BRAZILIAN EFFORTS TOWARDS REDUCING GREENHOUSE GAS EMISSIONS IN THE TRANSPORT SECTOR AND IN THE ENERGY INTENSIVE INDUSTRY

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Abstract: *Although Brazil, as a developing country, does not have commitments to reduce or limit its anthropogenic emissions of greenhouse gases, there are many programmes in the country that result in a considerable reduction of greenhouse gas emissions and contribute to the ultimate objective of the UNFCCC. This work aims at focusing on some successful initiatives undertaken in Brazil to reduce greenhouse gases emissions: the Motor Vehicle Air Pollution Control Programme – a governmental programme with the full participation of the vehicle industry – and the voluntary efforts made by the cement and aluminium industry.*

Brazil gives full importance to the problem of global warming, considering that it is a crucial issue for the future generations of all nations. Although Brazil is a developing country with many other socioeconomic priorities, it has played an important role in the international discussions about climate change and in the institutionalisation of such a problem.

The reduction of greenhouse gases emissions will require increasing attention by all countries. Such a process must be addressed taking into account a fair share of the burden associated with the required changes in the energy sector and others. The principle of common but differentiated responsibility, enshrined in the Climate Change Convention, entails an exercise of burden sharing among the countries.

In accordance with the principle of common but differentiated responsibilities, only the countries included in Annex I of the United Nations Framework Convention on Climate Change must take measures in order to reduce their emissions. Under the Convention, countries that are not listed in such a group do not have qualified commitments to reduce or limit anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol. It is recognised that the global emissions from developing countries will grow considering their needs to achieve social and economic development. Thus, it is important to underline that Brazil, as a developing country, does not have commitments to reduce or limit its anthropogenic emissions of greenhouse gases.

Moreover, in accordance with Article 4.2 (a) e (b) of the Convention, Parties included in Annex I have the additional commitment of adopting national policies and take corresponding measures on the mitigation of climate change, with the aim of returning in 2000 to their 1990 levels of anthropogenic emissions of greenhouse gases emissions. Thus, there is no obligation for the adoption of policies and measures in the short or long term to abide by the Convention which, specifically, aim at reducing or limiting greenhouse gases emissions in Brazil.

In spite of this and despite the fact that it is a developing country, there are many programmes in Brazil that result in a considerable reduction of greenhouse gas emissions and contribute to the ultimate objective of the UNFCCC.

Some of these initiatives are responsible for the fact that Brazil has a relatively “clean” energy matrix. The small share of greenhouse gas emissions from the Brazilian energy sector are a result of the high share of hydro energy supply (93% in 1999, being the world’s largest producer of hydroelectric energy) among the primary energy sources used in the generation of electricity.

Another important programme is related to the use of alcohol from sugar cane replacing gasoline in the road transportation. As a result, the net reduction in CO_2 emission rates is in the order of 2.46 t CO_2 equiv. per m^3 of ethanol consumed, which in 1995 results in a reduction of emissions in Brazil of 34 million tonnes of CO_2/year. The total net balance between 1975 and 1995 is in the order of 250-330 million tonnes of CO_2.

Some of these initiatives have been undertaken because of the increasing dependency on foreign exchange resulting from the oil price shocks or in order to postpone investments in new electrical generation facilities or oil refineries.

Thus, in Brazil we verify low levels of greenhouse gas emissions per unit of energy produced or consumed. Several other initiatives that are being implemented also contribute to lowering the curve of greenhouse gas emissions in the country.

Brazil's efforts related to GHG emission reductions include further research and development in the area of ethanol fuel from sugarcane; the development of hydro, wind, solar and thermal power plants; the use of charcoal from planted forests in the iron and steel industry; energy conservation and suppression of forest fires. Some of these efforts (ethanol fuel and energy conservation) were presented in the First UNFCCC Workshop of Policies and Measures, held in Copenhagen, in 2000.

This work aims at focusing on other successful initiatives undertaken in Brazil: the Motor Vehicle Air Pollution Control Programme – a governmental programme with the full participation of the vehicle industry – and the voluntary efforts to reduce greenhouse gases emissions by the cement and aluminium industry.

MOTOR VEHICLE AIR POLLUTION CONTROL PROGRAMME (PROCONVE)

In Brazil, highway transportation accounts for 96.1% of passenger transportation. Growing urban pollution, deficiencies in public policies regarding mass transportation 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[1], resulting in increased pollutant emissions from motor vehicles.

On May 6, 1986, resolution no. 18 of the National Environmental Council (Conama) created the Motor Vehicle Air Pollution Control Programme (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. This resolution established the basic guidelines of the Programme and determined the first emission limits. On October 28, 1993, Law no. 8,723 endorsed the requirement of taking the necessary steps to reduce vehicle pollution emission levels.

