

Brazil

The Federative Republic of Brazil (República Federativa do Brasil) with its capital city Brasília (1.821.946 inhabitants, 1996) is Latin America's largest country (8.511.957 km²) and comprise about 174,8 million people. The population density is 20 inhabitants per km² and an estimated share of 80 percent (1998) is living in urban regions. The country borders with every other South American nation, except Chile and Ecuador. Brazil's area makes it the fifth largest nation in the world after the Russian Federation, China, Canada and the United States of America.

Brazil with 595,458 million U.S. dollars in 2000, has the highest Gross Domestic Product within Latin America. It has the largest population, the broadest landmass and the strongest industrial base. Brazil commands respect in its economic and political relations both in Latin America and as an influential player on the world market. President Cardoso, re-elected for a second term in October 1998, has gone a long way in entrenching democracy and political stability as well as reforming the state and opening and restructuring the economy. In the last years, a real progress in education, health and human rights was made. The privatisation effort of the government has been very successful and in increased productivity as well as the export.

The landscape of Brazil is mainly characterised by large areas of rainforest. Even though huge areas are deforested every year, 58 percent of the country's area is still covered by rainforest.¹ Brazil's Amazon rainforest comprises about 30 percent of the remaining tropical forests world-wide. An unique living space for at least one tenth of the world's plant and animal species, which is acting as a mechanism for absorbing carbon dioxide from the atmosphere.

Recently, government supported the creation of the Tumucumaque National Park, in the Brazilian state of Amapá, borders French Guyana and Suriname, and covers almost 39.000 square kilometres. It will ensure full protection of an important part of the Amazon Forest with species, particularly fish and aquatic birds, found nowhere else on Earth. The park is also home to a large number of primates and other mammals such as sloths, jaguars, freshwater turtles and the harpy eagle. The park's borders were strategically designed by World Wildlife Fund (WWF) of Brazil and the Brazilian environmental agency under the guidance of the Brazilian Ministry of the Environment. The creation of Tumucumaque will help to fulfil the public promise, recently made by Brazilian President Cardoso, to protect an area equivalent to 10 per cent of the Amazon's natural forests. WWF is providing US\$1 million to Tumucumaque to help the Brazilian government mark out the area, prepare the park's management plan and buy equipment such as surveillance posts, boats and radios.²

Brazil is strongly dependent on hydropower and has suffered several droughts that drained its reservoirs. The country had been slow to follow through with plans to build power plants fired with fossil fuels, leaving electric generation capacity unable to meet Brazil's electricity

¹ Due to estimations of the Smithsonian Tropical Research Institute (STRI) during the period of 1995 and 2000 an area comparable to 7 soccer-fields was cleared every minute.

² Staff will be hired to patrol the protected zone. The full cost of these measures will be paid by a partnership involving the Brazilian government, the World Bank, the Global Environment Facility (GEF) and WWF.

demand. A power rationing program, in effect from June 2001 through March 2002, successfully avoided rolling blackouts. The Brazilian electricity consumption of 359 million MWh in 2000 was covered with a enormous 90,6 percent share of hydropower. Furthermore, 5,3 percent were contributed by the combustion of fossil fuels while 1,1 percent came from two nuclear power stations. The remainder of 3 percent was contributed by the utilisation of bioenergy.³

Brazil contains the second largest oil reserves in South America (after Venezuela), at 8,46 milliard barrels. Although Brazil continues to strive for independence in oil production, it is unlikely that the country will reach this goal within the next few years. Production has been rising steadily since the early 1990s, reaching almost 1,3 million barrels per day (bbl/d) in 2000. Brazil's oil consumption of 2000 was estimated at 803 million barrels.⁴

Brazil's natural gas production and consumption rose steadily throughout the 1990s, with imports beginning in 1999. Natural gas reserves as of December 2000 stood at 221,4 milliard cubic metres. Consumption is expected to rise in the coming decade as the country works on decreasing its dependence on hydropower by enlarging the utilisation of natural gas-fired plants.

The recoverable coal reserves of Brazil are estimated at approximately 5,27 milliard tonnes. The total coal consumption of 2000 amounted 21,3 million tons. Mainly, coal is used predominantly for Brazil's domestic steel industry, with a small portion burned to generate electricity. A 1996 study by the International Energy Agency (IEA) concluded that Brazil will continue to be one of the world's major coal importers during the next 10 to 15 years, with imports possibly doubling by 2010. The country's steel industry is expected to remain the largest domestic coal consumer for the foreseeable future.

Brazil has two operational nuclear plants (Angra-1 and Angra-2) and one under construction (Angra-3). Angra-1 was bought from the U.S. company Westinghouse in 1969. The Angra-2 plant came online in 2000. The construction time was 23 years and an total amount of 10 milliard US dollars was spent. The nuclear program historically came under the Ministry of Defence and now, a government company, Eletronuclear, has been created to administer the plants. President Cardoso said in early July 2002 that a decision regarding Angra-3 is 'imminent'. Equipment for the plant has been put into storage, but the electricity crisis forced interest in bringing the plant into service. If construction on the plant were allowed to resume, it would take an estimated five years for it to become operational.

Brazil is the largest energy consumer in South America, and the third largest in the Western Hemisphere, behind the United States and Canada. While in total energy consumption statistics the country is on the first place in the region, the per capita energy consumption is comparable to the average for Latin America. Brazil also is the largest emitter of carbon dioxide in the region, releasing 950 million tons of carbon into the atmosphere in 2000.⁵ Although Brazil's carbon emissions are fairly significant in the region, carbon intensity, the amount of carbon emitted per dollar of GDP, is comparatively low.⁶

³ WEC 2002.

