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Energy Dossier: Brazil

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Infrastructure and
Energy Department
Energy Division

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Prologue

Abstract

This Energy Dossier is part of a series of publications produced by the Energy Division of the Infrastructure and Environment Department of the Inter-American Development Bank. It is designed to increase the knowledge base about the composition and organization of the energy sector of Latin American and Caribbean countries. Each dossier describes the energy matrix of the country under analysis and then dives deeply into the institutional organization and regulatory framework of the energy sector in that country.

Keywords: Energy; electricity; energy matrix; institutional framework; energy policy; South America

JEL Codes: Q40; Q43; Q48

Index

Abbreviations

ANEEL	Agência Nacional de Energia Elétrica
ANP	Agência Nacional de Petróleo, Gás Natural e Biocombustíveis
CCEE	Câmara de Comercialização de Energia Elétrica
CNEN	Comissão Nacional de Energia Nuclear
CNG	Compressed natural gas
CNPE	Conselho Nacional de Politica Energética
CMSE	Comitê de Monitoramento do Setor Elétrico
E&P	Exploration and production
EIA	U.S. Energy Information Administration
EPE	Empresa de Pesquisa Energética
FINEP	Financiadora de Estudos e Projetos
GDP	Gross Domestic Product
GHG	Greenhouse gas
GWh	Gigawatt hour
IEA	International Energy Agency
IPP	Independent power producer
kboe/d	Thousands of barrels of oil equivalent per day
kWh	Kilowatt hour
LPG	Liquefied petroleum gas
LNG	Liquefied natural gas
Mboe/d	Million barrels of oil equivalent per day
MCTI	Ministério da Ciência, Tecnologia e Inovação
MDIC	Ministério do Desenvolvimento, Indústria e Comércio Exterior
MMA	Ministério do Meio Ambiente
MME	Ministério de Minas e Energia
MW	Megawatt
ONS	Operador Nacional do Sistema Elétrico
PES	Primary energy supply
PPSA	Pré-Sal Petróleo S.A. (Empresa Brasileira de Administração de Petróleo e Gás Natural S.A.)
PPP	Public-Private Partnership
Proinfa	Programa de Incentivo às Fontes Alternativas de Energia Elétrica
PSA	Production-Sharing Agreement
R&D	Research and development
SIN	Sistema Interligado Nacional
SINTREL	Sistema Nacional de Transmissão de Energia Elétrica
TEC	Total energy consumption
TWh	Terawatt hour

Brazil

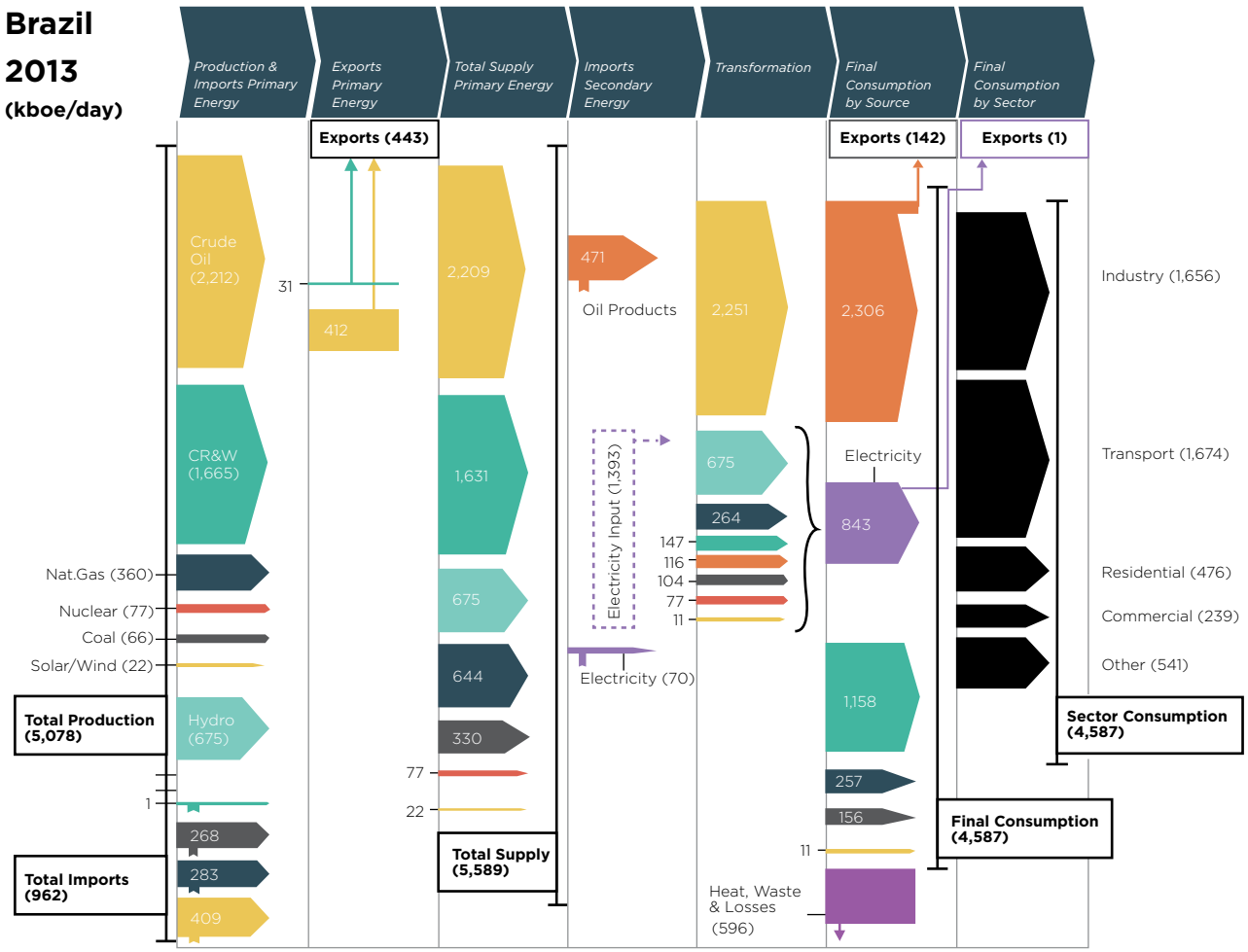
Brazil is an upper-middle-income country and the fifth-largest country in the world in area, covering 8.5 million square kilometers—larger than either the United States or Western Europe—and has a population of approximately 200 million people, most of them living in coastal areas. Brazil's economy is the seventh largest in the world, with a gross domestic product (GDP) of $2.2 trillion (2013), and it is reasonably diversified: the service sector represents 59 percent of the GDP, followed by industry (21 percent) and agriculture (15 percent). The country is generously endowed with natural resources and is a leading producer and exporter of agricultural produce, iron ore, bauxite, and limestone.

Brazil is the seventh-largest consumer of energy in the world and the third largest in the Americas, behind only the United States and Canada. Total energy consumption has increased by more than one-third in the last decade due to the country's economic growth and rising income levels. On the supply side, it is the tenth-largest energy producer in the world, with a significant part of this production coming from renewable energies (e.g., hydropower and biofuels). The country has an electricity installed capacity of 113 GW and proven reserves of 15.6 billion barrels of oil (15th worldwide) and 458 billion cubic meters of gas (31st worldwide). The recent discovery of large offshore pre-salt oil deposits may make Brazil one of the largest oil-producing countries in the world.

Brazil has a sophisticated and well-defined institutional framework in the energy sector, with policy-setting government authorities, regulatory agencies, state-owned enterprises, and private sector companies all operating in a dynamic market. Most of the existing energy laws and policies were put in place recently, following larger economic reforms introduced by the federal government in the 1990s and 2000s.

Current Energy Sector

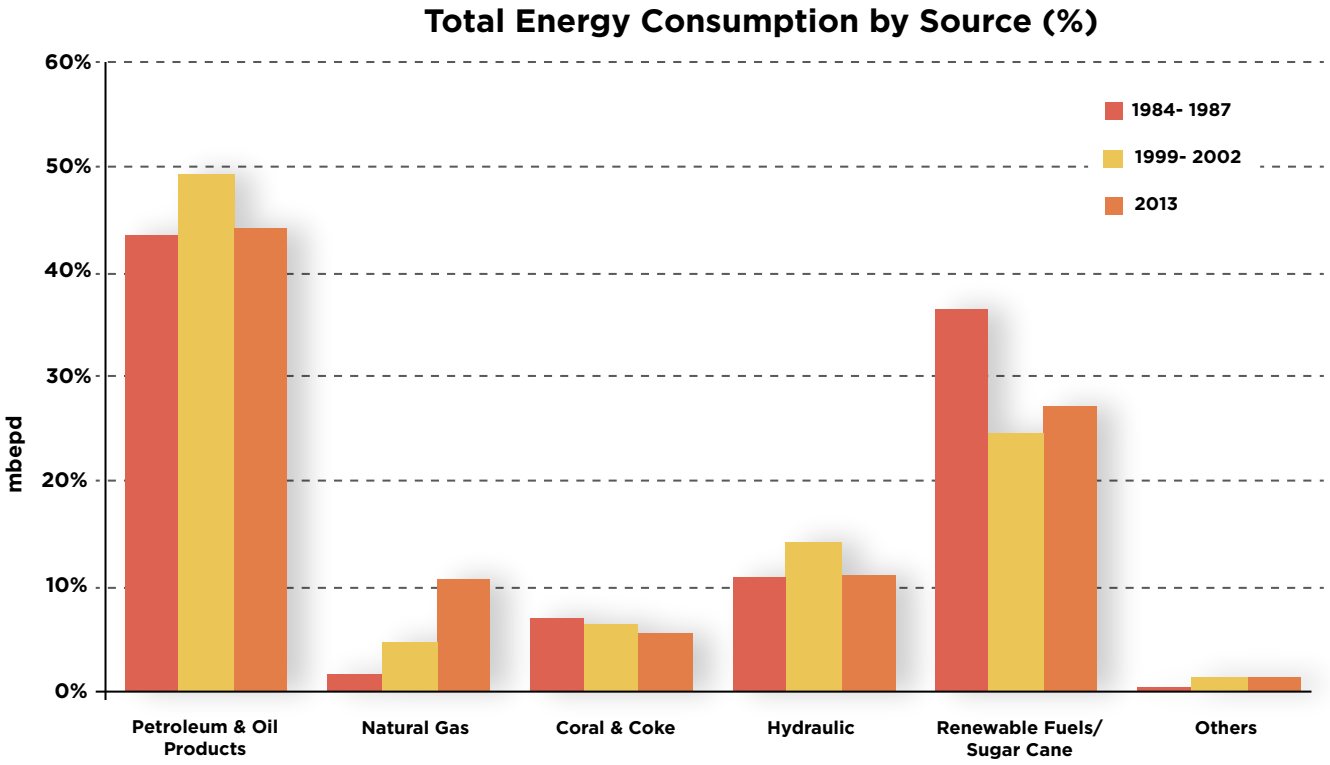
Energy Matrix



Editor: Ramón Espinasa (INE/ENE)
Authors: Lenin Balza (INE/ENE), Carlos Sucre (INE/ENE)
Source: Own calculations based on the IEA World Energy Balances.

In 2013, Brazil's total energy consumption (TEC) was 6.1 million barrels of oil equivalent per day (Mboe/d), an increase of 53.3 percent over the average from 1999–2002 and 25 percent over 2005–2008. In 2013, the country imported 1.5 Mboe/d of primary and secondary energy, most of it hydrocarbons, and exported 0.5 Mboe/d.

Figure 1



Source: Own calculations based on IEA data.

In 2013, fossil fuels made up 60.3 percent of Brazil's TEC, broken down as follows: 73 percent from petroleum and oil products, 18 percent from natural gas, and 9 percent from coal and coke.

The share of fossil fuels in the energy matrix has been relatively stable for the last decade, with only a small reduction of 2 percentage points; the mix of fossil fuel use has been affected by the higher consumption of natural gas, which increased its share by about 4 percentage points, but was offset by a reduction in the share of crude and oil products over the same period.

Renewable energy sources (excluding nuclear) made up 38 percent of the TEC, or 2.3 Mboe/d; 27 percent came from sugar cane products and 11 percent from hydraulic sources. Over the last decade, the share of energy from renewable sources was stable, with a small increase in renewable fuels offset by lower use of hydraulic energy, firewood, and charcoal.

Primary Energy Production, Commercial Balance, and Supply

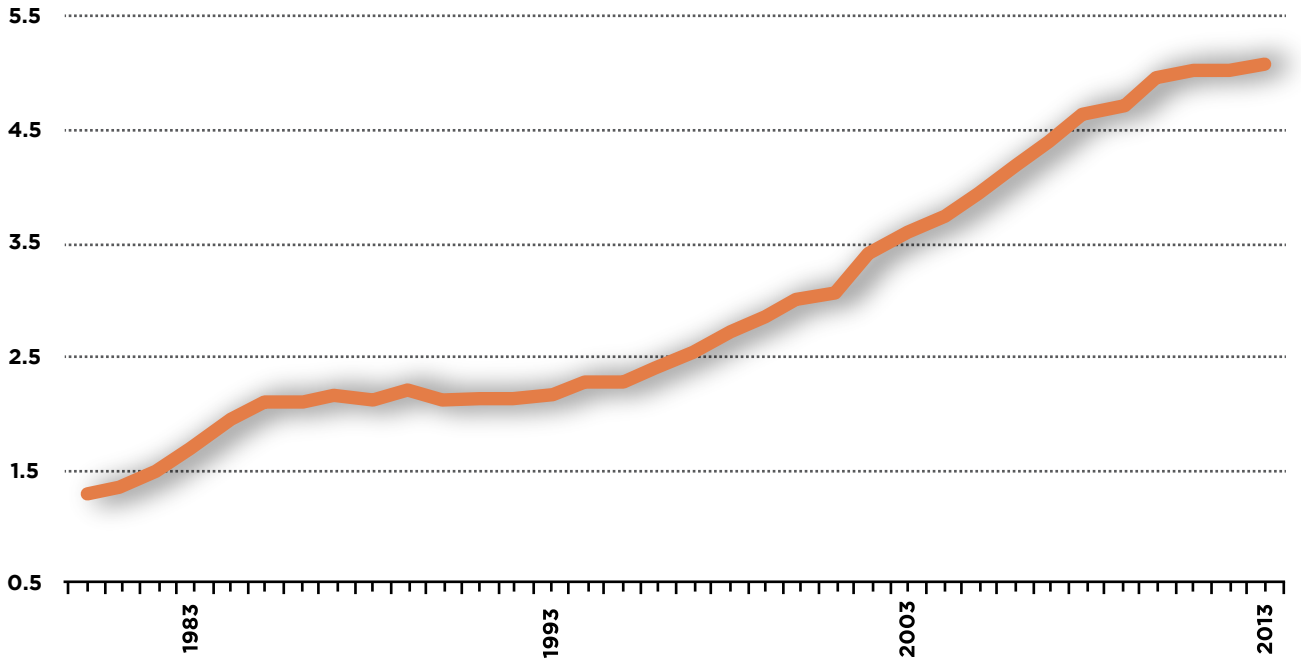
Primary Production

In 2013, Brazil's primary energy production reached 5.1 Mboe/d, a 66 percent increase over the period 1999–2002. This growth was driven by higher production of petroleum (+64%, from 1.34 to 2.2 Mboe/d, mostly from offshore) and natural gas (+178%, from 0.13 to 0.36 Mboe/d).