PROCONVE's 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 prototype and statistical monitoring of production vehicles; authorisation from the Brazilian Institute for the Environment and Renewable Natural Resources - 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 standards or design; prohibition of sale of vehicle models that have not been approved; and establishment of Inspection and Maintenance Programmes (I/M).

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 emission throughout their useful life. It is important to note that emission limits and other Proconve requirements apply both to national and imported vehicles/engines.

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

After PROCONVE was initiated, the need to use catalytic converters in vehicle tailpipes and electronic fuel injection instead of carburetors was identified in order to comply with the established emission levels. As the tetraethyl lead added to gasoline damaged catalysts in a short period of time, it became clear that this additive was incompatible

[1] Takes into account the number of vehicles going out of service. Cf. USP report on "Greenhouse Gas Emissions Brazil 1990-1994", prepared for the Ministry of Science and Technology.

with the new technologies used to reduce emissions. Thus, the efforts of Petrobras resulted in the removal of tetraethyl lead from gasoline in 1989. Brazil was the first country in the world to completely eliminate that toxic substance from its fuel matrix. Anhydrous ethanol was used to replace tetraethyl lead, with significant advantages, especially environmental ones.

With regard to light passenger cars, emission control was divided into three phases, according to the provisions of Resolution no. 18/86. The first two phases have already been accomplished. Phase I, from 1988 to 1991, focused on the improvement of model designs that were already being produced when the programme was established, as well as initiating the control of evaporative emissions. Phase II, based on the limits established in 1992, focused on emission reduction, with the application of new technologies such as electronic injection, electronically-controlled carburetors and catalytic converters. Phase III, in process, is characterised 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 1) equivalent to those currently in force in the United States; on whose experience the programme was based.

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 centres.

Just as was done for Otto Cycle vehicles, in 1998, 80% of urban buses, and in 2000, 80% of other vehicles should have complied with the limits established for Phase IV. In 2002, all vehicles should be in compliance with such limits.

While the basis for controlling light vehicles emissions in Brazil was the North-American legislation, for heavy vehicles, the model used was European. The Brazilian Phase IV corresponds to Euro phase II, which began in Europe in 1996.

It is important to note that not only vehicles produced in Brazil should comply with the emission limits. Law no. 8,723/93 requires that all imported vehicles meet the same requirements of national vehicles.

The success of the programme can be verified from the analysis of emission reductions, representing a dramatic reduction in average emission factors for light passenger vehicles from 1980 to 1997.

Average Emission Factors of New Light Vehicles

YEAR/ MODEL	FUEL	POLLUTANT				
		CO (g/km)	HC (g/km)	NO_x (g/km)	CHO (g/km)	Evaporative Fuel Emissions (g/test)
Before 80	Gasoline	54	4.7	1.2	0.05	NA
97	Gasohol	1.2	0.2	0.3	0.007	1.0
	Alcohol	0.9	0.3	0.3	0.012	1.1

Moreover, improvements have been verified in the sulfur content in diesel oil. Conama resolution no. 226, of August 20, 1997, contains the technical specifications for commercial diesel oil and establishes a timetable for decreasing the sulfur content in diesel oil.

In light of the aspects presented above, the number of vehicles in use in different regions of the country, and environmental needs, different limits were established for the diesel oil sold in the metropolitan areas of big cities (as established in the above-mentioned resolution) and in the rest of the country.

As from January 1998, the maximum sulfur content in national diesel oil is 0.5% and since January 2000 the diesel oil commercialised in the metropolitan areas of big 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%, according to a programme to improve diesel oil.

Given that its timetable is being strictly followed, with almost no costs to the government, and is achieving its targets satisfactorily, the programme is considered, even abroad, one of the best programmes for controlling emissions from mobile sources. Moreover, it is certainly one of the most successful environmental programmes ever implemented in the country.

BRAZILIAN EFFORTS TOWARS REDUCING GREENHOUSE GASES IN THE ENERGY INTENSIVE INDUSTRY

In a context of growing competitiveness, global markets today are increasingly selective not only in terms of economic performance of companies – assessed by prices, costs, added value, etc. – but also in terms of the companies' ecoefficiency and social responsibility.

Many industries in Brazil have been operating according to this integrated view of social, economic and environmental objectives, fully aligned with the concept of sustainable development, able to meet the needs of the present without jeopardising the capacity for future generations.

The effort to eliminate environmental impacts arising from operations has received strong recognition from society at large. The industry has acted with efficient control and good management practices since the first stages of the process – from the recovery of mined areas to the production of primary aluminium and manufactured products.