⁴ EIA SIEE 2000

⁵ SIEE 2000.

⁶ UN 2001-2002.

One reason for the comparatively lower carbon intensity in Brazil is the significant use of hydropower in the energy mix (more than 90 percent), as well as the use of biofuels and other forms of renewable energy. The most prominent biofuel in Brazil is ethanol in combination with the ethanol program 'Proalcool'⁷. This successful programme was initiated 1975 partially in response to the oil shock of 1973, and as an possibility to promote self-sufficiency. The ethanol program also has been one strategy to mitigate the environmental effects of rapid urbanization.

The IEA statement: 'Proalcool is the largest commercial biomass programme for energy production in the world' is definitely true. Currently one million people working in the sugar-alcohol sector, with 300.000 jobs in 350 private industrial companies and 50.000 cane farmers. São Paulo itself has 500.000 workers at more than 130 plants. The sugar cane production reached 320 million tons during the 2000/2001 harvesting season. Production rose to 18 million tons of sugar and 14 milliard litres of alcohol. The estimated sugar cane plantation area in Brazil is 3,9 million hectares.⁸ Creating more productive sugar cane plants is continuously advancing, with average yields increasing since 1990 from 129 to 143 kg of sugar per ton of green sugarcane owing to the growing of new selected plant varieties. Although no significant technological advances have been observed, the use of the 'best practices' in the factories has increased the average conversion efficiency to nearly 50 percent.⁹

The government is interested in establishing policies for clean fuels under the Kyoto Protocol. Biofuels can also be funded through the Clean Development Mechanism (CDM) and are therefore a new opportunity for the sugar and alcohol sector in the energy market. Nevertheless the individual use of biofuels is decreasing. Since 1995 the Brazilian fleet of alcohol-based vehicles has dropped to 4 million, less than 40 percent of the total fleet. New alcohol vehicles represent less than 1 percent, after reaching a peak of 80 percent during the 1980's.¹⁰ However, manufacturers are now being asked to increase the production substantially. The establishment of green fleets by local governments, and tests on an alcohol-diesel mix for municipal buses are the first steps to an increased use of biofuel in the transportation sector.

Regarding biomass availability and uses in Brazil it can be further states that besides sugarcane production, hydroelectricity and firewood play a major role as renewable resources in the national energy system.¹¹ In 1999 the use of biomass was characterised by 21.237 Mtoe (million tonnes of oil equivalent) firewood, 24.966 Mtoe sugar-cane residues and 3.385 Mtoe residues in general.¹² Following the report of Moreira/Goldemberg/Coelho, during the last decades a progressive transition on the absolute amount of biomass demand from many consumers in the residential sector using low efficiency stoves, to a significantly more reduced number in industrial sector, where the equipment is generally more efficient can be observed.¹³ The above drafted ethanol production from sugarcane and its usage in the

⁷ For further information *Dos Santos* 1997.

⁸ WEC 2002.

⁹ For further information *Sims* 2002: 238-240.

¹⁰ 'Brazil has water power and ethanol, but can they meet rising needs', in: *Climate Alert*, Vol. 10, No. 1 January-February 1997.

¹¹ Coelho/Bolognini/Paletta 2000.

¹² Moreira/Goldemberg/Coelho 2002: 1.

¹³ Moreira/Goldemberg/Coelho 2002: 1.

transportation sector could be seen as the largest commercial biomass program in the world.¹⁴ Comparing these figures with other examined countries, Brazil can be seen as a pioneer in the field of bioenergy.¹⁵ An assessment of the biomass availability and the potential for electricity generation shows, that Brazil has large potentials in sugarcane as well as agricultural residues, wood residues and vegetable oil. Table 4-1 shows different biomass types including their conversion yields.

Table Fehler! Kein Text mit angegebener Formatvorlage im Dokument.-1 - Different types of biomass with their conversion yields

Sugar cane bagasse	quantity of raw material available	82,3 million tons
	electricity generation capacity	1.000.000 kW
	electricity generation	14.798 TJ
	direct use from combustion	689.200 TJ
	total energy production	723.702 TJ
Wood residues	quantity of raw material available	2,2 million tons
	electricity generation	1.505 TJ
	direct use from combustion	19.443 TJ
	total energy production	23.027 TJ
Cane juice	quantity of raw material available	89,4 million tons
	ethanol production capacity	302.100 TJ/year
	yield of ethanol	2,25 GJ/ton
	ethanol production	201.506 TJ
	total energy production	224.570 TJ
Molasses	quantity of raw material available	9,3 million tons
	yield of ethanol	7,27 GJ/ton
	ethanol production	67.600 TJ
	total energy production	69.899 TJ
Black liquor	quantity of raw material available	9,7 million tons
	electricity generation capacity	520.000 kW
	electricity generation	10.572 TJ
	direct use from combustion	92.548 TJ
	total energy production	116.186 TJ

Source: World Energy Council, Survey of Energy Resources, 2002

¹⁴ 0,5 EJ from a total of 7 EJ of new and renewable energy production at global level, as stated in Moreira/Goldemberg/Coelho 2002: 2.

¹⁵ For further information De Andrade/De Andrade/Bodinaud 1998.