expansion of the number of Conservation Areas protected in the form of mosaics;
- expansion of protected lands around Conservation Areas;
- resolution of land ownership issues in Conservation Areas of indirect use;
- integration of Conservation Areas in regional, state and municipal development plans;
- expansion and training of staff;
- incentives for environmental education;
- training of residents of RESEXs in the sustainable use of resources, self-monitoring and preparation of development plans;
- creation of private concessions for sustainable use of FLONAs;
- regional development for generation of employment and income;
- development of ecotourism;
- expansion of financial resources for conservation areas.

Another problem identified is that deforestation and occupation of land around parks for real estate speculation and agricultural activities convert large areas of these parks into "green islands" under constant external pressure, disrespecting the legislation that calls for a 10 km buffer zone around the Conservation Areas. Within this buffer zone, defined in a CONAMA resolution, human occupation and economic activities must be compatible with the role of preservation of the area, and must pose no risk to its integrity.

7.8.3 - INTERNATIONAL COOPERATION IN SUPPORT OF CONSERVATION AREAS

The principal source of resources for protected areas is in international lending and cooperation programs. But the Conservation Units also receive significant resources from the Federal Government for expropriation of land, maintenance and management, along with direct collection of entrance fees and concessions for sales of forest products and byproducts.

The Conservation Areas component of the National Environmental Program (PNMA) is the largest source of resources for federal Conservation Areas in the period of 1991 to 1996. Part of the Brazilian counterpart for this component was financed by a donation from the German bank KFW.

With resources from the Brazilian Treasury, KFW and loans from the World Bank, PNMA financed programs for Conservation Areas, in various states. From 1991 to 1996, PNMA has applied a total of US$ 25.69 million in Conservation areas.

Another advance was the implementation and restoration of the physical infrastructure and equipment of the Conservation Areas, where around US$ 12.6 million from PNMA was invested in 1996 and 1997, as a contribution to the management of these areas. There has also been work towards land title surveys and demarcation of Conservation Areas, in order to enable future expropriations.

Other international agencies and organizations, such as IDB, USAID, WWF, and the governments of France and Canada, have contributed resources directly to the NGOs that work around the Conservation Areas, in general with rural extension programs, strengthening associations, and environmental education.

7.8.4 - PRIVATE NATURAL HERITAGE RESERVES - RPPNS

Another major advance in biodiversity conservation in Brazil has been the implementation of Private Natural Heritage Reserves (RPPNs). These are private areas set aside in perpetuity with the objective of biological conservation, regulated by Federal Decree nº 98,914, of January 31st, 1990, and strengthened by Law nº9985, of July 18, 2000. These areas have expanded greatly after 1992.

The current model was in place by 1990, where areas considered RPPNs are not deforested and there is no removal of extractivist products so that the area maintains the characteristics of a genetic bank, with full and permanent protection. Decree nº 1922, of June 5, 1996, established rules for recognition of RPPNs. By 1998, 150 of them had been created throughout Brazil, with a total of 341,057.34 ha, with areas of between 1,000 and 104,000 hectares.

The landowner can transform the entire area into an RPPN, or only part of it. To be classified as a RPPN, an area must be important for protection of biodiversity, contain landscape features of great beauty, or have characteristics that justify environmental recovery activities which would preserve fragile or threatened ecosystems. RPPN owners, whether individuals or companies, enjoy some advantages: they do not pay property tax - ITR on the part of their property classified as a RPPN; they have priority in obtaining resources from the National Environment Fund - FNMA; and they have protection against fires, hunting or deforestation.

Table 42 - RPPNs by State

STATE / REGION	No. of RPPNs	Area (ha)
Amapá	1	46.75
Amazonas	5	104,222.96
Pará	1	2,000.00
Rondônia	1	623.24
Roraima	1	109.59
Tocantins	1	745
Total North Region	**10**	**107,747.54**
Alagoas	3	180.5
Bahia	15	9,821.59
Ceará	3	3,124.33
Maranhão	5	1054.04
Paraíba	4	5,580.65
Pernambuco	1	1,485.00
Piauí	1	27,458.00
Rio Grande do Norte	2	910.24
Total Northeast Region	**34**	**49,614.35**
Distrito Federal	1	1.00
Goiás	15	13,306.60
Mato Grosso	6	82,040.79
Mato Grosso do Sul	9	49,533.35
Total Center West Region	**31**	**144,881.74**
Minas Gerais	30	21,841.60
Rio de Janeiro	16	3,037.78
São Paulo	10	346.19
Total Southeast Region	**56**	**25,225.57**
Paraná	4	2,272.35
Rio Grande do Sul	9	3,175.68
Santa Catarina	6	8,140.11
Total South Region	19	13,588.14
Total Brazil	**150**	**341,057.34**

Source: Ibama-DIREC, 1998.

7.8.5 - INDIGENOUS LANDS

In Brazil, indigenous areas are designated by the Federal government for the exclusive use of the indigenous communities that inhabit them. According to Art. 17 of Law nº 6001 of December 19, 1973 (Indian Statute), indigenous lands are those areas reserved (indigenous reserve; indigenous park and indigenous agricultural settlement) and the lands of the dominion of indigenous communities or of aborigines.

Concomitantly, Portaria nº 1060, of December 5, 1994, of the National Indian Foundation - FUNAI stipulates the name of indigenous land for any and all territory occupied by Indigenous peoples.