Primary production of renewable energy also contributed to this growth, mostly by way of sugar cane products (+69%, from 1 to 1.7 Mboe/d) and a more modest increase in hydraulic energy (+28%, from 0.53 to 0.68 Mboe/d). This growth was partly offset by a decrease in the production of uranium and firewood; these were the only two energy sources that saw an absolute reduction in primary energy production.

Figura 2

Primary Energy Production (thousand barrels of oil equivalent per day)



Source: Own calculations based on IEA data and Empresa de Pesquisa Energética (2013).

From a longer-term perspective, the country's increase in oil and gas production in the last two decades has affected the composition of its primary energy production matrix. The share of non-renewable energy increased from 38 percent (1993) to 52 percent (2013), while renewable energy reduced its share from 62 percent to 46 percent.

Commercial Balance

Over the last decade, Brazil's diverse energy mix has helped the country meet its domestic demands. Its net trade balance (the difference between imports and exports of primary energy) has been less than 10 percent of its total energy consumption each year. Disaggregated data, however, indicate that the country has historically relied on large imports of natural gas and coal, and, to a lesser extent, petroleum, oil products, and electricity.

Table 1

Commercial Balance

Item (Mboe/d)	2009	2010	2011	2012	2013
Total energy demand (a)	4.90	5.36	5.45	5.66	6.06
Primary energy production (b)	4.71	4.95	5.02	5.04	5.08
Dependence (a) - (b)	0.19	0.41	0.43	0.62	0.98
External dependence (c) / (a)	*3.9%*	*7.6%*	*7.9%*	*11.0%*	*16%*

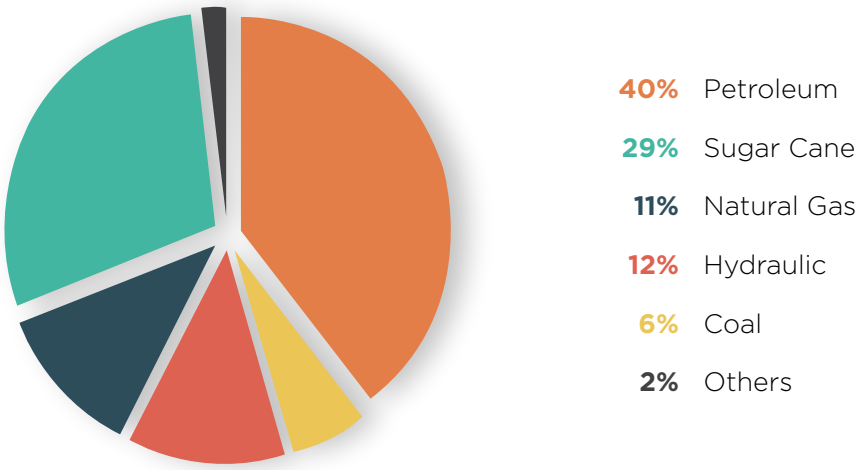
Over the last five years, the growth in the country's total energy demand outpaced its primary production, and its dependence on external energy increased from 3.9 percent to 16 percent (although these values are still much lower than those at the beginning of the decade).

Primary Energy Supply

The primary energy supply (PES) is the combination of the domestic supply and imported primary energy, and includes both sources like fossil fuels and renewables that are later converted by processing centers into secondary energy (e.g., electricity) for use in the economic sectors, by end consumers, or in the energy sector itself, and those that are to be exported.

Figure 3

Primary Energy Supply, % total



Source: Own calculations based on IEA data.

In 2013, Brazil's PES reached 5.59 Mboe/d, a 52 percent increase over the period 1999–2002 and 22 percent over 2005–2008. Petroleum, oil products, and natural gas made up 51 percent of the PES, followed by sugar cane and renewable fuel products at 29.8 percent and hydraulic power at 12.1 percent. Finally, coal and nuclear power made up 5.9 percent and 1.4 percent of the primary energy supply respectively.

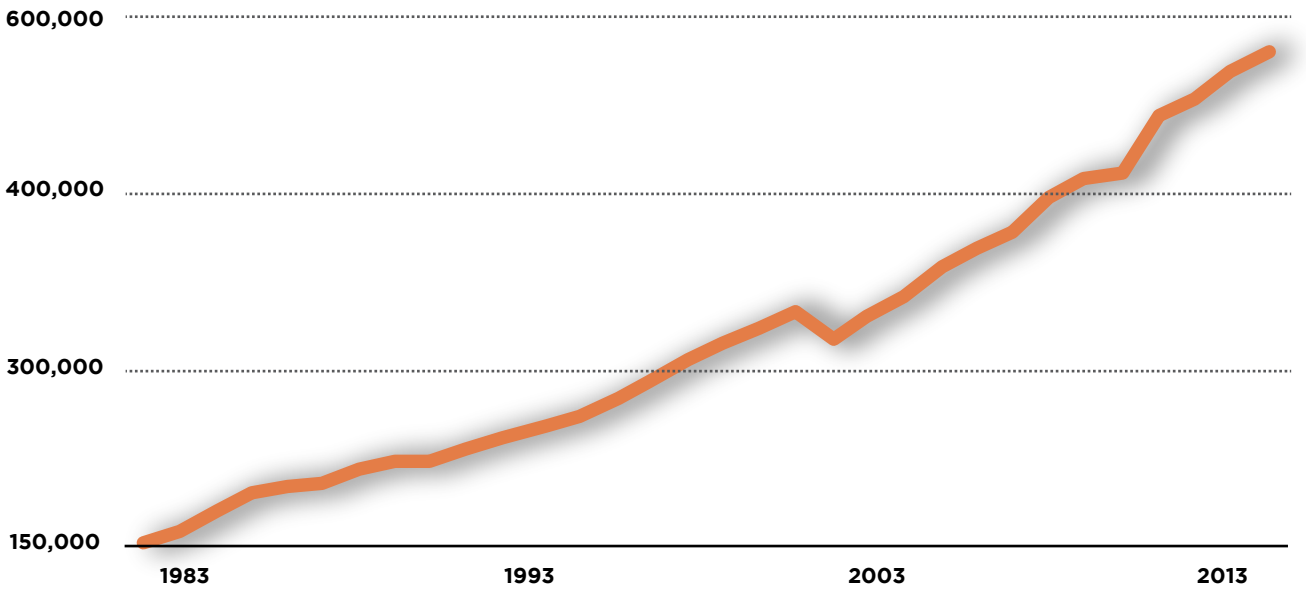
Electricity

Brazil is the largest electricity producer in the LAC region, representing about one-third of total electricity generation, followed by Mexico and Argentina. The three countries together account for two-thirds of LAC's electricity generation.

In the last 10 years, Brazil has faced increasing demands for electricity from its economic development, urbanization, and poverty reduction activities. To meet that demand, the country generated 570 TWh of electricity in 2013, representing a growth of 60 percent over 2003, or a 4 percent compound average growth rate (CAGR) over the last decade.

Figure 4

Electricity Generation (GWh)



Source: Own calculations based on IEA data.

Installed Capacity

A large part of Brazil's installed power capacity comes from hydropower plants. In 2013, Brazil had an installed capacity for electricity generation of 126,772 MW, of which 86,019 MW (68 percent) came from hydroelectric stations, 36,539 MW (28.8 percent) from thermal power stations, and the rest from nuclear stations.

Table 2

Installed Capacity (% total)

Energy Source	2000	2005	2009	2014
Fossil Fuels	10.	15	17	19
Nuclear	3	2	2	1
Renewables	88	83	81	80
Hydro	*84*	*76*	*75*	*66*
Non hydro	*4*	*7*	*6*	*14*
Total	**100**	**100**	**100**	**100**

Source: EIA

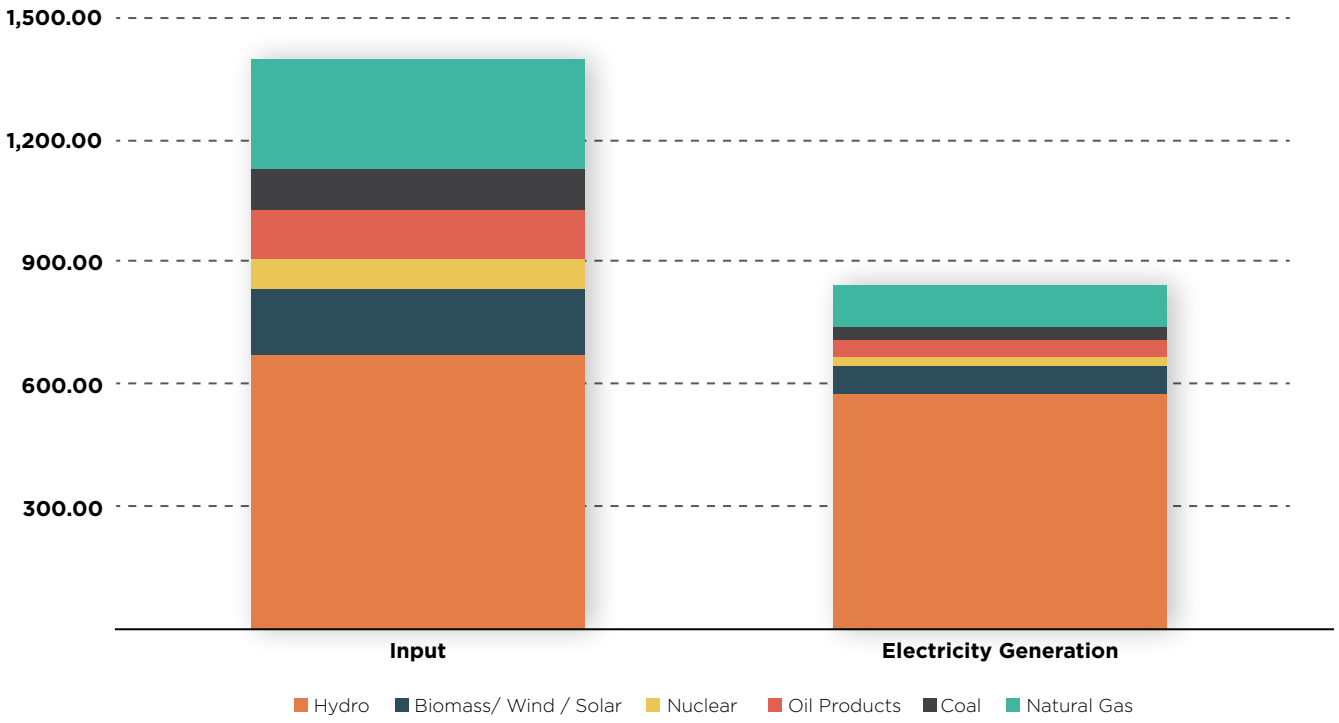
The country's electricity installed capacity increased by 53 GW (72 percent) between 2000 and 2013. More than half of this growth (29 GW) came from thermoelectric generation, predominantly through the higher utilization of natural gas, while renewable sources (mostly hydro) contributed an increase of 22 GW over the same period, mostly through the use of run-of-river dams, and not the more traditional reservoir dam.

Input to Electricity Generation

In 2013, renewable energy sources contributed 59.8 percent of the total inputs used for electricity generation. Compared to 1999–2002, the share of fossil fuels had increased from 22 percent to 35 percent, mostly due to the impact of higher usage of natural gas.

Figure 5

Electricity Generation Matrix (kboe/d)



Source: Own calculations based on IEA data.

The following table summarizes the evolution of the total inputs used for electricity generation.

Table 3

Fuel Input to Electricity (kboe/d)

Energy Sources	1999-2002		2005-2008		2013	
Coal and its products	59	8%	61.4	6.5%	104	7.5%
Oil products	75	10%	63	6.6%	116	8.3%
Natural gas	30	4%	78.7	8.3%	264	18.9%
Nuclear	50	7%	65.2	6.9%	77	5.5%
Renewables (*)	532	71%	681.6	71.8%	833	59.8%
Total	**764**	**100%**	**949.9**	**100%**	**1394**	**100%**

* Includes hydro, solar, wind, and biofuels.

Source: Own calculations based on IEA data.

Electricity Matrix

Brazil's electricity supply reached 570 TWh in 2013. The country's electricity matrix is based primarily on renewable generation (85 percent of the total). This comes mostly from hydropower, which supplies 77 percent of the total dispatched electricity, followed by thermoelectric generation (21 percent) fueled by natural gas. Nuclear power plants produced the remaining 3 percent.

Table 4

Electricity Consumption (GWh)

2013	569,990	100%
Coal	21,776	4%
Oil products	26,560	5%
Natural gas	69,002	12%
Nuclear	14,640	3%
Hydro	390,992	69%
Other renewables (*)	47,020	8%

* Includes hydro, solar, wind, and biofuels.

Source: Own calculations based on IEA data.

