



Rational use of energy for urban transportation in Brazil

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Abstract

Urban transportation in developing countries is usually associated to the use of a large amount of energy, which mainly depends on refined products of petroleum. The abusive burning of exhaustible fuels, like fossils ones, most applied to internal-combustion engines consumes a great amount of the national economic resource becoming the principal source of air and noise pollution.

The purpose of this paper is to show how Brazil is dealing with the problem of its large dependence on refined products of petroleum in urban transit and the necessity of a national engagement in the rational uses of this energy. Technological researches and government policies and legislation to rule the use of traditional petroleum derivatives energy sources and alternative ones for roadway vehicles are the main focus of this article. Distinction is given to the large experience in the use of alcohol (ethanol) to move passenger cars and to the problems that arise when defining and implementing a government plan to use Natural Gas as alternative fuel for buses and trucks.

1 Introduction

Transportation services belong to the economic segment which contributes to society development. This contribution heavily depends on energy consumption of unrenewable resources.

Unfortunately, development models used by contemporary societies, specially in countries in development, propose the use of natural resources, primary sources of energy, just to provide fuel and maintain transportation



modes, without any concern about either the limits of the used resources or in sustainable development(Sinay[7]).

The unrestricted use of those resources started being seriously thought about and questioned during the last two decades, when the society decided to undertake the difficult, though necessary task of controlling politics of development, specially those which would seek “ progress at any cost” without taking into account environmental depletion, which in turn would decrease life quality.

With the understanding of the sustainable development ideas, different segments from the private and public enterprises, specially those dedicated to the study of the roadway transportation problems which would arise in large urban centres started applying different work philosophies and tring to develop researches to identify alternative energetic resources less aggressive to the environment.

Brazil, a developing country strongly dependent on roadway transportation of passengers as well as of goods, engaged since early 1970 in the study of alternative energetic resources and in the improvement in rational use of fossil originated fuels.

2 Roadway transportation in Brazil

According to the National Energetic Balance - 1997, close to 13% of all the energy consumed in the country during the year of 1996 was destined to transportation. Of this total, 90% was used in roadway transportation, representing 43,6 million of tEP (equivalent tons of petroleum). 83% of the total energy used for roadway transportation came from petroleum refined products.

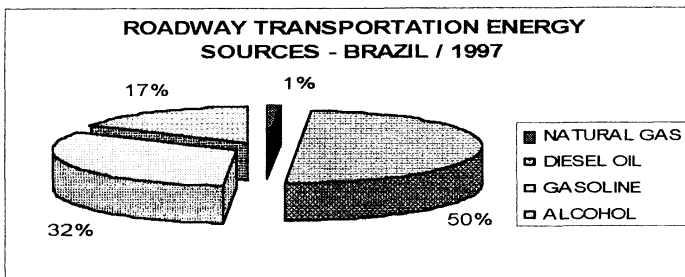


Figure-1: Division of Roadway Transportation Energy Sources

Urban transportation segment is urgently needed of measures which would guaranteed the rational use of traditional fuels or the use of alternative sources of energy which would help in keeping the atmosphere out of depletion.

Brazilian urban centres made the option for the use of passenger cars: no more than 40% of the trips monthly generated are accomplished by collective transports. This fact is not new: since the decade of the 50th political government



has heavily patronised the roadway transportation of passengers as well as of goods.

Unfortunately the concern with the environment and the life qualities is not so old. From 1956 to 1971 – period during which the automobile industry consolidates its performance in the national market, there was little concern with technological development of vehicles; from 1972 to 1980 - petroleum crisis of 1973 forces the government first to regulate the use of the diesel oil, and second to establish in 1975 the National Program of Alcohol - PROÁLCOOL, with the purpose of promoting the development of a Brazilian technology for adoption of the alcohol(ethanol) as fuel. Society becomes more demanding seeking for more economic vehicles; from 1981 to 1989 - the lost decade of the eighties forces the national industry to accompany the world tendency of looking for the improvement of traditional motors and studding alternative sources of energy as means to prevent environmental deterioration. By 1996, ethanol was being largely used in Brazil; PLANGÁS, whose purpose was to determine the viability of the use of natural gas for urban transport, was established and the CONAMA, National Council of the Environment, started controlling vehicular emissions; from 1990 to nowadays - an irreversible process of technological improvements begins with the opening of the national market for imported vehicles. In 1992, Rio de Janeiro - Brazil, housed the Eco-92, event that gathered representatives of more than 150 countries, with the purpose of stabilising measures that would treat the environmental pollution. In January of 1997, the Ministry of the Mines and Energy and the National Confederation of the Transports - NCT created the Program ECONOMIZAR, which purpose was the reduction of diesel oil used in roadway transportation.