Given this classification, Brazil has 97,624,245 ha of indigenous land, covering 11.42% of Brazilian territory. There are 561 indigenous lands, classified as registered, declared, demarcated, delimited and identified. The greatest number are in the North region, with 294 lands.

These areas are not considered conservation areas, since their primary management objective is not the protection of biological diversity. However, because of the size of the areas, they are very important in the process of protection of the biological wealth of the country.

7.9 - PREVENTION OF BURNING

7.9.1 - NATIONAL SYSTEM OF FOREST FIRE PREVENTION AND CONTROL - PREVFOGO

On April 10, 1989, federal government decree nº 97635 created the National System of Forest Fire Prevention and Control (PREVFOGO), which made IBAMA responsible for coordinating the actions necessary for the organization, implementation and operationalization of activities related to education, research, prevention, control and fighting of forest fires[118] and controlled burning[119].

In 1990, the first year of PREVFOGO, two different lines of activities, one short term and the other medium term, were defined.

The first had the basic objective of establishing emergency mechanisms for fire protection in the Federal Conservation Areas with the greatest risk of fires. To this end efforts were made to provide them with infrastructure and means of forest fire prevention and control, as well as human resources trained for this task. To provide for this training, IBAMA signed agreements with the Fire Departments of the States of Rio de Janeiro, the Federal District and Goiás. In 1991 these activities were expanded, and each year new protected areas and other states are being served by the program.

The second activity is aimed at designing the form of organization and operation of the system, whose stages are being gradually implemented and evaluated.

7.9.1.1 - Program Structure

PREVFOGO is made up of five programs: Prevention, Control, Fighting, Research and Training Each Program consists of a series of projects.

Prevention Program: involves actions that permit both anticipating decision-making about any risk of fires and acting directly in response to the potential causes of fires.

[118] This is all uncontrolled fires affecting any form of vegetation, which could be caused by humans (intentional or negligence), or by natural causes (lightning).
[119] These are agricultural/ranching or forestry practices, where controlled burning is used as a factor of production.

- Program for Control of Deliberate Burning and Forest Fires: seeks to establish a Fire Detection System (by satellite, air and local) and a system of Authorization and Control of Burning.

- Program for Fighting Forest Fires: the objective is develop a systematic approach that, once a fire is spotted, allows it to be contained within very tight limits, through the development of appropriate technologies for Brazilian conditions, the training and capacity-building of human resources, and the establishment of plans and strategies for fighting forest fires.

- Research Program: the necessity and urgency of learning about and mastering the issue of fires in forests and fields led PREVFOGO to consider the importance of coordinating such a program, that would allow establishment of indicators of how to manage fire in different ecosystems, through evaluation of its behavior and the environmental impacts it causes.

Training Program: the principal objective is to establish a structure for training of human resources to work in the area of forest fires and burning, in the management and operational context, in order to offer to all agencies forming part of the system opportunities to improve the level of knowledge and ability of their personnel. Being a pioneering initiative in Brazil, the establishment of this program has to address issues ranging from the training of trainers, to the definition of program content, the production of teaching material, and the physical establishment of some regional training centers.

7.9.2 - PROGRAM FOR THE PREVENTION AND CONTROL OF BURNING AND FOREST FIRES IN THE ARC OF DEFORESTATION (PROARCO)

7.9.2.1 - Burning and Fires in the Amazon Forest

Over the 1980s, deforestation in the Amazon consumed an average of 21,000 km^2/year of forests. In the wake of this deforestation, the greatest fires and burned over areas in the region were identified.

In this context, the combination of an excessive number of fires in deforested areas of the Amazon with the adverse effects *El Niño* could increase the susceptibility of the region's vegetation cover to fire, especially in the more southern part, corresponding to the Arc of Deforestation.

After the forest fire episode that occurred in the state of Roraima, the federal government recognized its limitations in dealing with such problems in isolation, without recourse to other governmental and non-governmental organizations and agencies.

In general, the episode showed that the governmental institutions that work in control of burning and forest fires do not have adequate equipment or capacity to effectively monitor and control these processes. The existing programs, at both the federal and state levels, have not proven effective in resolving these problems, and have resulted in sporadic, uncoordinated and discontinuous actions, with little optimization of infrastructure and financial, material and human resources.

7.9.2.2 - PROARCO: Response to the Problem

The experience of Roraima, the growing exposure of the forest to actions of fires and the expectation of worsening damage, especially resulting from *El Niño*, demanded an immediate response from federal and state governments and from society in the search for solutions that can minimize the problems caused by burning and forest fires.

The response was the Program for the Prevention and Control of Burning and Forest Fires in the Arc of Deforestation (PROARCO), launched by IBAMA in May of 1998.

The general purpose of PROARCO (www2.ibama.gov.br/proarco/index0.htm) is to prevent and combat forest fires on a large scale in the Legal Amazon, especially in the "arc of deforestation" (see section 7.7.3), identified as an area significantly altered through agricultural and ranching activities, forestry exploitation and other interventions, and subject to large-scale catastrophes.

Thus, the program intends to encourage the integration of the agencies of different levels of government and society in carrying out actions of prevention, inspection and control of burning and fighting forest fires in the region, decentralizing the execution of actions and defining the responsibilities of the federal government, states and municipalities.

7.9.3 - PROHIBITION OF BURNING IN SUGARCANE HARVEST IN THE STATE OF SÃO PAULO

The state of São Paulo is the largest sugarcane producer in Brazil, with around 3 million hectares of its territory dedicated to this crop, accounting for almost half of the area planted with sugarcane in Brazil. The state has a high level of technology used in production, forming the principal center of sugar and alcohol production in Brazil. In the 1995-96 agricultural year, sugarcane was the principal temporary crop in the state, along with corn.