Secondary Energy Trade and Final Energy Consumption

Secondary Energy Trade

Brazil increased its imports of petroleum products between 2009 and 2014. In 2013, these imports reached 471 kboe/d, an increase of 82 percent over the 2005–2008 average of 259 kboe/d. That year, exports of petroleum products decreased to 23 percent below the 2005–2008 average. Finally, electricity imports totaled 70 kboe/d, and small exports 0.8 kboe/d.

Final Energy Consumption by Sector

In 2013, Brazil's final energy consumption was 4.6 Mboe/d, an increase of 48 percent over 1999–2002 and 25 percent over 2005–2008. The two largest sectors combined—transportation (36.5 percent) and industry (36.1 percent)—represented about three-quarters of the country's total energy consumption and have maintained a relatively stable share over time, with just a small increase in the last decade.

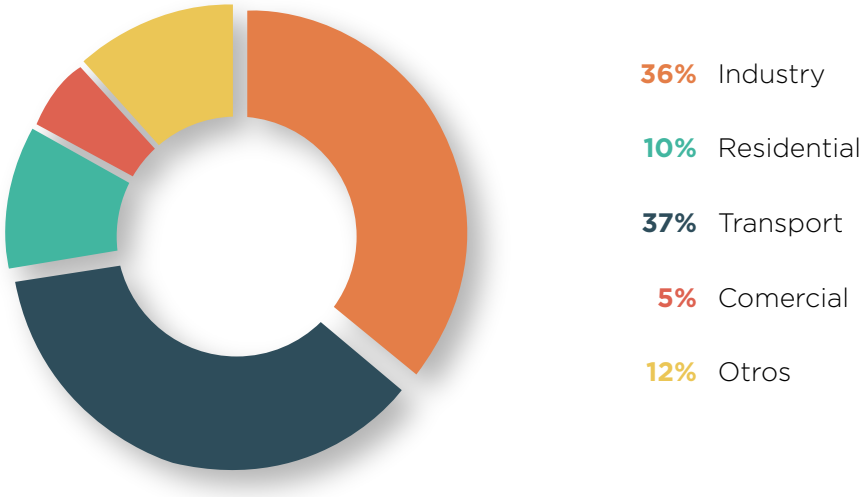
The transportation sector is the largest consumer of final energy in Brazil. In 2013, its consumption was 1.7 Mboe/d, 73 percent more than in 1999–2002 and 48 percent more than in 2005–2008. Within the transportation sector, the road and highway sector is by far the largest consumer of final energy, with a 92 percent share, followed distantly by airways with a 5 percent share. The transportation sector was supplied mostly by three products in 2013, which together accounted for 91 percent of final consumption: diesel oil (48 percent), gasoline (31 percent), and ethyl alcohol (13 percent).

The industrial sector is the second-largest consumer of final energy in Brazil. In 2013, it used 1.67 Mboe/d, accumulating a total increase of 45 percent over the period 1999–2002 and 14 percent over 2005–2008. The increase varied among industrial subsectors; the four largest subsectors and their respective increases in energy consumption from 1999 to 2013 were:

- Food and beverage production (+52%),
- Iron and steel production (+11%),
- Paper and pulp production (+52%), and
- Chemicals production (+10%).

Figure 6

Energy Consumption per Sector (% total, 2013)



Source: Own calculations based on IEA data.

In 2013, the residential sector (0.48 Mboe/d) and the commercial sector (0.24 Mboe/d) were the third- and fourth-largest final energy consumers in Brazil respectively. The residential sector was supplied mostly by electricity (45 percent share), but liquefied petroleum gas (LPG) also made a large contribution (28 percent). The commercial sector was predominantly supplied by electricity (91 percent).

Institutional Organization

Brazil is a presidential republic with a federal government structure comprising 26 states and one federal district. Articles 22 and 23 of the Brazilian Federal Constitution of 1988, as amended in 2005, reserve the exclusive right of the federal government to legislate on matters of energy, international trade, and transportation. This has created an important and central policy role for the federal government in these areas.

Article 177 (as modified by Constitutional Amendments 9/1995, 33/2011, and 49/2006) establishes the following as monopolies of the union:

I. Prospecting and exploration of deposits of petroleum, natural gas, and other fluid hydrocarbons

II. Refining of domestic and foreign petroleum

III. Import and export of the products and basic by-products of the activities set forth in the preceding items

IV. Ocean transportation of crude petroleum of domestic origin and of basic petroleum by-products produced in the country, and pipeline transportation of crude petroleum, its by-products, and natural gas of any origin

V. Prospecting, mining, enrichment, reprocessing, industrialization, and trading of nuclear mineral ores and minerals and their by-products

Moreover, Paragraph 1 of Article 177 of the Federal Constitution states, "The Union may contract with state-owned or with private enterprises for the execution of the activities provided for in items I through IV of this article"; and Article 175, "It is incumbent upon the Government, as set forth by law, to provide public utility services, either directly or by concession or permission, which will always be by public bidding." Furthermore, Article 176 says that "mineral resources and the hydraulic energy potentials form, for the purpose of exploitation or use, a property separate from that of the soil and belong to the Union".[1]

Policy Formulation

Brazil's energy sector is controlled by the Ministry of Mines and Energy (Ministério de Minas e Energia, or MME), which has overall policy competence (by Article 27, Item XVI of Law 10.683 of May 28, 2003, and Decree 7.798 of September 12, 2012) for the following:

- Geology, and mineral and energy resources
- Use of hydraulic energy
- Mining and metallurgy
- Oil, fuels, and electric power, including nuclear
- Energy access in rural areas and agro-energy, including rural electrification, when funded with resources from the national electrical system.

The MME was first established in 1960 (Law 3.782, July 22, 1960), and since then has taken on an increasing and evolving role because of the diversity of the energy mix in the country. Law 8.422 from 1992 reestablished and informed the existing structure and activities of the MME, which had been extinguished in 1990 by Law 8.028, when its activities were transferred to the Ministry of Infrastructure.

The National Energy Policy Law (9.478/1997) is one of the most important recent pieces of legislation related to energy. It created interagency committees and research and policy-setting institutions that advise the president of the republic on energy strategies; established new rules, regulations, and regulatory agencies; and introduced institutional reforms to the state-owned and -controlled enterprises Petrobras and Eletrobras. Most of these new organizations fall under the jurisdiction of the MME, but other ministries and inter-ministerial commissions that will be described later also play important roles in the energy sector.

The MME is organized into four secretaries: (i) petroleum, natural gas, and renewable fuels; (ii) the power sector; (iii) mining, geology, and mineral transformation; and (iv) energy planning and development (as defined by Portaria MME 89, February 27, 2014).

The MME presides over the National Council for Energy Policies (Conselho Nacional de Politica Energética, or CNPE), the main institution for proposing national policies and specific actions to the president of the republic.

The CNPE policy setting was established in 1997 (by Law 9.478, Article 2). It includes the MME minister, eight other ministers, and five other government officials.

[1] Tribunal Superior Eleitoral, 2016, available at http://english.tse.jus.br/arquivos/federal-constitution.

The CNPE's mission and main objectives are as follows:

I. Promoting the rational use of the country's energy resources, pursuant to the relevant legislation and following certain principles (detailed in the law)

II. Ensuring, in view of the regional characteristics of the country, the supply of energy resources to remote areas and areas of difficult access, and submitting specific measures to the national congress whenever these require the establishment of subsidies, in accordance with the specific provisions of Article 73 of Law 9.478 of 1997

III. Periodically reviewing the energy matrixes applicable to the different regions of the country and considering both conventional and alternative sources and the technologies available

IV. Establishing guidelines for specific programs, such as the use of natural gas, coal, thermal nuclear power, biofuels, solar power, wind power, and power derived from other sources (as defined by Law 11.097 of January 13, 2005)

V. Establishing import and export guidelines to meet the domestic consumption of petroleum and its by-products, natural gas, and condensate; ensuring the proper activities of the National System for Fuel Reserves (Sistema Nacional de Estoques de Combustíveis); and enforcing the Annual Strategic Fuel Stock Plan (Plano Anual de Estoques Estratégicos de Combustíveis) specified in Article 4 of Law 8.176 of February 8, 1991 (and worded by Law 12.490 of September 16, 2011)

VI. Proposing measures necessary to ensure the fulfillment of domestic demands for energy while considering short-, medium-, and long-term planning, and the possibility of recommending priority undertakings in calling for bids and implementations, due to their strategic nature and the public interest, in such a way as to optimize the relationship between moderate tariffs and the reliability of the electrical power system (worded by Law 10.848 of March 15, 2004)

VII. Establishing guidelines for the use of natural gas as a raw material for industrial productive processes, by regulating specific conditions and criteria aimed at ensuring its efficient use and compatible with domestic and international markets (added by Law 11.909 of March 4, 2009)

VIII. Defining blocks to be the objects of concession or production sharing (added by Law 12.351 of December 22, 2010)

IX. Defining strategies and policies for the economic and technological development of the petroleum, natural gas, and other fluid hydrocarbon and biofuel industries and their supply chains (worded by Law 12.490 of September 16, 2011)

X. Promoting the increase of minimum local content rates for goods and services, to be observed in bids, concessions, and production-sharing contracts pursuant to Item IX (added by Law 12.351 of December 22, 2010)

MME Main Organizations

- The Energy Research Company (Empresa de Pesquisa Energética, or EPE) provides services and studies to the development, planning, and research of the energy sector, including the areas of electricity, petroleum, natural gas and oil products, coal, renewable energy, and energy-efficiency measures.

  The company was established in 2004 (by Law 10.847) and is an independent entity subordinate only to the Minister of Mines and Energy. Every year the company presents to the CNPE the Ten-Year Plan for the Expansion of the Energy Sector (Plano Decenal de Expansão de Energia), and every two years the Long-Term National Energy Plan (Planos Nacionais de Energia).

- The Electric Sector Monitoring Committee (Comitê de Monitoramento do Setor Elétrico, or CMSE) was established in 2004 (Law 10.848), and a decree the same year (Number 5.175, on August 9, 2004) provided its regulations. The CMSE is chaired by the Minister of Mines and Energy and has nine permanent members: four representatives from MME, and the principals of Agência Nacional de Energia Elétrica (ANEEL), Agência Nacional de Petróleo, Gás Natural e Biocombustíveis (ANP), Câmara de Comercialização de Energia Elétrica (CCEE), EPE, and Operador Nacional do Sistema Elétrico (ONS)". Its primary responsibility is to monitor and analyze the power supply (including generation, transmission, distribution, import, and export) and its services, reliability, and safety across the country.

Other Ministries Involved in the Energy Sector

In addition to the Ministry of Mines and Energy, the country has other ministerial authorities that work on matters related to the energy sector. These are:

- The Ministry of the Environment (Ministério do Meio Ambiente, or MMA) was established in 1985 and modified by Laws 7.735 (February 22, 1989) and 10.683 (May 28, 2003). The ministry's main responsibilities are related to environmental policy; the preservation, conservation, and utilization of ecosystems; and biodiversity and forests.
- The Ministry of Science, Technology, and Innovation (Ministério da Ciência, Tecnologia e Inovação, or MCTI) was established by Decree 91.146 (March 15, 1985) and subsequently restructured under Decree 5.886 (September 6, 2006). The ministry's main responsibilities are establishing national policies for scientific research, technology, innovation, bio-security, national space, information technology and automation, and nuclear power. Several institutions under the MCTI are close to the energy sector: (i) the Commissão Nacional de Energia Nuclear (CNEN) was created in 1956 as the agency responsible for the orientation, planning, supervision, and control of Brazil's nuclear and radioactive programs; (ii) the Financiadora de Estudos e Projetos (FINEP) has the mission of promoting and financing innovation; and (iii) the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) offers financing arrangements to promote research and development.
- The Ministry of Development, Industry, and External Trade (Ministério do Desenvolvimento, Indústria e Comércio Exterior, or MDIC) was originally established in 1960 (Law 3.782). Its mandate is to establish, execute, and assess public policies for promoting competition, external trade, investment, and innovation by companies and the well-being of consumers.
- The Ministry of Agriculture, Livestock, and Food Supply (Ministério da Agricultura, Pecuária e Abastecimento, or MAPA) is one of the oldest institutions in the country, having started operations in 1860. Its current structure is defined mostly by Law 10.683 of 2003. The ministry sets public policies on agriculture to promote the sustainable development and competitiveness of agribusinesses for the benefit of Brazilian society. The ministry also coordinates an Inter-Ministerial Sugar and Alcohol Council (Conselho Interministerial do Açúcar e do Álcool), which acts as a steering committee for assessing the appropriate involvement of sugarcane ethanol in the national energy mix, the economic mechanisms required to enhance the self-sufficiency of the biofuels sector, and the scientific and technological development of the sugarcane ethanol sector (Decree 3.546, 2000).

Regulatory Framework

The regulatory regime in Brazil has developed mostly from the privatization program introduced by the federal government in the 1990s. The government reduced its direct involvement in the market by breaking up sectors that had been dominated by state companies and either licensing or making concessions to the private sector. Laws 8.018 (April 11, 1990) and 8.031 (April 12, 1990) were created to address these considerations.

It was against this background that the federal government introduced the Plano Diretor da Reforma do Estado (Master Plan for State Reform) in 1995, establishing the framework for the creation of Brazilian regulatory agencies in several sectors, such as telecommunication, energy, infrastructure, civil aviation, and transportation. These reforms were aimed at increasing the productivity of the public sector while reducing its size and focusing it more on core development and less on production. The government also introduced these reforms as a way to ensure that Brazilian society took full advantage of the new constitution of 1988.

In additional to the regulatory agencies, the institutional framework also includes the Federal Court of Accounts of Brazil (Tribunal de Contas da União, or TCU), which oversees the accounts of administrators and other people responsible for federal public funds and assets and those who are under union responsibilities. The TCU is an executive board consisting of nine ministers and is an autonomous and independent office of the Department of Justice dedicated to the court, whose main task is providing for the defense of the legal order. The TCU supervises and audits activities carried out on behalf of the Brazilian government, which includes those of the regulatory agencies.

Electric Sector Regulator

The **National Electric Power Agency** (Agência Nacional de Energia Elétrica, or ANEEL) was the first regulatory agency created from Brazil's 1990s reforms. It was established by Law 9.427 (December 26, 1996) and started operations in December 1997 as part of the MME (Decree 2.335/1997).