Examples of "good practices" in two sectors of intensive energy industry are presented below, showing that the Brazilian private sector has improved process control and upgraded technologies, resulting in a reduction of greenhouse gases.

Cement

In the past three decades, cement production has grown steadily in Brazil. This can be observed in the position rank of the country: Brazil was the thirteenth largest cement producer in the world in 1995; the eighth largest producer in 1996, the seventh in 1997 and the sixth in 1998 (SNIC, 1999).

Cement manufacture is very energy intensive and results in significant energy-related and process emissions of greenhouse gases, mainly CO_2.

The main manufacturing processes for the production of Portland Cement are called dry process and wet process. There are, moreover, intermediate processes as semidry or semiwet. The first two are the main processes in use in Brazil. These processes vary basically in accordance with how raw materials are used. The clinker produced in both process is essentially the same, with the same quality of the final product. Nevertheless, the dry process is much less energy-intensive than the wet process.

In 1995, in Brazil, around 95% of the cement were produced through the dry process. The main benefit of this technology is the reduction in the average specific consumption of thermal energy, which is 850 kcal/kg of clinker; in the wet process this figure is 1380 kcal/kg of clinker (TOLMASQUIN, 2000).

Thus, we verify in Brazil a 38% reduction in the specific energy consumption for cement production in the period 1970-2000 and, in the same period, 40% reduction in specific carbon emissions from energy use for cement production.

Several factors have contributed to these decreases in specific energy and carbon intensities of cement production over time in Brazil. Some of them are worth mentioning: 1) changes in the production process related to raw materials (shift from wet into dry process), with impacts in both energy use and carbon emissions; 2) the increase in the energy efficiency of cement production in general by optimising heat uses, also with impacts in both energy use and carbon emissions; 3) changes in the input fuel - the substitution of higher-carbon-content petroleum coke for lower-carbon-content fuel oil, coal and charcoal as an input fuel - resulting in impacts mostly on the carbon intensity from energy use. This third factor explains the increase in specific carbon emissions from energy use for cement production in Brazil in the last couple years (SHAEFFER, 2000).

Aluminium

Brazil is still ranked sixth in the world primary aluminium production, with a volume of 1,271,400 tonnes in 2000, following the United States of America, Russia, China, Canada and Australia.

The Brazilian Aluminium Association (ABAL) is the coordinator in Brazil of the inventory of greenhouse gases emissions in the aluminium production sector. ABAL is fully committed with the reduction of greenhouse gases and made a voluntary agreement to reduce PFC (Carbon tetrafluorides – CF_4 and Carbon hexafluorides – C_2F_6) and CO_2 emissions from aluminium smelters. This effort is supported by the Brazilian Ministry of Science and Technology.

For the third year in a row, the Aluminium Brazilian Association (Associação Brasileira de Alumínio – ABAL) Statistical Yearbook presents significant figures related to the aluminium industry environmental performance, which confirm the efforts focused on process control and prevention.

Many companies that have implemented their Environment Management Systems are able to receive ISO 14001 certification. This certification has been given to activities of mining, alumina refinery, primary aluminium, rolled products, castings, packing, electrical cable and aluminium powder.

One of the major commitments of the Brazilian aluminium industry is to reduce emissions that cause the greenhouse effect. The control of PFCs in the primary aluminium production places Brazil in a very good position compared to the main producers worldwide. ABAL's Committee on Environment and Sustainable Development reports these results to the IAI – International Aluminium Association and to the Brazilian Ministry of Science and Technology.

It is important to remark that the Tabereaux equation, used to compute emission factors, considers the number and duration of the anode effect by production cell and the electrical current efficiency.

The PFC emissions rate is estimated to have decreased from 1.9 to 1.3 tonnes of CO_2 equivalent per tonne of aluminium from 1994 to 1996 (EPA, 1999), a reduction of 24%. In recent years, the verified reduction was 12%.

Moreover, it is worth mentioning that the aluminium recycling rate has been growing in the last 10 years. In 2000, ABAL statistics indicated that the country achieved a new record, since it recycles 78% of all consumed aluminium cans. Thus, the country stays among the world leaders in recycling, bettering the index in the United States as well as the indexes of traditional recycling countries in Europe. This corresponds to around 7 billion cans recovered by the industry and a volume of 102,800 tonnes, representing 19% growth over the 86,000 tonnes collected in 1999.

The high recycling rate achieved by the Brazilian industry is a good example of sustainable development, with many socioeconomic and environmental benefits, and, additionally, reducing the emissions of greenhouse gases in the aluminium sector.

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