Deleafing of sugarcane through burning is currently practiced in São Paulo, as in other states, and other countries. However, this practice has been contested by members of the state Public Attorney's Office through court actions and by the actions of communities concerned about the effects of this agricultural practice on health, safety, the environment and quality of life in the urban areas near the plantations. The practice has also been questioned by government staff from the environment area because of the environmental damage, especially air pollution and risks of fires and deforestation.

However, mechanical harvest of sugarcane has been growing in recent years, with some environmental benefits. In the mechanical collection system, the leaves are not burned, which avoids emissions of atmospheric pollutants, and the dry leaves, tips and green leaves which are cut off are spread on the soil surface, forming a layer of material that, when it degrades, provides a source of nutrients to the soil and to the sugarcane crop, or used to generate energy.

Since the mid 1990s the government of the State of São Paulo has adopted measures to try to reduce the problems resulting from burning of sugarcane crops, which is one of the most serious environmental problems in the state, without harming agricultural production and the jobs generated in the sector. Plant owners have applied considerable pressure, alleging economic obstacles to adoption of less polluting measures for the sugarcane harvest, which has generated ongoing debates and negotiations for new deadlines for the gradual elimination of burning to remove leaves. There is also another complicating factor in the process of gradual elimination of burning and its replacement by agricultural mechanization, which is the increase in rural unemployment, with the possibility of layoffs of the workers employed in the sugarcane harvest.

In 1998, the State Secretary of Agriculture and Supply and the Secretary of Environment issued joint resolution # 01/98, regulating the gradual elimination of burning of sugarcane leaves, and requiring the presentation of plans, criteria, deadlines and reports for the elimination of burning, among other measures.

Later, in 1999, the discussions under the Chamber of the Sugar and Alcohol Sector of the State of São Paulo were resumed, seeking new negotiations of the regulations in 1997 State decree # 42,056, which failed to meet a range of demands.

In the year 2000, the São Paulo State Legislative Assembly approved a law that defined procedures, prohibitions, rules for implementation, and precautionary measures to be obeyed when using fire in agricultural, ranching and forestry practices (Law nº 10,547, of May 2, 2000), known as the "Law of Burning". This law did not establish a clear timetable for the elimination of burning, nor did it identify clear penalties for those who fail to comply. Thus, new legal measures are being undertaken to regulate the process of prohibition of burning of sugarcane in the state[120].

7.10 - STATE PROGRAM ON GLOBAL CLIMATE CHANGE - PROCLIMA - SP

The main reason for the creation of PROCLIMA by the São Paulo State Environmental Secretariat, in 1995, was the fact that continuous economic and demographic growth, that met the development needs of the state of São Paulo, would mean an increase in energy consumption in industrial and agricultural activities, resulting in a net increase in greenhouse gas emissions.

Given that São Paulo is responsible for 40% of the GDP 44% of the industrial production of the country[121], it had a responsibility to take measures to adapt its economy to the implications of global climate change.

Another assumption of the program is that the State of São Paulo is also responsible for complying with the obligations assumed by the Brazilian Government under the United Nations Convention on Climate Change.

The general objectives of the program are:

- development of national inventories of anthropogenic greenhouse gases by sources and removals by sinks of all greenhouse gases in the state, not controlled by the Montreal Protocol;
- formulation and implementation of programs containing measures aimed at controlling anthropogenic actions which cause climate change;
- promotion of practices and processes that control, reduce or prevent anthropogenic emissions in some relevant sectors, such as energy, transport, industry, agriculture, cattle ranching, and waste management;
- promotion of the exchange of scientific, technological, technical, social, economic and legal information pertaining to climate change, and about the economic and social consequences of certain response strategies;
- promotion of education, training and awareness of the population concerning the problem of global climate change;

[120] Law # 10,547 was regulated by Decree # 45,869, from June 22, 2001, which among other things provides that: "the use of fire as a deleafing method and to facilitate the sugarcane harvest, should be eliminated gradually, with the reduction in each five year period being no less than 25% of the area of each agro-industrial unit or property not linked to the agro-industrial unit, (...)". The decree establishes that starting in 2001, burning of sugarcane crops will not be conducted on 25% of the areas suitable for mechanical harvest, and 13.35% of the areas which cannot be harvested mechanically. Complying with these provisions, along with various others, was considered difficult by sugarcane producers. A new draft bill, for which compliance is considered more feasible by rural producers, while meeting the demands of environmental agencies, is before the State Legislative Assembly.

[121] It is estimated that CO_2 emissions from the energy sector of the State of São Paulo correspond to 40% of these emissions in Brazil.

- promotion of research about the issue by institutes and universities and help establish a national and international cooperation network, as well as disseminate information and give orientation to people about positive behaviors and practices for the prevention of climate change;
- promotion of measures and initiatives at the state level to comply with the obligations Brazil has assumed under the United Nations Framework Convention on Climate Change;

The program was developed under the coordination of CETESB, particularly by the Office of the Director of Technology Development and Transfer. The activities developed by the program, either under the direct coordination of the Secretary's office or by the Office of the Director of Technology Development and Transfer of CETESB, include the following.

The objectives and premises of PROCLIMA, as well as the activities developed under the program, are important examples to be followed by other Brazilian states in order to promote the implementation of the Climate Change Convention and nationally and internationally recognized environmental protection principles.