ANEEL oversees the production, transmission, distribution, and commercialization of electricity. It handles the promotion of auctions for the purchase of electricity through long-term contracts within the national interconnected system, and sets tariffs for consumers where applicable. It also oversees and runs the concessions, bids, and inspections of utilities services. It supervises competition for electricity-system expansion to resolve conflicts among agents, designs and implements new regulations, and establishes power accessibility targets for each distribution utility. Its overall mission is to provide favorable conditions for maintaining a balance among the agents of the electric power market to the benefit of society.

The agency also oversees a research and development (R&D) program established by the law, wherein the electric power generation, transmission, and distribution concessionaries have to invest a minimum percentage of their net operating incomes into R&D every year.

Like the country's other regulatory agencies, ANEEL is managed by a director general and four directors, all appointed by the president of the republic and subject to approval by the federal senate. All directors have a mandate of four years.

The electricity regulatory framework includes two other organizations:

- The **National Electrical System Operator** (Operador Nacional do Sistema Elétrico, or ONS) is a private non-profit entity under the control of ANEEL. It was created in 1998 (Law 9648) and is responsible for coordinating the generation and installation that make up the nation's transmission system. ONS oversees Brazil's National Interconnected System (Sistema Interligado Nacional, or SIN) for electricity transmission, which covers most of the country's power grid.
- The **Chamber of Electric Energy Commercialization** (Câmara de Comercialização de Energia Elétrica, or CCEE) is a private non-profit civil organization formed in 2004 by government decree to carry out the wholesale transactions and commercialization of electric power within the SIN. CCEE is also in charge of determining the settlement price for differences (spot price) to value short-term market transactions.

Petroleum, Natural Gas, and Biofuels Sector Regulator

The **National Agency of Petroleum, Natural Gas, and Biofuels** (Agência Nacional de Petróleo, Gás Natural e Biocombustíveis, or ANP) was established by Law 9.478 (August 6, 1997) as part of the MME. It is responsible for implementing national policies for the petroleum, natural gas, and biofuel sectors, with a focus on guaranteeing the fuel supply and protecting consumers' interests.

Like ANEEL, ANP has one director general and four directors, who are appointed by the president (subject to approval by senate) to four-year non-concomitant terms. The agency is run by this executive board and its decisions are published on its website. It also holds public hearings before making any decision on regulations.

The main purposes of ANP are:

- To establish the rules (resolutions and instructions) for the operation of the oil, gas, and biofuel industries
- To organize auctions and sign contracts on behalf of the Brazilian state with the concessionaries in the exploration, development, and production activities, and to grant permits for the activities of regulated industries
- To ensure compliance with the rules in the regulated industry activities, directly or by agreement with other public authorities

ANP is also a reference center for data and information on the oil and gas industry. It maintains the Exploration and Production Database (BDEP), undertakes studies on oil and gas potential and the development of the sector, receives and publishes releases on discoveries, and discloses official statistics on reserves and production in Brazil.

In the upstream sector (exploration and production, or E&P), ANP subsidizes the CNPE in its decisions on which areas are to be offered for concession in the bidding rounds; after defining those areas, ANP prepares the tender protocol, holds the auctions, and prepares the draft contracts. In the case of concessions, it signs the contracts on behalf of the Brazilian state. It is also ANP's role to measure the production of oil and gas in each production field and to calculate the values of royalties, "special participation," and "payments for retaining an area" (paid to private land owners in onshore E&P).

In the middle and downstream sectors, ANP authorizes companies to build, operate, and expand refineries, natural gas–processing facilities, and means of storage and transportation of oil and oil products. ANP's authorization is also required for import and export (including production and storage) of oil, biodiesel, and ethanol, and for distribution of compressed natural gas (CNG) and liquefied natural gas (LNG).

Moreover, to promote competition in the petroleum and gas markets, Article 10 of the Petroleum Law calls for ANP to inform the relevant government authorities of any potentially anticompetitive practices in the markets it regulates.

Electricity Sector

Electricity Sector Institutional Framework

	Generation	Transmission	Distribution
Dimensions	**Installed Capacity** Hydro 67.8% Thermal 28.8% Wind 1.7% Nuclear 1.6% Solar <0.1%	**Interconnected System** • 87,286 kilometers of transmission lines from 230kV to 750kV • 2 dc links connecting the binational Itaipu power plant to the grid	**Energy Consumption** Industrial 41% Residential 24% Commercial 16% Public 8% Agriculture 5% Others 6%
Market characteristics	**Installed Capacity (million kW)** **Largest companies** CHESF 10.6 Furnas 9.9 Eletronorte 9.2 Tractebel 7.3 Itaipu 7.0 Private companies account for ~15 percent of generation.	**Transmission Lines (kilometers)** **Largest companies** Furnas 19,277 CHESF 18,568 CTEEP 12,316 Eletrosul 11,300 CEMIG 7,506 Private companies:~35 out of 45 companies in the transmission systems.	**Energy Consumption (GWh)** **Largest companies** CEMIG 49,333 ELETROPAULO 45,600 CPFL 29,390 COPEL 26,075 Light 24,771 Private companies account for ~75 percent of distributed energy.
	• Co-existence between state-controlled and private companies. There are no limitations on the foreign ownership of electricity companies; however, every company must be incorporated under Brazilian law.		
Prices	Generation companies (public concessions, independent power producers, or self-producers) sell their power to both RCE and FCE consumers.	Tariffs and rates are established using a specific method set by ANEEL and adjusted annually. Expansion is established using a bidding process for new transmission lines.	There are two types of consumers: • Regulated Contracting Environment (RCE) • Free Contracting Environment (FCE)
Institutuional	Policy setting: Conselho Nacional de Politica Energética (CNPE) Regulator: Agência Nacional de Energia Elétrica (ANEEL) Strategic research and studies: Empresa de Pesquisa Energética (EPE) Commercialization: Câmara de Comercialização de Energia Elétrica (CCEE) Operations: Operador Nacional do Sistema Elétrico (ONS)		

Source: ANP (2013).

Notwithstanding the privatization process of the 1990s, state control still plays a role in the electricity sector in Brazil. Large government-controlled companies dominate the sector: nationally owned Eletrobras holds about one-third of generation capacity, and state-owned companies CESP, CEMIG, and COPEL each control about 7 percent.

Eletrobras is Brazil's semi-public national electric utility and the largest power company in Latin America. Founded in 1962, it is a holding company for Brazil's large regional electric companies. It takes part in the generation, transmission, and distribution of electricity, in addition to owning half of the Itaipu electricity complex.

In 2004, the Brazilian government implemented a new model for the electricity sector: a hybrid approach to state involvement that split the sector into regulated and unregulated markets for different producers and consumers. This approach allows for both public and private investment in new generation and distribution projects.

One of the major changes introduced by the new electricity model was the creation of two energy trading environments: a Regulated Contracting Environment (RCE), in which distributor-captive consumers negotiate contracts through auctions, and a Free Contracting Environment (FCE), in which consumers freely negotiate their contracts. The commercialization of electricity is carried out through a specific auction system coordinated by the government.

Under the RCE, participants include generators, distributors, and traders (who can only trade in existing energy auctions). Participants in the RCE enter into contracts, regulated by ANEEL, through energy auctions, held by the CCEE, which settle the price. In the FCE, generators, traders, and consumers freely negotiate prices, contract rules, and establish the types of contract.

In mid-2012, Brazil had a total of 2,286 agents (i.e., companies) registered with the CCEE. The RCE includes major distributors that amount to 2 percent of the number of companies but represent about 73 percent of the total volume. The participation of an agent in the CCEE is defined by the Commercialization Convention of Electricity, which was introduced by ANEEL in 2004 and specifies a set of rules and obligations for all participants.

Table 6

Types of Agents and Share of Market

Type of Agents (2012)	# Agents	Share
Regulated Contracting Environment (RCE)		
Distributor	47	2%
Free Contracting Environment (FCE)		
Self-Production	41	2%
Trader	144	6%
Free Consumer	592	26%
Special Consumer	985	43%
Generator	32	1%
Independent Producer	455	19%
Total	**2,286**	**100%**

Source: Own calculations based on ANP (2013).

Transmission

Brazil's transmission system includes the participation of private and government-controlled companies (at federal and state levels) through concessions, which can revert to the state. The long-term planning of the sector is carried out by the MME, which presents proposals to ANEEL for the expansion and improvement of the transmission system.

The ONS presents short-term (three-year) improvements to the system for adequacy and security. Once the decision is made to build a new system, the concession is decided on a competitive basis using the public auction process to foster the participation of the private sector in the electric power industry.

The transmission system in Brazil was affected by Law 10.848 (2004), which among other things unbundled the sector: distribution was segregated from the generation and transmission segments. The transmission system is still concentrated in federal- and state-owned companies, but to adapt to the new regulatory model they have had to sign new contracts with the government for the concession period (30 years). The regulator, ANEEL, calculated and set the revenues according to a specific methodology based on their assets and cost base.

As indicated, however, the new transmission systems follow the public auction process, which is open to national and international companies registered in Brazil. The public sector is also allowed to participate in the auction process, either individually or in consortiums and partnerships with the private sector in Public-Private Partnerships (PPPs). The winner is responsible for the construction, operation, and maintenance of the transmission system during the 30-year concession period. Its revenue is expected to cover the investment made by the company, its operating and maintenance costs, and its profits according to the permitted annual revenue (Receita Anual Permitida, or RAP).

The length of the transmission system continues to expand in Brazil. From 2008 to 2012, the country added 14,500 kilometers of lines, a 16 percent increase.

Table 7

Transmission Lines (kilometers)

Type of Line	2008	2012	Growth	Share
260 kV	37,710	47,858	27%	46%
345 kV	9,772	10,224	5%	10%
440 kV	6,671	6,728	<1%	6%
500 kV	31,868	35,726	12%	34%
600 kV cc	3,224	3,224	-	3%
750 kV	2,683	2,683	-	2%
Total	**91,928**	**106,443**	**16%**	**100%**

Source: Empresa de Pesquisa Energética (2013).

Distribution

Power distribution is considered a public service in Brazil, so distribution companies are allowed to operate under a specific concession or permission arranged through a contract with the government defining a set of rights and obligations.

In contrast to the generation and transmission sub-sectors, most of the distribution sub-sector is operated by private companies (some of them products of the privatization process of the 1990s). These currently account for two-thirds of the electricity distribution. In 2012, Brazil had 63 companies holding public service concessions organized by geographic area. The five largest represented about 39 percent of the total electricity consumption and 36 percent of the total number of consumers.

Table 8

Electricity Distributors

Largest Electricity Distributors	Consumption (GWh)	% Brazil	# Consumers (thousands)	% Brazil
CEMIG	49,333	11.0%	7,535	10.4%
Eletropaulo	45,600	10.2%	6,486	9.0%
CPFL	29,390	6.6%	3,829	5.3%
Copel	26,075	5.8%	4,038	5.6%
Light	24,771	5.5%	4,030	5.6%

Source: Empresa de Pesquisa Energética (2013).

In 2012, ANEEL introduced new regulation (Resolution 482/2012) establishing conditions for micro-generation (up to 100 kW of power) and mini-generation (from 100 kW to 1 MW), allowing consumers to install smart generators and exchange electricity with local distributors. Under this system of mini-grids or off-grids, consumers can generate their own power (using renewable energy such as solar and wind), which if not consumed is injected into the system in exchange for a credit applied in subsequent months. This regulation was updated in 2015 with more flexibility to allow for micro-generation and raising the limits on generation to 5MW.

On the consumption side, the country has a large customer base of 72,377,000 end consumers of electricity, of whom the vast majority (61,687,000) are residential. The total consumption has reached 448,117 GWh with an average consumption of 516 kWh per month; the residential sector has reached 117,646 GWh, with an average consumption of 159 kWh per month. Electricity access in Brazil, according to the World Bank, stands at 99.5%. This level of near universal coverage is a substantial achievement, considering access stood at 90% in 1990 and is largely the result of programs like Luz Para Todos, in force today and started in 2003, which emphasized the inclusion of low income consumers to the electricity grid.

Table 9

Consumer Composition

Consumer Classes	Captive Consumers		Free Consumers	
	Number (thousands)	Consumption (GWh)	Number (thousands)	Consumption (GWh)
Residential	61,697	117,646	-	-
Industrial	571	69,940	2	113,535
Commercial	5,270	74,707	1	4,531
Rural	4,129	22,731	<1	221
Public Sector	695	39,274	<1	2,244
Own Use	12	3,130	<1	158
Total	**72,374**	**327,427**	**3**	**120,690**

Source: Empresa de Pesquisa Energética (2013).

Renewables

The National Energy Policy Law (Law 9.478, amended in 1997) has framed bioenergy production and consumption in Brazil. The law has as an objective the increase of the contribution of renewable energy to the national matrix based on economic, social, and environmental considerations (Article 1). This policy builds on the country's long tradition of using renewable energy in the transportation and power sectors.

Nuclear Power

Brazil's main legislation regarding the nuclear sector is the National Policy on Nuclear Energy (1962), which established state control over nuclear materials.

The National Nuclear Energy Commission (Comissão Nacional de Energia Nuclear, or CNEN) is a federal institution established by Law 4.118 (August 27, 1962, but originally from Decree 40.110 of 1956) and answerable to MCTI. CNEN has co-authority (with the Brazilian Institute of the Environment and Renewable Natural Resources, IBAMA) over radiator aspects of nuclear licensing, and also invests in research and development through 14 facilities around the country, including the Nuclear Energy Research Center Institute (Instituto de Pesquisas Energéticas e Nucleares, or IPEN) in São Paulo and the Institute of Nuclear Engineering (Instituto de Engenharia Nuclear, or IEN) in Rio de Janeiro.

The Brazilian nuclear utility company Eletronuclear was established in 1997 through a merger of the state-owned companies Furnas and Nuclen. It is a subsidiary of Eletrobras (a part of MME), which controls 99.9 percent of its shares. Eletronuclear has its headquarters in the city of Rio de Janeiro, a plant in Angra dos Reis (Rio de Janeiro), and offices in Brasilia and Recife.

