CARBON EMISSIONS FROM THE BRAZILIAN ENERGY SYSTEM[1]

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The signing of the United Nations Framework Convention on Climate Change - UNFCC by 150 countries in Rio de Janeiro, in 1992, demonstrated the nations' concern with climate change, as it represents a significant threat to the environment and to world economic development. The ultimate objective of the Convention is the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the global climate system, within a time-frame sufficient to allow ecosystems to adapt naturally to climate change.

This work is part of the Brazilian effort to adjusting the methodology already established by IPCC (IPCC, 1995) for the estimation of carbon dioxide (CO_2) emissions by energy sources, to the specific conditions of the Brazilian energy system, employing it in the calculation of Brazilian emissions from 1990 to 1994.

1 - CO_2 Emissions from Fossil Fuel Use in the Brazilian Energy System

To estimate emissions from fossil sources the top-down methodology developed by IPCC (IPCC, 1995) was used, with adjustments made to meet the peculiarities of the Brazilian energy system.

The use of the top-down methodology enables the calculation of CO_2 emissions using data only on the amount of energy supplied to the country. It involves a balance concerning the domestic production of primary fuels, net imports of primary and secondary fuels, and the internal change in stocks of such fuels. The methodology assumes that once brought into the national economy in a certain year, the carbon contained in fuel is either released to the atmosphere or is saved in some way (e.g., in increases of fuel stocks, stored in non-energy products, left partially unoxidised).

Therefore, the greatest advantage of the top-down methodology is that it does not require detailed information on how the fuel is utilized by the end user or what intermediate transformations it undergoes before it is consumed. A detailed description of IPCC's top-down methodology, as well as the adjustments that were introduced in consideration of the particular characteristics of the Brazilian energy system are presented in the full report. (Rosa et all, 1998)

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It should be noted that only CO_2 emissions from fuel consumption in the energy system are considered here. The estimation of fugitive emissions of other greenhouse gases released during production, storage, distribution, and use of energy is not included in the scope of this work.The total emissions are showed in the Table1 and the time evolution of the emissions are summarized in Figures 1 and 2, in Mt C[3] and in percentage, respectively.

The data presented indicate the predominance ($\approx$77 to 78%, depending on the year) of liquid fuel emissions, which are practically restricted to emissions from oil derivatives. Solid fuel emissions are ranked second ($\approx$19 to 20%, depending on the year), their main source is the coking coal imported to be converted to coke, the utilization of which grew over the period. Gaseous fuel emissions, mainly from natural gas, did not contribute much to total emissions ($\approx$3%), in spite of the growing use over the period.

As the results demonstrate, total CO_2 emissions from fossil fuel burning grew from around 55.3 Mt C[4, 5] in 1990 to 64.1 Mt C in 1994, which represents an increase of approximately 17%, that is, an annual average of 4% a year.

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[3] Mt C = carbon megaton = 1 million tons of carbon

[4] The emissions presented here as expressed in mass of carbon emitted. Their conversion to mass of CO_2 is carried out by multiplying them by the ratio between the molecular weight of CO_2 and that of carbon (44/12).

[5] Mt C (megaton of carbon) = 1 million tons of carbon = 10^3 Gg C.