7.11 - CITIES FOR CLIMATE PROTECTION

The Cities for Climate Protection Campaign (CCP) is an initiative of the International Council for Local Environmental Initiatives (ICLEI) launched in June of 1991. This is an international campaign to mobilize local government actions to reduce greenhouse gas emissions and support the international collective effort of municipal governments vis-à-vis national governments and the U.N. Framework Convention on Climate Change.

One of the objectives of the Campaign is to coordinate initiatives and provide technical support and educational material to municipalities for the development of local capacity to understand and implement the "Local Action Plans" for reduction of greenhouse gas emissions. To this end, one of the central objectives of the Campaign is to develop and maintain a structure that encourages Campaign participants to monitor, quantify and report their results to ICLEI and to their national governments.

By June 30, 1997, CCP has already recruited 174 local governments, representing a population of 100 million people throughout the world. Urban CO_2 emissions from these cities contribute around 5% of total global emissions.

While developing countries have not signed any commitments for greenhouse gas reduction targets, according to the Kyoto Protocol, cities of these countries can and are invited to join this campaign and take initiatives to reduce their emissions.

In Brazil, six large cities with a total of approximately 9,3 million inhabitants have joined this Campaign: Rio de Janeiro, RJ, Volta Redonda, RJ, Niterói, RJ, Betim, MG, Goiânia, GO and Porto Alegre, RS. These cities have all formalized their participation in the Campaign by signing a resolution by the municipal government, in accordance with the basic guidelines established by INCEI for participation, and carrying out projects for optimization and effectiveness in the reduction of greenhouse gas emissions, with many of them already taking local measures to this end.

For example, the Rio de Janeiro, through its Environmental Secretariat, has been taking the initiative through the following activities and programs: development of criteria for land use and occupation and management plans in conservation areas; systematic monitoring and control of activities which modify the environment; registry of potentially polluting activities; efficient energy consumption;

development and investment in alternative transport; cycle path program; appropriate waste treatment and recycling; air quality control; preservation and recovery of vegetation cover; establishment of environmental information system; public awareness and commitment to environmental issues.

Box 4 – Other urban environmental initiatives

Other Brazilian cities are carrying out environmental activities and programs, although outside the CCP, which also include the reduction or limitation of greenhouse gases in their justification.

The City of São Paulo, through its Environmental Secretariat (SMMA), is also negotiating its membership in the CCP campaign, and its Strategic Planning and Management System presents a range of plans, programs and projects for the improvement, preservation and conservation of environmental quality. Examples include the Inspection and Maintenance Program for Vehicles in Use (I/M-SP); the Natural Gas Program; the One Million Trees Program; and the Implantation of Cycle Paths Program.

Curitiba has traditionally demonstrated a concern with the regulation of urban space, which is reflected in general environmental issues. The Collective Transport System is experimenting with biodiesel, which involves a composition of traditional products with non-polluting components and alcohol, used as an alternative fuel in some transport lines. The city also has a policy of creation of spaces as alternatives to automobile use, such as cycle paths; air quality monitoring; land use and zoning legislation; solid wastes disposal policies; waste separation projects; and environmental education programs.

Various small and mid-sized cities throughout Brazil have shown their commitment to environmental preservation, and many have developed action plans (Local Agenda 21, etc.) to this end.

7.12 - FINANCIAL AND TAXATION MEASURES

7.12.1 - AN EVALUATION OF FISCAL INCENTIVES OF FISET FOR FORESTATION/REFORESTATION

Since the mid-1960s, the resources for Brazilian forestry policy have been concentrated in reforestation and silviculture industry, to the detriment of the other areas under the responsibility of the Brazilian Institute for Forestry Development (IBDF), created in 1967.

7.12.1.1 - Incentives

On September 2, 1966, Law nº 5106 introduced the Fiscal Incentives for Reforestation, benefiting individuals and companies paying Income Tax who chose to allocate part of their taxes payable to reforestation activities. In the first case, an individual can deduct from their gross income all the investments made in this activity, to a limit of 50% of their income, and companies can deduct the amount of their expenses from their taxes payable, to a limit of 50% of the taxes.

According to Decree-law nº 1134 of November 16, 1970, a company can, instead of deducting the expenses made from the amount of taxes owing, discount up to 50% of this tax for the application (in the following fiscal year) in forestry projects that have been previously approved by IBDF.

Decree Law nº 1376, from December 12, 1974, created a new modality of managing those resources, through the establishment of Funds, not only for reforestation, but also for other activities such as fishing and tourism.

With the creation of the fiscal incentive fund for forestation/reforestation (FISET-F/R), the IBDF came to assume greater responsibility for the administration of incentives. The incentives are not based on resources generated by the projects themselves, since they are based on the initial phase, which makes them very attractive to potential reforestation companies.

7.12.1.2 - Positive Results

After twenty years of activity, FISET-F/R was made extinct by Law nº 7714 of December 29, 1988. The IBDF was also eliminated and its responsibilities were assumed by IBAMA, created in 1989. Despite all the distortions in the implementation of FISET-F/R, we can list some positive points, resulting from the operations of the Program:

- 7.2 million hectares (the largest planted forest on the planet) were planted, even though 15% of this total was lost because of using unsuitable areas or lack of a market;
- 1.6 million direct fixed jobs were created;
- there was a generation of wealth in the order of 4.7% of the GDP;
- the country is the fourth largest exporter of paper and the third largest pulp exporter (according to data from 1998);
- 2.3 million hectares of native forest were conserved, constituting the largest ecological corridor in the Atlantic Forest;
- a level of US$ 13 billion in exports per year was reached;
- US$ 4.5 billion in taxes were collected;
- technology to stimulate companies from the farmland reforestation sector was developed.