Brazil has two nuclear power plants, the 640-MW Angra 1 and the 1,350-MW Angra 2, which together make up 2–3 percent of the national installed capacity. Both plants are operated by Eletronuclear. The Angra 1 plant began commercial operations in December 1984, and Angra 2 in December 2000. Construction of a third plant, the 1,405-MW Angra 3, started in 1984 but encountered delays, and construction only began again in 2008. Completion is now estimated for 2016.

Other Renewable Energy Initiatives

Proinfa

In 2004, the Brazilian Program of Incentives for Alternative Electricity Sources (Programa de Incentivo às Fontes Alternativas de Energia Elétrica, or Proinfa) within the MME established (Decree 5.025) the incorporation of 3,300 MW of renewable energy into the national energy grid: (i) wind (1,423 MW), (ii) biomass (0.685 MW), and (iii) small hydro-electrical centrals (1,192 MW). The long-term objective is to obtain 10 percent of electricity from these sources in the second phase of the program (Law 10.438/2002, amended by Laws 10.762/2003 and 11.07/2004). The 144 projects identified for the program will be awarded 20-year contracts and generate power directly to Eletrobras. These projects did not include solar energy because of its off-grid and small-scale character.

In addition to ethanol, biodiesel, and hydropower, the country has increased its use of other renewable energies. One example is electricity produced from wind, which reached 6,579 GWh in 2013, an increase of 30 percent over the previous year. The installed capacity for wind generation also continues to grow; according to ANEEL, the national wind farm expanded by 313 MW to reach a total installed capacity of 2,207 MW by the end of 2013.

The program is also focused on the environmental benefits of reducing greenhouse gas emission, and was eligible for Certified Emissions Reduction (CER) under the Clean Development Mechanism (CDM) of the Kyoto Protocol.

Energy Efficiency

Brazil's energy-efficiency framework consists of several initiatives. The country has passed energy-efficiency legislation setting standards for appliances and buildings (Law 10.295, October 17, 2001, and Decree 4.509, December 19, 2001) and for investment in research and development of energy-efficiency technology (Law 9.991, July 24, 2000).

More recently, in October 2011, the MME unveiled a dedicated program, the National Energy Efficiency Plan (Plano Nacional de Eficiência Energética: Premissas e Diretrizes Básicas, or PNEf), which included a regulatory framework, instruments, and actions. The plan introduced the goal of a 10 percent reduction in electricity consumption by 2030 and clarified the responsibilities of the various stakeholders, including the government, the regulatory agencies, society, and the private sector. The plan covered several areas of the energy sector, including electricity and the use of oil and natural gas products.

Procel (National Program for the Conservation of Electrical Power)

This is a labeling and reward program created on December 30, 1985, by the MME and the Ministry of Commerce and funded by the Eletrobras budget and the Global Reversion Reserve. It is aimed at reducing both the production and the consumption of electricity in order to eliminate waste and reduce costs. According to Eletrobras, from 1986 to 2013 this program saved approximately 70.1 billion kWh.

Social Fuel Seal (Selo Combustível Social)

In Brazil, small-scale agriculture has been promoted through tax benefits awarded to biodiesel producers purchasing raw materials from family farmers (Decree 5.297, December 6, 2004). It ties tax incentives, federal credit, and government-led procurement of biodiesel to the satisfaction of requirements that promote regional socioeconomic development by requiring the integration of smallholders into the biodiesel production chain. The Social Fuel Seal allows biodiesel producers who source a percentage of their input from feedstock produced by smallholders to receive certain fiscal incentives and sell their biodiesel in national auctions to satisfy the regulatory blending requirements.

Climate Change

Another important goal of Brazil's energy policy is mitigating the accumulation of greenhouse gas (GHG) emissions and fostering the sustainable development of the energy sector (uniquely, most of Brazil's emissions come from land use—change and forestry—and not from fossil fuel use).

The country has specific policies and legislations in place to deal with environmental considerations, but Law 12.187 (December 29, 2009) introduced the National Policy on Climate Change (Política Nacional sobre Mudança do Clima, or PNMC), creating an ambitious voluntary national GHG emission reduction to mitigate climate change. The new legislation is tasked to create adaptation and conservation policies as well as foster the development of a national cap and trade policy. The legislation sets a voluntary commitment to reduce between 36.1 percent and 38.9 percent of the projected GHG emissions by 2020 and establishes that the mitigation actions be quantifiable and verifiable.

Hydrocarbon sector

Hydrocarbon Sector Institutional Matrix

Institutions

- Policy setting: Ministério de Minas e Energia (MME)
- Inter-governmental: Conselho Nacional de Politica Energética (CNPE)
- Regulator: Agência Nacional de Petróleo, Gás Natural e Biocombustíveis (ANP)
- Research and Studies: Empresa de Pesquisa Energética (EPE)

Upstream

Exploration and Production

Main Companies (Top 5)	Crude Production (thousand barrels)	Gas Production (thousand m3)
Petrobras	691,332	23,233,683
Statoil Brasil	13,473	21,514
Shell Brasil	12,816	186,865
Sinochem Petroleum	8,892	14,342
BG Brasil	7,900	321,997
Total production	754,409 thousand barrels	25,821,624 thousand m3
Proven reserves	15,314 billion barrels	459,187 billion m3
Regulatory regime	Three types of contracts: • Concession • Production Sharing • Onerus Assignment	

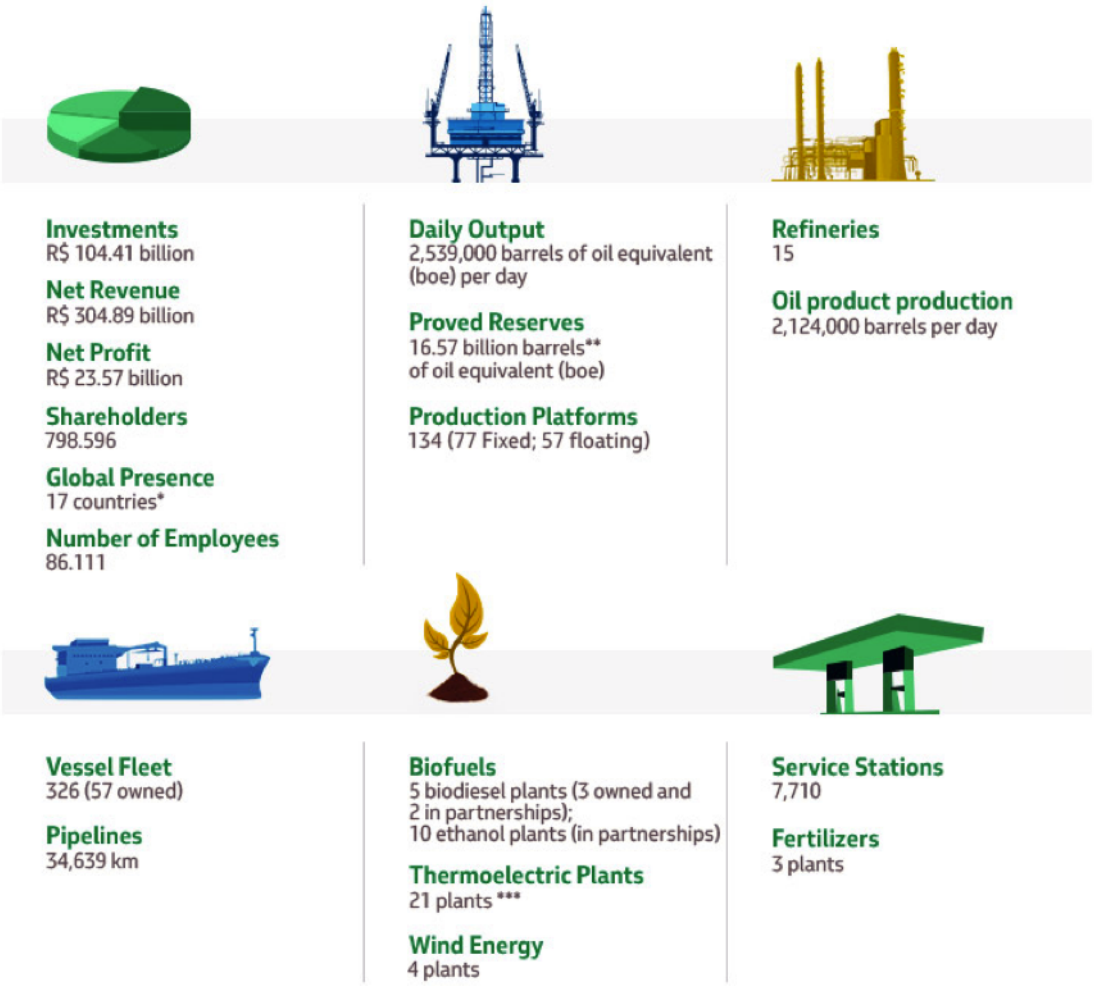
Trade Balances

	Import	Export
Volume (barrels)	113.9 million	200.5 million
Value (US $)	13.4 billion	20.3 billion
Average Price (Freight on Board)	US $ 118 /barrel	US $ 101 /barrel
Main Sources:	•Nigeria (55%) •Saudi Arabia (23%) •Iraq (8%)	•United States (28%) •China (23%) •India (17%)

Source: ANP (2013).

Petrobras is a key player in the Brazilian energy sector. The company was established in 1953 and is active in several areas of the hydrocarbon and renewable energy sectors. Petrobras has a mixed-capital structure, with floating shares traded domestically and internationally but with the federal government controlling the majority of its voting rights. The reforms introduced by Law 9.478 had a large impact on the company's activities; a detailed history of the company is presented in the last section of this dossier.

The following illustration summarizes the main dimensions of Petrobras operations (as of May 2014).



Source: Petrobras

Upstream Sector: Exploration and Production (E&P)

Following the direction and articles of the Brazilian constitution and the decisions of the CNPE, ANP is responsible for implementing policies aimed at guaranteeing the fuel supply and protecting consumers' interests.

The agency manages the hybrid system of three types of oil and gas regimes in Brazil: (i) concessions, applicable to most E&P activities; (ii) production sharing, applicable to specific areas such as the pre-salt; and (iii) the onerous assignment between the federal government and Petrobras. (These regimes are described in detail in the last section, on the historic evolution of the institutional framework.)

The federal government holds competitive auctions for E&P activities, which are promoted by ANP on its behalf. After all aspects of the tender process are completed, and the exploration phase and declaration of commercialization are finalized, companies can start the production process. At the end of 2013, there were 776 blocks under concession arrangements, distributed as follows.

Table 11

Exploration and Production Block Concession Arrangements

Type of Blocks / Number	Total	Offshore	Growth	Share
Exploration	338	168	168	2
Product Development	73	41	32	-
Production	365	94	271	-
Total	**776**	**303**	**471**	**2**

Source: ANP (2013).

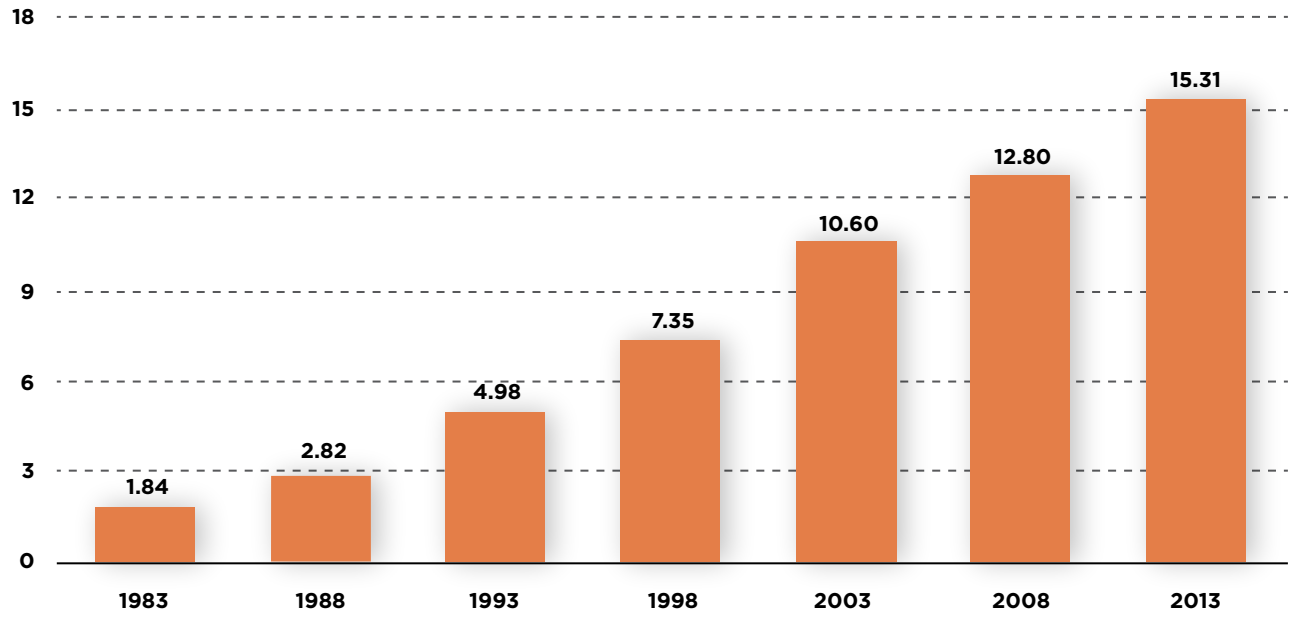
Petroleum

In 2013, Brazil was ranked 15th worldwide for proven petroleum reserves, with 15.6 billion barrels, and the country's total reserve (including probable and potential) is estimated at 30.2 billion barrels. Over the last few decades, the country has consistently increased its proven oil reserves, as illustrated in Figure 7. Of these proven reserves, 94 percent were offshore, concentrated mainly in Rio de Janeiro state.

The same year, Brazil produced 738.7 million barrels of oil (equivalent to 2.02 million barrels/day), mostly offshore (91 percent of total production). Of this total, 110 million barrels (303,000/day) came from the pre-salt area. During the previous 10 years, the country saw a 3.5 percent average annual increase in oil production, and its reserve-to-production (R/P) ratio increased from 20.8 years in 2004 to 21.1 years in 2013.