Table 1 - CO_2 Emissions from Fossil Sources in the Brazilian Energy System

SOURCE	Year									
	1990		1991		1992		1993		1994	
	Gg C[6]	%	Gg C	%	Gg C	%	Gg C	%	Gg C	%
Liquid Fossil	**43130**	**78.0**	**44262**	**76.4**	**45631**	**77.1**	**47493**	**77.0**	**49876**	**77.3**
Oil	50408	91.2	49495	85.4	50760	85.7	51340	83.3	52575	81.5
Natural Gas Liquids	653	1.2	719	1.2	712	1.2	712	1.2	751	1.2
Gasoline	-1420	-2.6	-953	-1.6	-1356	-2.3	-2523	-4.1	-1702	-2.6
Jet Kerosene	-455	-0.8	-414	-0.7	-315	-0.5	-289	-0.5	-211	-0.3
Lighting Kerosene	-10	0.0	3	0.0	-49	-0.1	-60	-0.1	-28	0.0
Diesel Oil	279	0.5	1268	2.2	1349	2.3	2583	4.2	1538	2.4
Fuel Oil	-1595	-2.9	-1823	-3.1	-1596	-2.7	-800	-1.3	113	0.2
LPG	1000	1.8	1122	1.9	1231	2.1	1049	1.7	1388	2.2
Naphtha	-3109	-5.6	-2847	-4.9	-2597	-4.4	-2471	-4.0	-2122	-3.3
Asphalt	-1130	-2.0	-880	-1.5	-1097	-1.9	-985	-1.6	-1186	-1.8
Lubricants	-226	-0.4	-195	-0.3	-306	-0.5	-242	-0.4	-235	-0.4
Petroleum coke	-21	0.0	-2	0.0	-8	0.0	15	0.0	-19	0.0
Other non-energy oil products	-1254	-2.3	-1243	-2.1	-1007	-1.9	-846	-1.4	-994	-1.5
Solid Fossil	**10216**	**18.5**	**11770**	**20.3**	**11479**	**19.4**	**11875**	**19.3**	**12212**	**18.9**
Coking coal	8272	15.0	8523	14.7	8552	14.4	9096	14.8	8989	13.9
Steam coal	2082	3.8	2590	4.5	2196	3.7	1944	3.2	2101	3.3
Tars	-106	-0.2	-94	-0.2	-39	-0.1	-44	-0.1	-60	-0.1
Coke	-33	-0.1	751	1.3	770	1.3	878	1.4	1182	1.8
Gaseous Fossil	**1741**	**3.2**	**1702**	**2.9**	**1892**	**3.2**	**2064**	**3.3**	**2135**	**3.3**
Dry natural gas	1889	3.4	1836	3.2	1992	3.4	2186	3.5	2266	3.5
Refinery gas	-148	-0.3	-134	-0.2	-100	-0.2	-122	-0.2	-131	-0.2
Other primary sources [a]	**174**	**0.3**	**190**	**0.3**	**202**	**0.3**	**220**	**0.4**	**306**	**0.5**
TOTAL - FOSSIL	**55262**	**100.0**	**57924**	**100.0**	**59204**	**100.0**	**61652**	**100.0**	**64529**	**100.0**

[a] They comprise primary sources with different physical states.

[6] 1 Gg C (gigagram of carbon) = 10^9 gram of carbon = 10^{-3} Mt C

Figure 1 - Carbon Emissions from Fossil Fuels (Mt C)

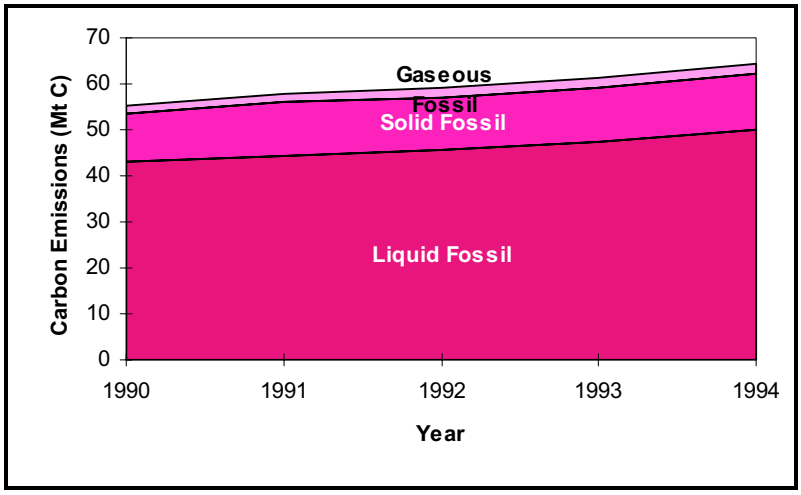

Figure 2 - Carbon Emissions from Fossil Fuels (%)