7.12.1.3 - Negative Results

While before the incentives reforestation was restricted to only a few companies, with FISET-F/R extensive forests were planted on a large scale during the 20 years that the incentives were available. But despite this relative success, which includes import substitution, contribution to exports and advances in the area of biotechnology, the program was criticized by various social segments because of the social costs involved, which caused serious distortions.

Information provided by reports by IBDF itself indicated great disparities were found between the effective (market) cost of implementation and maintenance of the forestry projects receiving incentives and the cost paid by IBDF, which was evidence of the inefficiency in the procedures adopted in project approvals and in the payment of project costs. Much of the capitalization of the sector and its growth is likely linked to this difference. Thus, the program has failed to contribute to the reduction of public deficits.

Also, IBDF's project selection process was very simplistic, placing a limit only on the cost side. The analysis was completely suspect from a methodological point of view and deficient in terms of the objectives that a development agency should pursue.

Also, the monitoring of the projects carried out by IBDF was inadequate. It was restricted to verification of its physical implementation, making its correction difficult in a suitable timeframe, in the case of errors of implementation. There was no monitoring of projects after their implementation and maintenance of the period for which incentives were offered.

According to the Auditor General of the Federal Government (TCU), 50% of the planting carried out under this program throughout Brazil was with the cutting period expired and was uneconomical because of the lack of a consumer market or because of high transport costs, because of the distance to consumer centers.

The incentive legislation lacked proper instruments for implementation, in terms of punishment for deviations, poor use of resources, losses, etc., and when it required the beneficiary to refund the incentives, there was no provision for monetary correction for inflation. The TCU team found losses estimated at 15% of the forestry investments, resulting from occasional events, diversion of resources and abandonment of projects. The IBDF was slow in prosecuting companies with violations, and there was little success in administrative or legal initiatives adopted.

One should not ignore the contribution that the reforestation activities stimulated have made to environmental conservation, but the way the incentives were managed over a period of 20 years, some aspects were prejudicial to the environment, such as the permissions for native forests to be cleared in order to be replaced by homogeneous reforestation. This type of implicit subsidy to the removal of natural forests was widely criticized and seen as economically inefficient.

Nowadays an incentive like FISET would not likely be considered by the Brazilian government, since it was based on tax refunds and during the 20 years that the incentive was offered, US$ 6 billion was spent to stimulated forestation activities.

7.12.2 – Green Protocol

In 1995, the federal government launched the “Green Protocol” program, with the goal of incorporating environmental variables as an indispensable criteria of sustainable development, in the process of analysis for offering official credit and tax benefits.

The two original objectives of the Protocol are to give priority in the allocation of public resources through credit operations or tax benefits to projects with the greatest potential for social and environmental self-sustainability, and avoiding the use of such resources in projects that contribute to greater environmental damage in Brazil.

The decree of May 29, 1995 created the Working Group that developed the lines of activity of the Green Protocol, culminating in the signing of the Sustainable Development Charter of Principals”[122], by the five federal banks (Brazilian Development Bank (BNDES), Banco do Brasil, Caixa Econômica Federal, Banco do Nordeste do Brasil and the Banco da Amazônia).

In compliance with the Charter, to fulfill the intentions of the Green Protocol, the signatory federal banks, in conjunction with the Ministries of Environment, of Finance, of Planning and of Agriculture, as well as the Central Bank, became members of a Working Group coordinated by the Chamber of

[122] This “Charter”, in listing the General Principals of Sustainable Development, calls for the banking sector to increasingly provide financing to projects that are not damaging to the environment or that meet the characteristics of sustainability; that environmental risks should be taken into account in the analyses and conditions for financing, and that environmental management requires the adoption of practices that anticipate and prevent environmental degradation.

Natural Resources of the Chief of Staff (*Casa Civil*) of the Presidency of the Republic, with FINEP joining later.

This working group identified some priorities from among the directives of the initial document of the Green Protocol, to be carried out jointly or individually, in accordance with the mandate of each institution involved. This priorities included three basic groups of issues:

- defining criteria and preparing instruments for analyzing the environmental variable in allocation of credit;
- identifying needs for improvements in the environmental licensing system and for changes the legal framework and environmental regulations;
- pursuing new sources and mechanisms for increasing the funds available for environmental projects.

The greatest difficulties found in addressing the issues cited, especially in effectively incorporating the proposals of the Green Protocol in the day to day credit operations of the federal banks, involved the need to challenge some structural factors related to the form of production and the type of consumption in our society, as well as change procedures and positions of the State and its financial institutions. However, these new forms of operating are increasingly justifiable, since environmental issues are becoming treated less as externalities in the economic and financial system and a becoming more important, both in government projects and in private undertakings and trade relations (see section 7.12.5).

The Green Protocol has achieved results, principally in terms of: building awareness and capacity in the federal financial institutions involved; institutional adaptation of licensing mechanisms; the effort to identify external private resources directed to the environment; design of projects and programs in conjunction with the banks, oriented to sustainable development and to mitigation of environmental impacts; and in particular, the rationalization of use of agro-toxics.