3 Traditional sources of energy

There are two basic ways to improve the use of traditional energy: to control the specific fuel consumption in use and to control the emissions of the fuel combustion. To control emissions is an important task in the search of larger efficiency in the use of energy, since the fuel lost as vapor form or by an incomplete combustion represents waste of energy.

3.1 The fuel's consumption control

The first important providence in the direction of controlling fuel's consumption came in the 70's, when the Brazilian government established the Ordinance 79.134 (17/07/77)(Lazzari & Winter[2]), that disposes on the motor adjustments to the use of diesel oil, and the Resolution 510/77(Lazzari & Winter[2]) that disposes on the circulation and on the control of trucks and buses moved with diesel. In both cases it was tried to restraint the excessive diesel's consumption. To evaluate emissions it was checked the smoke expelled by the pipe of exhaust of the motors using Ringelmann's Scale, as disposed in NB 225 Rule of ABNT –



Associação Brasileira de Normas Técnicas(Lazzari & Winter[2]).

Recently, in January of 1997, the project ECONOMIZAR was created. Resulting of the partnership between the Ministry of the Mines and Energy, through Petrobrás/CONPET with the National Confederation of the Transports – NCT through the Institute of Development, Technical Attendance and Quality in Transports – IDAQ. It is a project of national ambit that comes to offer free technical support to roadway transportation companies, with the purpose of reducing, in a period of 2 to 5 years, next to 13% in the diesel's specific consumption, which represents 50.000 barrels/days. For that, there were created mobile units that up to present day have already visited more than 860 companies in 17 states, inspecting about 18.000 vehicles and evaluating the methodologies of administration of the use of the fuels, vehicles conditions and motors consumption, the practice of maintenance of the vehicles, labour qualification, quality of the consumed diesel, cares with the greeting, storage and facilities, identification of adopted practices and experiences that contribute to increase the efficiency of the use of diesel oil.

3.2 The control of vehicular emissions

Until the 80's, nothing was done in the sense of regulating the levels of emission of roadway transportation in Brazil. In 1976, the Resolution 507/76 (CONTRAN – Conselho Nacional de Trânsito)(Lazzari & Winter[2]) established requirements in the control of gasoline vehicular motors emissions, but only in 1986, with the Resolution 18/86 (CONAMA – Conselho Nacional do Meio Ambiente), the Pollution Control Program – PROCONVE(GEIPOT[6]), was instituted for automotive vehicles.

PROCONVE has as prime objective the reduction of polluter emission levels of automotive vehicles, besides motivating the national technological development in the field of automotive engineering and in the development of methods and equipment for pollution measuring.

The maximum limits of polluter emissions were fixed, with a specific schedule for three different classes of vehicles: light vehicles (automobiles); commercial vehicles (pick-ups, vans, utilitarian, etc) and heavy vehicles (buses and trucks)(GEIPOT[6])

To attain those limits there were necessary technologies and systems that would improve the motors operation, providing fuels' perfect combustion. Table-1(GEIPOT[6]) exhibits the program. To attend the 1992 phase it was required the catalyts. For the current phase, initiated in 1997, needed, among them: electronic injection and “embarked” electronic equipment.

Table-1: Vehicular Emission Limits – PROCONVE/CONAMA 1998

POLLUTER	1988 to 1992(1)	Class 1	01/01/1998 Class 2	01/01/1998 Class 3	01/01/1998 Class 4
CO(g/km)	24	2	2	6,2	4,9
HC(g/km)	2,1	0,3	0,3	0,5	1,23
NOx(g/km)	2	0,6	0,6	1,4	9
PM(g/km)	NE	0,05	0,05	0,16	0,7
CHO(g/km)	NE	0,03	0,03	0,06	Do not apply
Vapores (g/ensaio)	NE	6	NE	NE	NE
LEGEND: CO: Carbonic Oxide, HC: Nox: Nitrogenic Oxides, PM: Particulated CHO: Aldehydes, NE: Not specified					
Notes: (1) Only for Class 1 Vehicle CLASSE 1: Light Vehicles CLASSE 2: Commercial Vehicles (TGW < 1700kg) CLASSE 3: Commercial Vehicles (TGW > 1700kg) CLASSE 4: Heavy Vehicles (TGW > 3000kg)					

All vehicle models, national or imported, need the " License for Use of the Configuration of the Vehicle or Motor - LCVM ", emitted by IBAMA., to be able to transit

In 1997, CONAMA defined the general guidelines for the Program of Inspection and Maintenance–I/M, regarding vehicles' noise and air polluter emission. In addition, the National Council of Traffic - CONTRAN has regulated and approved, from 1998 on, the inspection as being a conditioning for the vehicles annual licensing. This Inspection is under the responsibility of Environmental Municipal Organ.

Pertaining this objective, the government of Rio de Janeiro established the Decree 22.599 - 01/11/1996, regulating the State Law 2.539, which made obligatory the calibrating of the polluter gases emission of roadway vehicles fleet in the Metropolitan Area. Other large cities, like São Paulo adopted similar measures. Great São Paulo has to establishing a rigid control of circulation according to last digit in the license number. This measure assured an improvement of 12,5% in the average speed of the urban traffic flow, with the corresponding reduction in fuels use.