Figure 7

Brazil's Proven Oil Reserves (in billion barrels)



Source: BP (2014).

Gas

In 2013, Brazil was ranked 31st globally in proven natural gas reserves, with 458 billion cubic meters. The country's total reserve is estimated at 839 billion cubic meters. Natural gas production reached 28.2 billion cubic meters in 2013, representing a stable 5.8 percent average annual increase for the previous 10 years. Of this, 73 percent was distributed offshore and 27 percent onshore.

Of the total natural gas production, 66.6 percent (18.8 billion cubic meters) came from associated gas. Brazil's R/P ratio for gas was 16.3 years in 2013, lower than its 2004 ratio of 19.2. Overall, the country held the 34th position in the global ranking of natural gas production.

Midstream: Natural Gas

In Brazil, natural gas is used mostly in the industrial sector, but it sees some residential use. Total consumption in 2013 was 26 billion cubic meters, highly concentrated in the southeast, which accounted for two-thirds of the consumption. In the last 10 years, the domestic consumption of natural gas has increased by 6.3 percent per year on average.

To meet its growing demand for natural gas, Brazil also imports gas from two sources:

- The first is Bolivia, via the Bolivia–Brazil pipeline, which extends 3,150 kilometers from Santa Cruz de la Sierra in Bolivia to Porto Alegre in southern Brazil, with 557 kilometers of its length in Bolivia and 2,593 kilometers in Brazil. In 2012, Brazil imported 10.1 billion cubic meters of natural gas from Bolivia.

- The second is LNG imports. In 2012, Brazil imported 3.0 billion cubic meters of LNG, mostly from Qatar (1.1), Trinidad and Tobago (0.8), and Nigeria (0.5). Brazil has three LNG-import terminals:

  i. Pecem, in the state of Ceara in the northeast, with a capacity of 2.6 Bcma and a storage capacity of 129,000 cubic meters;

  ii. Guanabara, in the state of Rio de Janeiro, with 7.3 Bcma capacity and 173,400 cubic meter storage capacity; and

  iii. Salvador, in the northeast state of Bahia, with 5.1 Bcma capacity and 138,000 cubic meter storage capacity.

Despite the significant increase in demand, natural gas remains a minor participant in Brazil's energy mix. In 2013 it made up 13 percent of the domestic energy supply and 7 percent of the consumption. Domestic consumption experienced different trends that year: the industrial demand for natural gas dropped 1.1 percent from the previous year, and there was a 48 percent increase in thermal power generation using natural gas (including self-producers and public service power plants).

Pipeline Network

Petrobras controls almost all the existing pipelines and LNG terminals, but recent legislation (see further discussion of Law 11.909 in the next section) has opened the sector to private investment.

Transpetro is a wholly owned subsidiary of Petrobras responsible for fuel transportation and logistics, natural gas processing, and import and export of oil, oil byproducts, gas, and ethanol. The company has a distribution network of 7.151 kilometers of natural gas pipelines, an operating capacity of 19.7 million cubic meters/day of natural gas, and 4.5 million cubic meters/day of natural gas condensate. The infrastructure includes 29 receiving points, 136 delivery points, and 19 compressor stations.

The Brazil–Bolivia pipeline is managed differently. On the Brazilian side, the transportation of natural gas is carried out by the TBG Transportadora Brasileira Gasoduto Bolívia–Brasil S.A. consortium, of which Gaspetro, a Petrobras subsidiary, controls 51 percent of the shares.

Gas Legislation: The Gas Act

On March 4, 2009, the government enacted Law 11.909, the Natural Gas Act, which deals with activities related to the transportation of natural gas (previously covered by Article 177 of the constitution) and its treatment, processing, storage, liquefaction, regasification, and commercialization. This law altered Law 9.478 (August 6, 1997), and Decree 7.382 (December 2, 2010) regulated Chapters I through V of the new legislation.

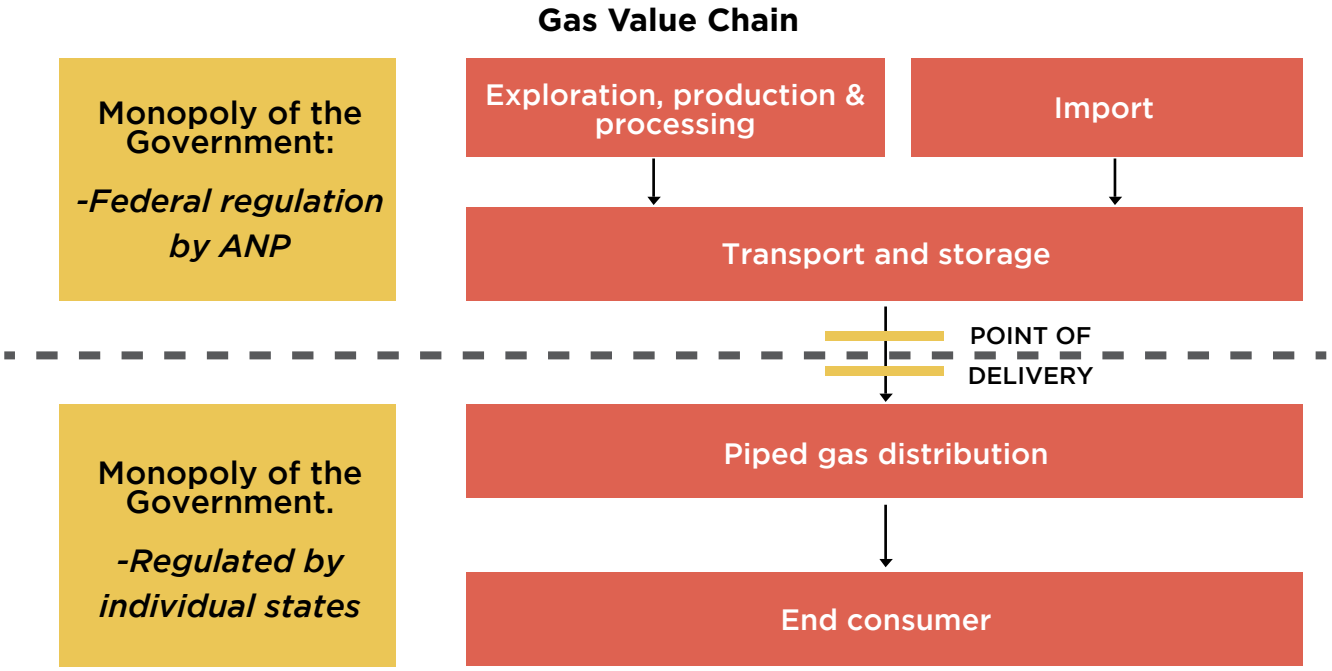
The oil and gas regulator ANP took on an important role with the introduction of Law 11.909, which gave it the following tasks: (i) authorize natural gas sales within the federal government's sphere of jurisdiction; (ii) organize auctions and sign concession contracts for gas transportation pipelines; (iii) establish (in the case of concessions) or approve (in the case of permits) rates for transporting natural gas; and (iv) supervise the resulting contracts and permits. ANP also regulates and supervises natural gas storage, oversees the product's traffic through the transportation network, and coordinates natural gas distribution in contingency situations.

The Natural Gas Act and Law 9.478 also introduced "self-production" and "self-importer" agents, which use natural gas as a raw material or a fuel in their industrial processes. These agents are required to preregister with ANP and submit detailed plans for how they will use natural gas, from production or import through to final consumption.

The concessions for natural gas exploration and production are a monopoly of the government supervised by the Brazilian Court of Audit (Tribunal de Contas da União, or TCU). In general, the TCU audits the accounts of administrators and other people responsible for federal public funds, assets, and other valuables.

According to Article 25, Paragraph 2 of the federal constitution, individual states can exploit the distribution of piped gas directly or through concession. In this part of the value chain (i.e., after the point of delivery), the activities are subject to state regulation, as illustrated below.

Figure 8



Source: Brazilian Court of Audit (TCU) with adjustments by authors.

Decree 7.382 (December 2, 2010) introduced important regulations to the Natural Gas Act, such as assigning the MME responsibility for determining which gas transport pipelines are to be built or expanded. In order to fulfill this responsibility, the ministry must prepare, with the support of EPE and of ANP, the Decennial Plan for Expansion of Transport Gas Pipelines.

The decree also regulated the access of third parties to the transportation pipelines and established a 10-year exclusivity period for new pipelines. After 10 years, carriers must open up their pipelines to third-party transportation.

Downstream: Refining, Distribution, and Marketing

Brazil has an evolving downstream sector of continental scale, which creates challenges for managing the supply-and-demand balance of oil products and biofuels. In the last decade, the country saw a large increase in domestic demand for refined products, and its refineries were operating at close to full capacity.

In 2013, Brazil had a 2.2 million barrels per day (bbl/d) refinery capacity—about 2.3 percent of the world's total—and processed a total of 2.1 million bbl/d in 16 refineries, of which 12 were owned by Petrobras. Of the petroleum processed in the country, 80 percent was domestic and 20 percent came from imports. Brazil's refinery system is relatively simple, so it usually has to export some of its heavy crude oil and import light crude oil.

Table 12

Refineries in Brazil

Refineries above 100 bbl/d				Refineries below 100 bbl/d			
Name	**Location**	**Start-Up Operation**	**Capacity (bbl/d)**	**Name**	**Location**	**Start-Up Operation**	**Capacity (bbl/d)**
Replan	São Paulo	1972	415.5	Recap	São Paulo	1954	53.5
RLAM	Bahia	1950	377.4	Reman	Amazonas	1956	45.9
Revap	São Paulo	1980	251.6	RPCC	Rio Grande do Norte	2000	37.7
Reduc	Rio de Janeiro	1961	242.2	Rio Grandense	Rio Grande do Sul	1937	17.0
Repar	Paraná	1977	207.6	Manguin-hos	Rio de Janeiro	1954	13.8
Refap	Rio Grande do Sul	1968	201.3	Univen	São Paulo	2007	9.2
RPBC	São Paulo	1955	170.0	Lubnor	Ceará	1966	8.2
Regap	Minas Gerais	1968	150.9	DaxOil	Bahia	2008	2.1

Source: ANP (2013).

In 2013, Brazil had 601 pipelines for the transportation of oil products and gas, totaling 19,700 kilometers across the country. At the end of 2013, the country had 329 distribution depots for liquid fuels—mostly concentrated in the southeast (115) and south (52) parts of the country—for an aggregated storage capacity of 3.8 million cubic meters.

Retail and marketing activities are deregulated in Brazil, and at the end of 2013 there were 38,893 retail sites, with the following market-share distribution: 20 percent BR (Petrobras), 15 percent Ipiranga, 10 percent Raizen (Shell brand), and 4 percent Alesat. The companies are organized as SINDICOM (Sindicato Nacional das Empresas Distribuidoras de Combustíveis e de Lubrificantes), which was established in 1941.

The prices of oil products to end consumers are based on market conditions and not set by the government. Prices were deregulated in 2002 along with the possibility to import oil products, although Petrobras continues to set post-refinery prices. Prices are monitored by ANP, which conducts regular surveys and publishes average prices on its website.

For the distribution of piped gas, each state establishes concessions to public or private companies (national or foreign), which have been organized as ABEGÁS (Associacão Brasileira das Empresas Distribuidoras de Gás Canalizado) since 1990.

Liquefied Petroleum Gas (LPG)

LPG is widely used in Brazil and has a core position in the residential energy mix—it is present in about 95 percent of households, where it is used for cooking and water heating. Since the 1950s, the government regulated and subsidized LPG to consumers, but in 2001 prices were deregulated and the subsidies removed. To minimize the impact of this change, the government did introduce vouchers to help low-income families purchase LPG.

By federal legislation (Law 8.716, February 8, 1991), LPG is forbidden to be supplied for certain uses, including any type of engine or automotive purpose, thus it is not used in the transportation sector in Brazil. In 2013, total LPG consumption was 13.3 million cubic meters, and in the last 10 years, the share of LPG in the Brazilian energy matrix declined from 3.8 to 3.2 percent.

On the market side, 3 of the 19 companies currently in operation carry about 2/3 of the distribution volume: Ultragas (23 percent), Liquigas/Petrobras (23 percent), and SHV Gas Brasil (21 percent). These companies are organized as SindiGás (Sindicato Nacional das Empresas Distribuidoras de Gás Liquefeito de Petróleo), which was created in 1974. The LPG price to consumers is deregulated, but most of the product is supplied by Petrobras, either from its own refineries or from imports.

Bidding Process

The president of the republic and the MME via the CNPE are the government authorities who decide which areas are to be offered in the oil and gas exploration and production bidding process. Per Law 9.478, ANP plays an important role in this process. Other legislations guiding the bidding process are CNPE Decree 8/2003 and ANP Resolution 27/2011.

To support the bidding process, ANP undertakes geological and geophysical studies to demarcate the areas with production potential. After defining these areas, it prepares the tender protocol, holds the auctions, and prepares the draft contracts, either in the concession system or in the production-sharing regime. For the preparation of future bidding rounds, ANP also accepts suggestions from companies about areas or blocks of interest, as well as comments that might contribute to successful rounds. All communications on this subject are for internal use only, ANP makes no commitment to nominate such areas or blocks in subsequent licensing rounds, and companies responding are under no obligation to bid for such blocks or areas.

The bidding rounds are open to any company or consortium that meets the technical, legal, and financial requirements established by ANP. Since 1999, ANP has carried out 12 rounds for oil and gas exploration and production. This number does not include two other rounds:

- Round 0 was held in August 1998 to ratify the concession regime between Petrobras and ANP for 115 blocks in which the company had already made investments.
- Round 8, in 2006, was suspended due to judicial dispute.

On its website, ANP provides public access to general data on the exploration blocks under concession, such as concessionaires, operator, signing date, and minimum work obligation. Similar information is also provided for blocks already relinquished.

In the last two decades, Brazil has made a great effort to expand geological and seismic research, as exploration and production in the country are still in their infancy. According to ANP, of the 29 geological basins with hydrocarbon potential in the country (amounting to about 7.5 million square kilometers), only 311,000 square kilometers were under concession

in 2011 (344,000 square kilometers were under production), a mere 4.5 percent of the basin area with hydrocarbon potential that had been studied and mapped.