7.12.3 - THE ECOLOGICAL ICMS TAX AND TH APPLICATION OF THE "PROTECTOR-RECEIVES" AND "NON-POLLUTOR RECEIVES" PRINCIPALS IN ENVIRONMENTAL MANAGEMENT

7.12.3.1 - The ICMS tax of the States

The ICMS (Tax on the Circulation of Goods and Services) accounts for a significant part of the revenue of Brazilian states and is also an important source of resources for municipalities. Article 158 of the Federal Constitution stipulates that 25% of the resources from the ICMS be forwarded to the municipalities; of this 25%, 75% must be distributed according the aggregate value generated by each municipality and the remaining 25% according to criteria established by the states themselves.

In recent years, the distribution of this latter 25% incorporated, in some states, a new category, which stimulated municipalities to maintain conservation areas and develop appropriate environmental practices, such as waste and sewage treatment.

This category has been collectively known as the "Ecological ICMS" and is aimed at compensating those municipalities that give up the right to generate products and services for the municipality so that society can enjoy the environmental resources and services on its territory. It is an excellent incentive for municipalities to not abandon these environmentally correct activities because of not being duly compensated by resources from the ICMS (which previously privileged almost only economic activity) and so that others, especially those that were not blessed by nature with areas of natural preservation, create reserves and undertake ecological activities.

To cite one example, the municipality of Piraquara, in the state of Paraná, which has 90% of its territory forming headwaters areas for Curitiba's water supply and the remaining 10% destined to conservation areas, receives 82% of the resources from its ICMS because of the environmental criteria of the Ecological ICMS. In Minas Gerais, the municipality of Marliéria had an increase of 2131% in its ICMS revenue between 1995 and 1998.

According to the WWF, which carried out a wide-ranging study of the issue, the adoption of the Ecological ICMS is the first experience of including environmental criteria in the redistribution of taxes. Some Brazilian states already use the Ecological ICMS very successfully, while other are still developing the legal instruments for its application.

The state of Paraná is a pioneer in the application of the Ecological ICMS, followed by São Paulo, Minas Gerais, Rondônia, Mato Grosso do Sul and Rio Grande do Sul. Each state established its own criteria for distribution according to the specific characteristics of the region, which contributes to legitimating the application of the Ecological ICMS in areas with different environmental characteristics.

Table 43 – Ecological ICMS Tax in the Units of the Federation

State	Year Ecological ICMS approved	% of ICMS of the municipalities distributed by environmental criteria	Criteria for distribution
Paraná	1991 (Complementary State Law nº 59/91)	5%	50% - municipalities that have conservation areas within their boundaries; 50% - municipalities that have headwater protection areas for water supplies within their boundaries;
São Paulo	1993 (Complementary State Law nº 8510/93)	0,5%	Municipalities with areas destined to environmental protection, but created and under the responsibility of the state.
Minas Gerais	1995 (Complementary State Law nº 12,040/95)	Applied gradually: 0.33% in 1996, 0.66 in 1997 and 1% since 1998.	50% - municipalities that have conservation areas within their boundaries; 50% - municipalities that have solid waste or sewage treatment systems that serve a certain proportion of the population
Rondônia	1996 (Complementary State Law nº 147/96)	5%	Conservation areas and other specially protected areas.
Rio Grande do Sul	1993 (State Law), but the Ecological ICMS only entered into force in 1999.	2,57%	Municipalities that have headwater protection areas for water supplies and conservation areas;
Mato Grosso do Sul	1994 (Complementary	5%	Municipalities that have conservation areas;

	State Law nº 077 of 07/12/94)		

7.12.3.2 - Environmental management principals in the application of the Ecological ICMS

Environmental management in countries with abundant resources apply the principal of "user/polluter-pays", which is still not common in countries with limited finances. In situations of poverty, it is more effective to invert this concept and apply the principal of "protector receives", since in these countries the disposition to receive is much greater than the disposition to pay. Those that clean up receive; those that keep on polluting the environment lose money to those who clean up[123].

The adoption of this "protector-receives" system depends on the existence of a government which is committed to reducing inequalities between poor and rich and demographic pressure on large cities, is interested in promoting small and medium-sized cities, and is environmentally sensitive to the "ecologization" of public policies, sanitation and health services.

In this context, to a greater or lesser extent and depending on the specific legislation of each state, the Ecological ICMS represents a mechanism for transferring resources to municipalities which "invest" in environmental conservation through maintenance of environmental reserves or headwaters on their territory, following the "protector receives" principal, as well as to municipalities which undertake environmentally healthy activities such as sanitation, following the "non-polluter receives" principal.

The "protector receives" principal reward those who preserve a resource of collective and public interest. This principal is analogous to that adopted to compensate owners of real estate of historical value, which are protected as cultural heritage, allowing them to transfer the right to construct to another site, without penalizing these property owners. If such rewards were not adopted, the intention to protect could have the opposite result, ou seja, accelerated destruction of the nature feature that it is desired to protect.

Most states that implemented the ICMS follow more the principal of "protector-receives", through financial compensation and increase in the allocation of the ICMS to municipalities that have part of their territory occupied by conservation areas – environmental protection areas, parks, ecological stations, etc. – or that invest in protection of headwaters, through conservation areas, as seen in Table 43.

In terms of the "non-polluter receives" principal, only Minas Gerais gives economic incentives to municipalities that invest in sanitation. Cities that operate water and sewage treatment states for at least 50% of its population, or which serve at least 70% of their inhabitants with solid waste disposal systems, receive an additional allocation of the tax[124].