4 Alternative energy sources

The two main alternatives to traditional fuels were the use of alcohol and of natural gas.



4.1 The National Program of Alcohol–PROÁLCOOL

The PROALCOOL is the most important world wide known renewable alternative fuel program. It begun in 1975 as a way of reducing the national economic dependence on petroleum. In 1978, during the second petroleum crisis, this program had not yet reached its purpose, due to the government excess of bureaucracy. The first alcohol propelled automobile was introduced in the market in 1979 and the program succeeded over the scepticism that surrounded it since its beginning[1]. The fleet began to grow in 1983 and the program reached its apex in 1986, when 53% of the total produced fleet of passengers car were alcohol moved vehicles. Unfortunately, the economy globalisation that brought world technology benefits, contributed to the decline of the use of alcohol once imported equipment were not adapted to its use. The inexpressive figure of the program in recent days is a result of the lack of government incentive to PROÁLCOOL, to the reduction of international prices of the petroleum barrel in the 90's and to the crisis of the alcohol provisioning due to the lack of producers' compromising and professionalism. In recent pronouncement in the United Nations Special Assembly for the Environment (june/1997), the President Fernando Henrique Cardoso declared the Brazilian intention of giving new push to PROÁLCOOL as part of the Renewable Energy Program that foresees the growing use of non polluting fuels, as biogas, alcohol, wood and vegetable oils.

It is very important to make clear that although alcohol comes from the fermentation of the sugar cane broth, and therefore of a renewable energy source, its production in Brazil depends on the use of equipment moved by diesel oil such as trucks and agricultural machines. It also generates as residues: the crushed sugar cane, witch is burned in the boilers of the factory as part of the fuel for the process of distillation of the cane broth, and a strong polluter: the "vinhoto".

In conventional processes, the production of a litre of alcohol generates twelve litres of "vinhoto", that are usually thrown in river beds and ponds, causing tremendous damages to the environment. It is calculated that the volume of wasted energy is ten times higher than the one obtained from the use of produced alcohol[1]. The solution is in optimisation of the production process through the improvement of the rate of alcohol/"vinhoto" and the use of this "vinhoto" as raw material for digestion and production of biogas. In the case of the generation of biogas, the methane could be used for refuelling the boiler of alcohol producing process and the vehicles used for manipulation of sugar cane

4.2 The National Plan of Natural Gas–PLANGÁS

In the middle of the eightieth decade the PLANGAS project was established as a government initiative through the National Commission of Energy. In areas



where the natural gas was available, the program recommended the substitution of the diesel consumed by urban transit, inter-city buses, captive fleets and cargo vehicles by this gas(PLANGÁS[5]).

The program experienced great resistance from the bus fleet owners, which pointed out: the reduction of the vehicles autonomy, the low price of natural gas vehicles out of the restricted areas provisioned by pipelines and, the lack of the natural gas price attractiveness, kept around 79,84% of the diesel oil price(Bruni[4]).

In 1991, Brazilian government liberated the use of this fuel for the cabs, as form of regulating the market of natural gas. But has not established a credit line for financing the purchase of new vehicles. Another difficulty for the acceptance of natural gas is due to the fuel short offer, forcing the user to wait in long lines for provision. Although the governmental decree liberating the product use for private vehicles in 1996, only 2% of all the natural gas is being used in automotive propulsion(Bruni[4]).

5 Conclusion

The urban transportation in Brazil will continue to be dependent upon traditional fuel, petroleum refined and not recycled products for a long time. However urban centres with severe atmosphere pollution problems shall opt for strict emission inspection programs and for the use of clearer fuels. The choice depends upon the local financial resources.

Only society consciousness towards the environmental preservation will promote the acceptance and the use of alternative fuels forcing a progressive production, prices reduction and an increasing tendency to establish and support energetic resources control programs promoted by public/private partnership, as it is the case of the ECONOMIZAR Project.

In Brazil, the use of natural gas substituting the diesel oil for passengers and cargoes urban transportation is a recommended and viable solution, once it reduces the atmosphere pollution specially in large urban centers. The natural gas would be a reliable substitute of gasoline in automobile freightage also. In both cases, there will be great difficulty in the program implementation, due to the economical and political aspects already described, and to the fact that the product resources are distant from urban centers, increasing considerably the cost supply. Another alternative source to be considered, is the generation of methane gas by the biodigestion of industrial and urban wastes, all of them abundant in large urban centers.

The alcohol is also an alternative fuel that has been used with success in the past.

Certainly society will become more conscious of the necessity to study new natural resources having in mind the sustainable development philosophy by which techniques which provide social and economical development without depleting the environment should be prioritized.



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