Moreover, since the change to the regulatory regime in 1997, the proven oil reserves in the country have increased from 7.1 billion barrels (in 1998) to 14.2 billion barrels (2010), and the proven gas reserves from 228 billion to 423 billion cubic meters.

In 2013, following five years with no oil and gas bidding rounds, the Brazilian government authorized ANP to carry out three new bidding rounds.

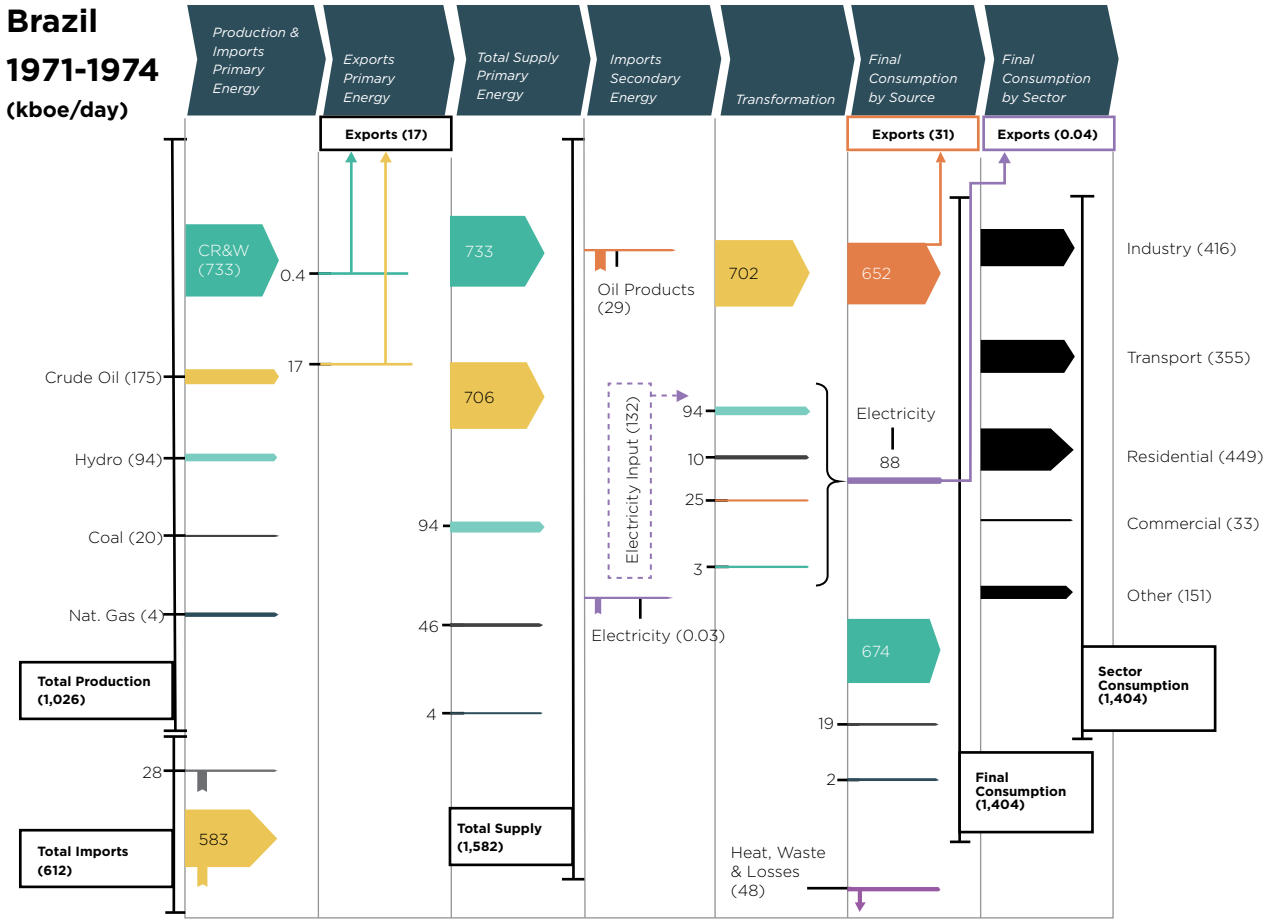
Biofuels

Brazil is the second-largest producer and consumer of biofuels in the world, after the United States, and is one of the world's top exporters of sugarcane ethanol fuel. Two main biofuels are used in transportation. The first is ethanol, produced from sugarcane and divided into two types: hydrated ethanol is consumed directly in engines developed for it or in flex fuel engines (in Brazil most vehicles are capable of running on pure ethanol or gasoline); anhydrous ethanol is blended with gasoline in proportions between 20 and 25 percent. The second type of biofuel used in transportation is biodiesel, which is produced from several vegetable species in Brazil (e.g., soybean, palm, sunflower) using a chemical process of trans-esterification and added to petro-diesel. The Program for the Production and Use of Biodiesel (PNPB) created by Law 11.097 (January 13, 2005) had the dual goals of increasing domestic production and consumption of biodiesel, and of decreasing socioeconomic inequality within and between regions. The new legislation promoted the introduction of biofuels to the Brazilian energy matrix, established a minimum blending requirement, and reduced taxes on biodiesel production.

The companies engaging in biofuel production are organized into an association called UNICA (União da Indústria da Cana-de-Açúcar), which includes 130 companies representing 50 percent of the ethanol and 60 percent of the sugar produced in the country. UNICA was formed in 1997 and has its main office in São Paulo with representatives in the United States and Europe.

ANP plays an important regulatory role related to biofuels, supervising the export, import, distribution, resale, and commercialization of biofuels. The agency is also responsible for fuel-quality and -supply guarantees in defense of the consumer's interest. Law 12.490/2011 added ethanol to the products whose production, distribution, and trade are regulated by ANP. For biodiesel, ANP specifies the product and regulates and supervises the activities related to its production, including the construction, modification, and operation of plants.

Evolution of the Energy Matrix



Editor: Ramón Espinasa (INE/ENE)
Authors: Lenin Balza (INE/ENE), Carlos Sucre (INE/ENE)
Source: Own calculations based on the IEA World Energy Balances.

1971–1974

In the early 1970s, Brazil had a high dependency on imported crude oil to supply its hydrocarbon sector. Local crude production contributed only 25 percent of the total crude supply. The country obtained most of its electricity from renewable sources; during this period, hydropower accounted for 71 percent of Brazil's electricity generation.

Total Energy Consumption

Brazil's total energy consumption reached 1,648 kboe/d between 1971 and 1974. The two largest energy sources were renewable fuels (733 kboe/d, 44 percent), with all supplies coming from domestic production, and petroleum products (741 kboe/d, 44 percent), with most coming from imports (583 kboe/d). The remainder was supplied mostly by hydropower (94 kboe/d), followed by coal and gas.

In response to the oil crises of 1973–1974, the country developed a strategy to reformulate its supply policy, intensify petroleum prospecting, and increase electricity generation from hydropower and nuclear fuels. One of these initiatives was Pro-Álcool, launched in 1974 to replace gasoline in the transportation sector with hydrated ethanol from sugar cane.

Electricity

During this period, power generation consumed on average 132 kboe/d, of which 71 percent came from domestic hydropower, followed by oil products (19 percent) and coal (9 percent). From these fuel inputs, the country generated 61,290 GWh, of which the vast majority came from hydropower, with 54,362 GWh (89 percent, as a result of its high efficiency levels), followed by oil products, with 4,611 GWh (8 percent).

Table 13

Electricity Inputs and Generation by Source

1971-1974	Sources (kboe/d)	%	Generation (GWh)	%
Coal	10	8	1,518	2
Oil Products	25	19	4,611	8
Natural Gas	0	0	0	0
Hydropower	94	71	54,362	89
Biofuels and Waste	3	2	799	1
Total	**132**	**100**	**61,290**	**100**

Source: Own calculations based on IEA energy balances.

Final Consumption by Sector and Source

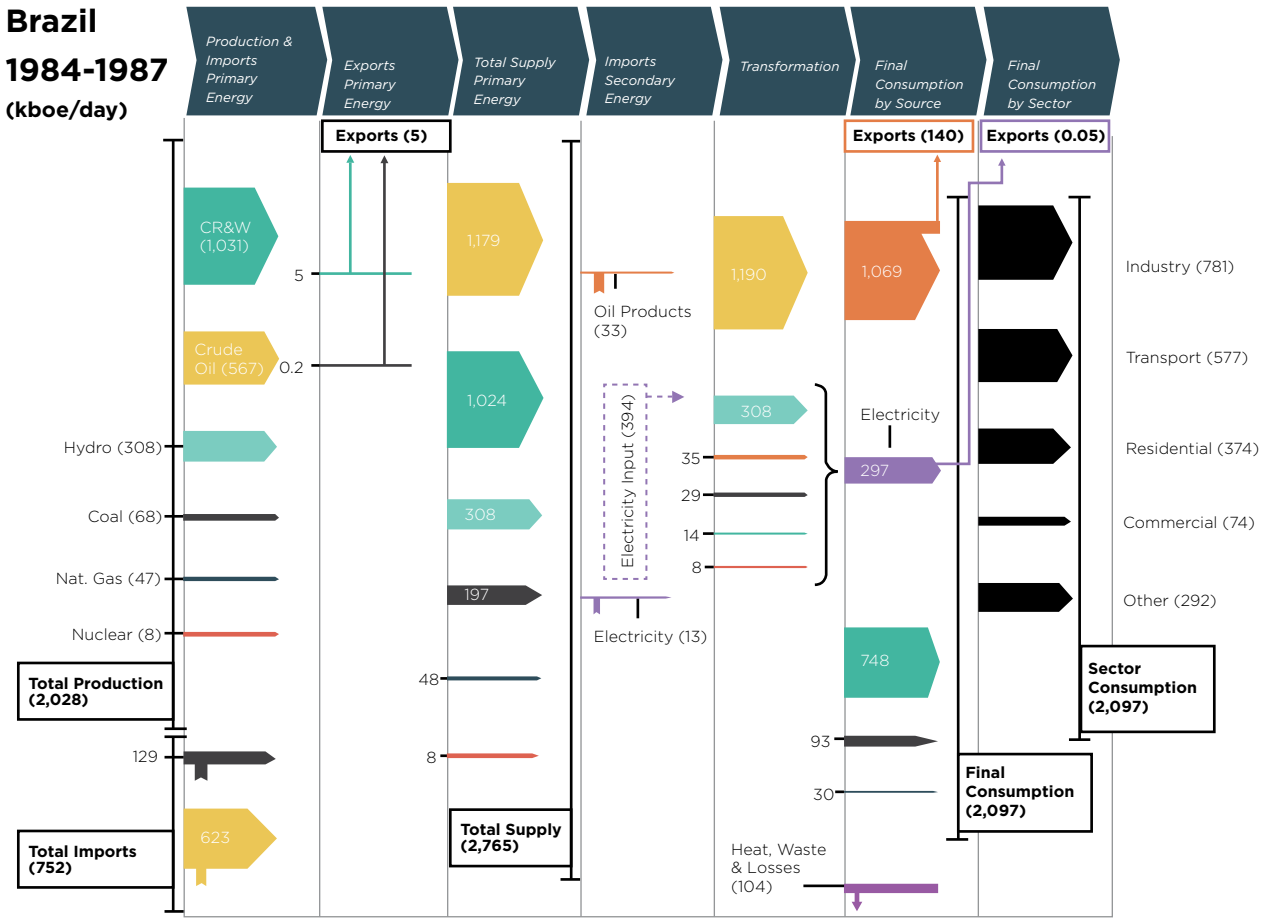
From 1971 to 1974, average annual total consumption by sector was 1,404 kboe/d. The residential sector was the largest energy consumer in the country, with a demand of 449 kboe/d (32 percent of total consumption). Most of this was supplied by renewable energy from hydropower generation (86 percent). The second-largest sector was industry, at 416 kboe/d (30 percent of total consumption), also supplied by renewable energy (45 percent) and oil products (39 percent). The transportation sector was the third largest, at 354.8 kboe/d (25 percent of total consumption). The vast majority of the energy consumed by this sector was supplied by refined oil products.

Table 14

Consumption by Sector and Source

Source/ Sector	Industry	Transport	Residential	Commercial	Others
Coal	3.7%	0%	0.5%	1.3%	0.7%
Oil Products	39.4%	98.7%	9.1%	22.5%	38.95%
Natural Gas	0.2%	0%	0%	0%	0.6%
Renewable Energy	45.2%	1%	86.4%	14.2%	59.25%
Electricity	11.5%	0.3%	4.1%	62.1%	0.6%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Own calculations based on IEA energy balances.



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Source: Own calculations based on the IEA World Energy Balances.

1984–1987

In the mid-1980s, Brazil made significant progress in increasing its domestic production of crude oil, from an average of 175 kboe/d to 567 kboe/d, but it also expanded its production of renewable fuels. As a result, the balance between renewable and hydrocarbon fuels remained broadly constant, with equal contributions from the two types of fuels. When Angra 1 launched its operations in 1985, nuclear energy became part of the country's energy mix.

Total Energy Consumption

Brazil's total energy consumption reached 2,808 kboe/d during this period. Compared to 1971–1974, renewable fuels had increased 40 percent to 1,026 kboe/d, and crude oil had increased 61 percent to 1,190 kboe/d. Following the discovery of large offshore oil fields in the Campos Basin, the volume of domestic production increased threefold while imports remained stable. The country also increased its use of coal and started exporting renewable fuels and small quantities of refined oil products.

Electricity

In this period, Brazil increased its electricity generation threefold over the previous decade. Hydropower remained the largest energy source, supplying 78 percent of the country's electricity, an increase of 7 percentage points from the previous decade. Because of its high efficiency, hydropower produced 178,246 GWh (equivalent to 272 kboe/d, or 91.6 percent of generation consumption). The power sector benefited from the inauguration of the megadam Itaipu but also became more diverse with the introduction of nuclear power to the matrix energy following the opening of Angra 1.