Three months after receiving the environmental license to operate a sanitary landfill, waste separation plant or sewage treatment station, the municipalities begin to receive the additional resources. They have autonomy in the use of these, and several use them in sanitation and in the creation of parks, so that their share grows even more. The incentive promotes competition between the municipalities and recognizes the example of those who achieve results. To use the benefits of the ICMS, the municipalities must invest, do their homework, act technically, and abandon expectations of receiving

[123] Andrés Ribeiro, M., 1999. "Sobre o Princípio Protetor-Recebedor", Revista Eco 21, Rio de Janeiro, pp. 43-48.
[124] Idem.

resources before first carrying out their work[125]. They need to have qualified technical staff to carry out projects, implement them, and get landfills, plants and treatment stations up and running.

No municipality benefited from the Law in the first year. In the second year, one municipality was included, and in the third year six, benefiting around 20% of the population of the state of Minas Gerais, which attests to the positive stimulation of the ICMS Law. Many other municipalities are investing their own resources in the expectation of receiving a return on their investment. Each year, with more municipalities benefiting, the share going to each is progressively reduced, but the selective incentive will be achieving its objective of encouraging investments in the environmental area.

The Ecological ICMS stimulates local governments to invest in actions that will produce more effective results then would result from simply penalizing local governments that do not treat their urban effluents, for example. These are thus positive incentives and a non-coercive form of regulation.

7.12.4 – EMISSIONS REDUCTIONS RESULTING FORM TAX INCENTIVES FOR VEHICLES WITH 1.0 LITER ENGINES IN BRAZIL

In 1993, a tax incentive was introduced in Brazil to stimulate production of automobiles with small engines (≤1.0 liter[126]). The objective of the reduction in the Industrial Products Tax (IPI) was to encourage the production of more efficient automobiles that would be accessible to the lower-income population. By the year 2000, around 64% of domestic sales of new automobiles consisted of those with motors smaller than 1.0 liter, as shown in Table 43.

Table 44 – Sales, Fuel Economy and IPI on Automobiles in Brazil, based on Vehicles with 1.0 Liter Engines and Other Motor Vehicles

1.0 L. (1000 cc)				**All Others**			
Year	Sales (number of vehicles)	Fuel economy (km/l)	IPI (%)	Sales (number of vehicles)	Fuel economy (km/l)	IPI (%)	% of Sales (1.0 L /total)
1992	92,573	8	14.0	504,391	8	31.0	15.5
1993	241,964	9	0.1	661,864	8	25.0	26.8
1994	447,867	10	0.1	679,806	8	25.0	39.7
1995	595,845	10	8.0	811,228	8	25.0	42.3
1996	701,440	10	8.0	704,105	8	25.0	49.9
1997	871,873	10	13.0	697,854	8	30.0	55.5
1998	702,927	12	8.0	508,958	8	25.0	58.0
1999	605,635	12	7.0	406,212	9	20.0	59.9
2000	754,419	12	10.0	422,355	9	25.0	64.1

Source: Database provided by ANFAVEA (2001), GEIPOT (2001) and Carsale (2001).

[125] Ibid.
[126] Vehicles with 1.0 liter or 1000 cubic centimeter (cc) engines.

Since automobiles with engines smaller than 1.0 liter have a lower specific consumption than the average for vehicles with more powerful engines, the reduction of the IPI also resulted in reductions of carbon emissions. In this analysis, it is assumed that in the absence of this fiscal incentive, the renewable of the fleet would be based on cars with fuel consumption equivalent to the average of more powerful automobiles for each year since 1993, which is the same as assuming that cars with 1.0 liter engines in Brazil were purchased by a portion of the population that previously had acquired more powerful automobiles. In other words, it is assumed that the fiscal incentives did not stimulate car purchases that would not have otherwise occurred; it only changed the type of automobile acquired. In accordance with the scrappage curve for light vehicles in Brazil, it was also assumed that all automobiles produced since 1993 are still in use, while the annual distance traveled by older cars is less than that of newer models.

The estimate of avoided carbon emissions in the period of 1993 to 2000, resulting from the measures analyzed here, is based on the total number of automobiles with 1.0 liter engines sold since 1993, the average distance traveled by the vehicles and their different fuel economies, defined as shown in Table 43, with the last parameters changing according to the year the car was manufactured. The total estimated avoided emissions for the period between 1993 and 2000 is 6.1 million tC[127].

7.12.5 - ENVIRONMENTAL RESPONSIBILITY OF BANKS

As mentioned above, Art. 225 of the 1988 Federal Constitution attributes to the state and the collective the duty to preserve the ecologically balanced environment for present and future generations. Public and private banks cannot be excluded from the concept of the “collective”.

Furthermore, in Brazil there are various legal provisions that seek to provide guidelines for public and private banks for their activities that affect the environment.

Articles 3, 12 and 14 of the National Environmental Policy Law have provisions that, applied to financial institutions, in a broad sense raise financing and credit to the level of environmental control instruments. Financing, especially involving government incentives, must incorporate the environmental component in lending decisions, based on environmental impact studies prior to project analysis and awarding of credit, as has been occurring with the World Bank.

Financing agencies include not only traditional banks, but also cooperatives, autonomous state agencies, private and public joint stock companies, multi-service and investment banks and pension funds, in fact all those institutions that can, in a broad sense, fit under the description “entities or bodies that provide financing or government incentives”. Thus, banks can be subject to the requirement to pay compensation for environmental damage caused, with this responsibility considered objective.

The Law of Environmental Crimes (Law nº 9605, from 1998) has various provisions with a direct impact on the environmental responsibility of banks, especially Articles 2, 3 and 4.

This law establishes the penal responsibility of legal entities, and holds that legal entities will have administrative, civil and penal responsibility in cases where an infraction is committed by a decision of its legal or contractual representative, or of its collegiate body, in the interest or benefit of its entity. The responsibility of legal entities does not exclude that of individual authors, co-authors or participants in the same act.

[127] Adopting an average of 22% of anhydrous alcohol mixed with gasoline.

It is possible to understand the concept of environmentally reckless management when art. 4 of law nº 7492 from 1986 is combined with Art. 12 of Law nº 6938, de 1981. Art. 12 of Law nº 6938, de 1981 clearly provides that entities providing financing and government incentives will make compliance with environmental licensing and the standards, rules and criteria of CONAMA a condition of approval of benefits – financing and governmental incentives. In addition, Paragraph 3 of Article 225 provides for penal and administrative sanctions for individual or corporate lawbreakers, whose conduct or activities are considered damaging to the environment, independently of the obligation to make reparations for the damage caused.

In other words, in recklessly managing the financial institution, awarding credit without compliance with environmental licensing or CONAMA standards, the administrator of the financial institution would be prejudicing his or her company, since it could be condemned to compensate any financial losses to the environment; and more than this, the administrator is putting him or herself in the condition of equality with the polluter who is practicing the crime of pollution and could expose other lives to danger. Their crime could therefore be seen as damage to the environment that is the heritage of all, the common good of the people (Art. 225, *caput*, of the Federal Constitution).

In the case of fiscal incentives, there is another facet to be examined, since such incentives are part of the tax that is being reduced, and society is giving up, to support a given activity in a given site. Thus, the tax itself is being used to cause damage to the environment.

It should also be noted that responsibility can be placed on international lending institutions through the principals of International Public Law, which is strengthened by domestic legal provisions. But it is clear that the damage caused by international lending agencies cannot be beyond the reach of the country's jurisdiction, nor can the acts of their employees.

7.12.6 - RURAL CREDIT: RESTRICTIONS ON ENVIRONMENTAL LAWBREAKERS

In terms of the rural sector, the necessary symbiosis between the productive and financial sector becomes more complex and delicate, because of the risks of the activity, easily influenced by external factors, as well as by absolutely unpredictable weather events, and by price fluctuations on the domestic and international markets.

The unpredictability of harvest, the long production cycle and the occurrence of prices that do not provide a return on investments are factors that in modern nations maintain a system of subsidies specifically for primary activities, despite a political and ideological trend towards the elimination of subsidies to activities in the industrial and service sectors. Thus, even with the evolution of the objectives included in the old GATT[128] agreement, primary activity, especially agriculture, continues to be heavily subsidized by governments: the U.S. farm credit system and the Common Agricultural Policy of the European Community are some examples of such practices.

Brazilian legislation calls for, as the principal form of compensating the structural problems of the activity, a specific credit policy for the sector, with lines of credit tied to resources coming from institutional allocations[129], or from resources from the treasury.

[128] It should be noted that the General Agreement on Tariffs and Trade (GATT) does not prohibit subsidies to primary activities, which is thus fully acceptable under International Law. However, the Agriculture Agreement, created under the auspices of the WTO, established bilateral targets and timetables for reduction in subsidies to the primary sector.

[129] Such resources are classified as: mandatory funds, as a percentage of the mandatory bank deposit, paid by the Central Bank for use in Rural Credit; tied funds, which come from rural operations, including fines, interest and payments from Rural Credit operations; funds from rural savings accounts, an institute created by the legislature for raising resources for supporting rural programs; resources from funds, programs and specific lines, and free resources from financial institutions. All the allocations, however, are established in legislation or set by the National Monetary Council.

Art 2 of Law nº 4829, de 1967 defines Rural Credit as "(...) provision of financial resources by public agencies and establishment of private lines of credit for rural producers or their cooperatives, for the exclusive application in activities that fit und the objectives of the legislation in force."

A very important factor, especially in an activity of very high environmental impact[130] such as agriculture and ranching, is creating compatibility between the rural activity of the proponent/beneficiary and the environmental demands coming from the law and from the competent authorities. Cannot permit environmental lawbreakers to benefit from loans from the National Rural Credit System.

Thus Article 14 of Law nº 6938 from 1981, which addresses National Environmental Policy, its objectives and mechanisms of formulation and application, provides that *"Without prejudice to the penalties established by federal, state and municipal legislation, non-compliance with the measures necessary to the preservation or correction of inconveniences and damages caused by the degradation of environmental quality will subject the transgressors to (...) II – to the loss or restriction of the fiscal incentives and benefits conceded by the State; III – to the loss or suspension of participation in lines of financing in official credit establishments; IV – to suspension of their activity."*.

The application of Art. 14, Para. III of Law 6938, de 1981, with the effective suspension of environmental lawbreakers from all lines of credit or benefit[131] belonging to the Natural Rural Credit System, could become one – if not the greatest – coercion factor for ensuring the enforcing of environmental regulations, since as mentioned above, the rural sector is heavily dependent on subsidized credit.

[130] Non-Governmental Organizations have concluded that agricultural/ranching activities, which uses almost exclusively clearcutting and insists on using burning practices, is potentially more damaging than logging activities, since this activity is concentrated on the extraction of specific plant types of a minimum size, which tends to spare smaller specimens.

[131] Such benefits may include those set out in Law 9138/95 and in CMN resolutions 2238 and 2279, as well as all forms of annexes, extensions, discounts, refinancing, etc.