Cuadro 15

Electricity Inputs and Generation by Source

1984-1987	Sources (kboe/d)	%	Generation (GWh)	%
Coal	29	7	5,096	3
Oil Products	35	9	6,312	3
Natural Gas	0	0	0	0
Hydropower	308	78	178,247	92
Nuclear	8	2	1,535	1
Biofuels and Waste	14	4	3,443	2
Total	**394**	**100**	**194,633**	**100**

Source: Own calculations based on IEA energy balances.

Final Consumption by Sector and Source

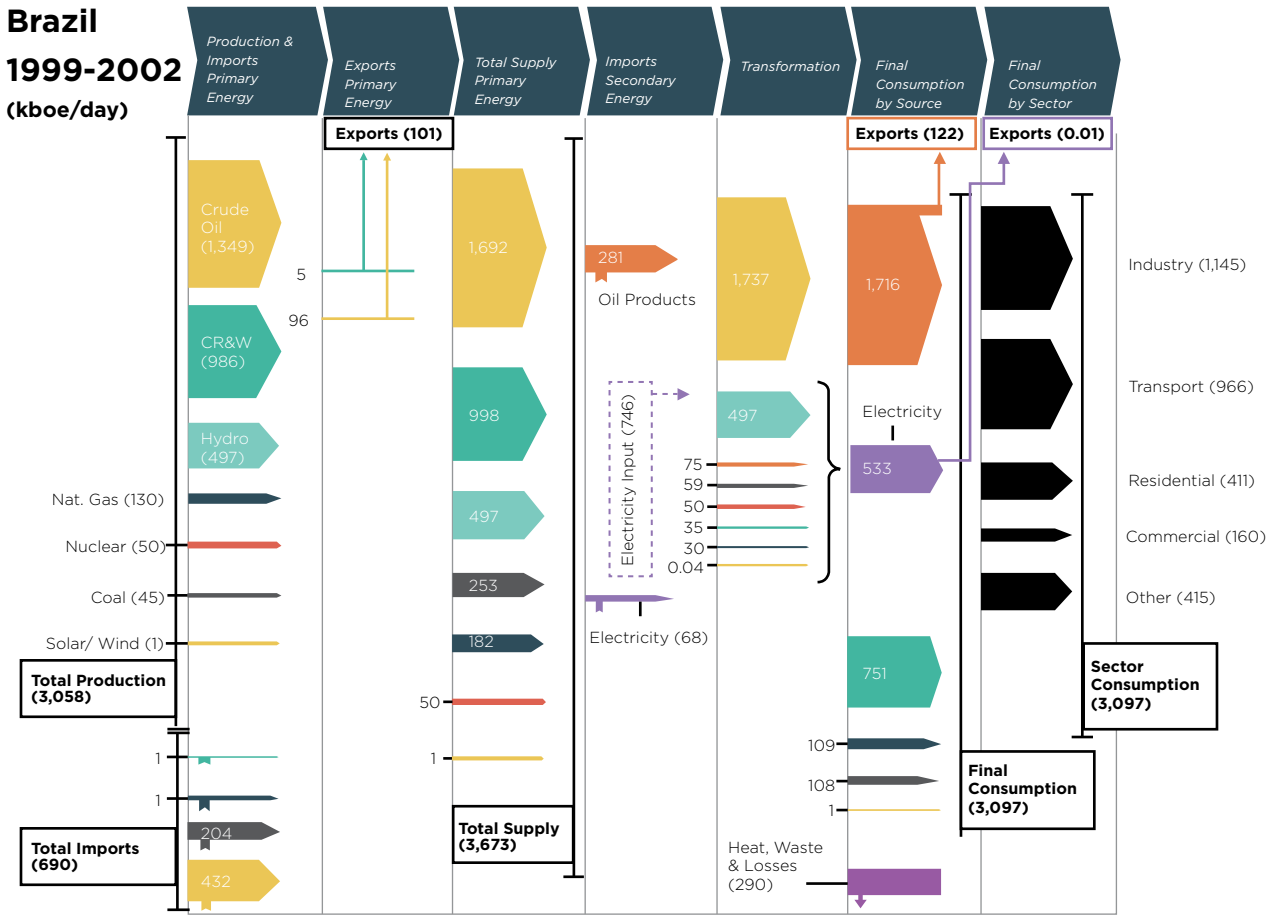
During the period 1984–1987, the average annual consumption by sector was 2,098 kboe/d. Industry surpassed the residential sector as the largest consumer of energy, with an average consumption of 780.9 kboe/d (37 percent of total consumption). The largest part of the energy used in this sector came from renewable fuels (46.8 percent), followed by electricity (21.7 percent). The second-largest consumer was the transportation sector, with an average consumption of 576.9 kboe/d (27 percent of total consumption), mostly sourced from oil products (83.1 percent). The residential sector followed, with a consumption of 373.82 kboe/d (18 percent of total consumption), mostly supplied by renewable energy (61.5 percent).

Table 16

Consumption by Sector and Source

Source/Sector	Industry	Transport	Residential	Commercial	Others
Coal	10.9%	0%	0.7%	1.4%	1.4%
Oil Products	18.9%	83.1%	21.9%	13.2%	71.9%
Natural Gas	1.7%	0%	0%	0%	5.7%
Renewable Energy	46.8%	16.5%	61.5%	6.5%	18.2%
Electricity	21.7%	0.3%	15.9%	78.9%	2.8%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Own calculations based on IEA energy balances.



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Source: Own calculations based on the IEA World Energy Balances.

1999–2002

At the turn of the century, energy flow in Brazil was marked by four main trends: the continued expansion of hydropower generation, the significant increase in domestic oil production (mostly offshore), the introduction of natural gas through the Bolivia–Brazil pipeline, and the introduction of new renewable sources such as wind energy. In 2001–2002, the country also faced a period of compulsory electricity rationing of about 20 percent, implemented by the government to reduce electricity demand.

Total Energy Consumption

Brazil's total energy consumption reached 3,996 kboe/d during the years 1999–2002. The growth in demand was met by an increase in petroleum use, mostly from internal sources, as domestic production more than doubled during this period, from 0.6 to 1.3 Mboe/d, while imports declined from 0.6 to 0.4 Mboe/d. Natural gas use also expanded considerably; the total volume (including imports) increased more than threefold, albeit from a low starting point.

Electricity

In this period, the most notable shift was the reduction of hydropower's share in the energy matrix. Brazil faced severe droughts that affected the reservoir levels of its rivers and dams and reduced its capacity for hydropower generation (by 6.7 percentage points compared to the 1984–1987 period). This reduction was offset by the introduction of natural gas, nuclear power, and renewable energy fuels, which together contributed 25,468 GWh during this period.

Table 17

Electricity Inputs and Generation by Source

1999-2002	Sources (kboe/d)	%	Generation (GWh)	%
Coal	59.4	8	10,560	3.1
Oil Products	75.1	10.1	15,240	4.5
Natural Gas	29.9	4	7,339	2.2
Hydropower	497.3	66.6	287,919	84.9
Renewables	34.7	4.6	8,595	2.5
Nuclear	49.9	6.7	9,534	2.8
Others	<0.1	<1	25	<1
Total	**746.3**	**100**	**339,212**	**100**

Source: Own calculations based on IEA energy balances.

Final Consumption by Sector and Source

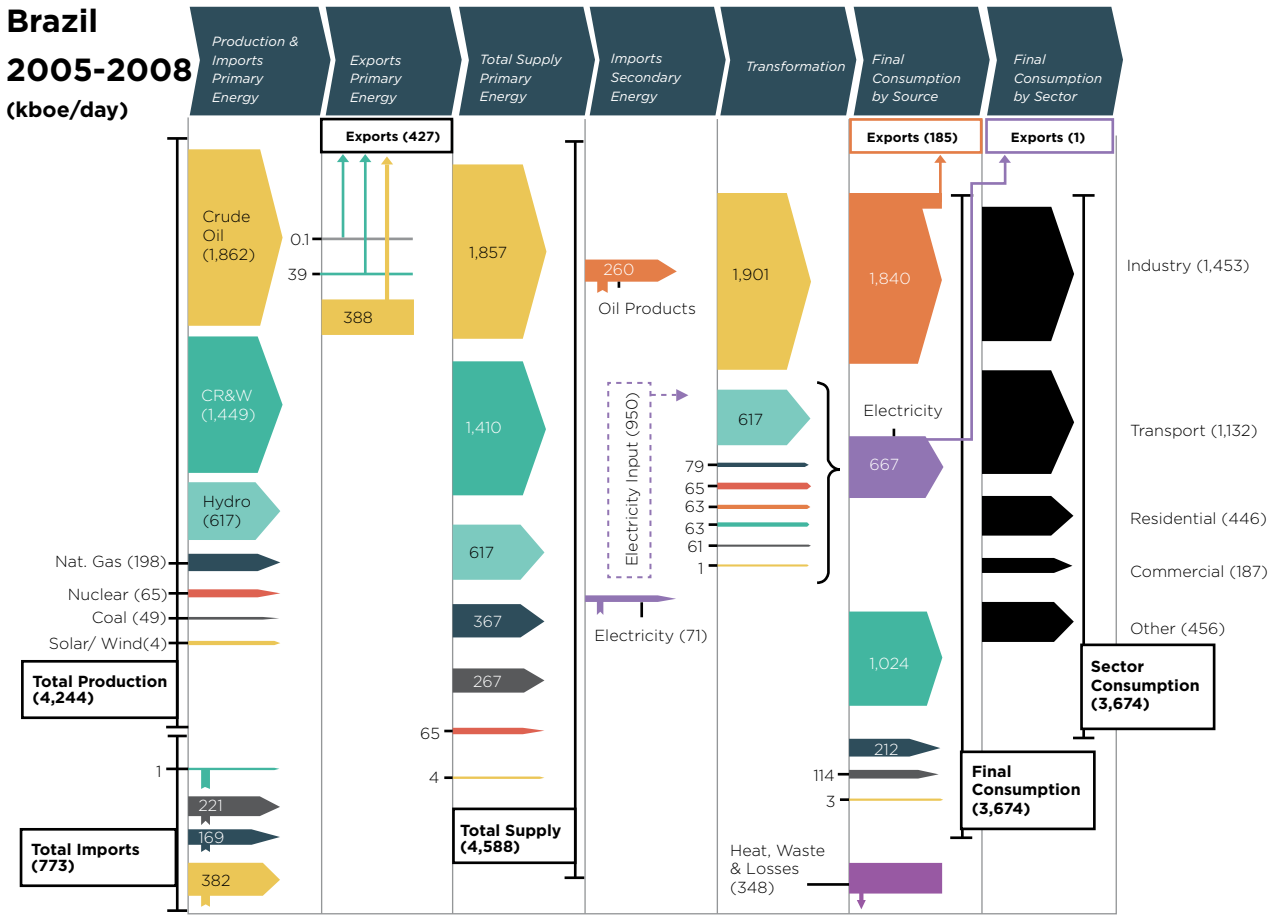
Between 1999 and 2002, the average annual total consumption by sector was 3,096 kboe/d. As in the previous period, the industrial sector was Brazil's largest energy consumer, using an average of 1,145 kboe/d (37 percent of total consumption), supplied mostly by renewable energy (38.9 percent), electricity (21.7 percent), and oil products (23.1 percent). The second-largest sector was transportation, with a consumption of 966.3 kboe/d (31 percent of total consumption), mostly sourced from oil products (86.2 percent). The residential sector followed with a consumption of 410.5 kboe/d (13 percent of total consumption), supplied almost equally by renewable energy (35.7 percent), electricity (32.7 percent), and oil products (30.9 percent).

Table 18

Consumption by Sector and Source

Source/Sector	Industry	Transport	Residential	Commercial	Others
Coal	9.2%	0%	0%	0%	0.6%
Oil Products	23.1%	86.2%	30.9%	17.6%	82.4%
Natural Gas	7.1%	0.9%	0.7%	1.6%	3.3%
Renewable Energy	38.9%	12.7%	35.7%	1.7%	8.4%
Electricity	21.7%	0.2%	32.7%	79.1%	5.3%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Own calculations based on IEA energy balances.



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Source: Own calculations based on the IEA World Energy Balances.

2005–2008

In the early 21st century, Brazil continued expanding its hydropower generation, increasing domestic oil production, and pursuing the full utilization of renewable fuels. During this period, the country inaugurated the last units of the Itaipu dam and greatly reduced its dependency on foreign crude oil and refined products. In 2006, Petrobras achieved self-sufficiency in oil and gas production, with platforms P-34 and P-50 going on-stream, and produced an average of 1.9 Mboe/d.

Total Energy Consumption

During the period 2005–2008, Brazil's total energy consumption was 4.9 Mboe/d, representing an increase of 0.9 Mboe/d in just a few years. This increase was met by higher domestic production of crude oil (+0.5 Mboe/d) and renewable fuels (+0.5 Mboe/d).

The country balanced its export and import of crude oil and became a net exporter of a small volume of crude. The shares of energy supplied by hydropower and other renewable sources were kept constant during this period.

Electricity

One important shift was the expansion of thermoelectric plants and a greater use of natural gas, which more than doubled from 7,739 GWh (1999–2002 average) to 20,447 GWh. Hydropower remained the largest source of electricity, producing an average 357,458 GWh (82.6 percent of total generation). Coal and oil products reduced their share in the electricity energy matrix. Brazil thus produced 86.6 percent of its electricity from renewable energy sources, 10.5 percent from fossil fuel sources, and 2.9 percent from nuclear plants.

Table 19

Electricity Inputs and Generation by Source

2005-2008	Sources (kboe/d)	%	Generation (GWh)	%
Coal	61.3	6.5	11,054	2.6
Oil Products	63.2	6.7	13,872	3.2
Natural Gas	79.2	8.3	20,447	4.7
Hydropower	617.2	65	357,458	82.6
Renewables	62.9	6.6	16,988	3.9
Nuclear	65.3	6.9	12,482	2.9
Others	0.6	0.1	370	0.1
Total	**949.9**	**100**	**432,670**	**100**

Source: Own calculations based on IEA energy balances.

Final Consumption by Sector and Source

In the period 2005–2008, the average annual total consumption by sector was 3,674 kboe/d. Following the trend of the previous decades, the industry sector remained Brazil's largest energy consumer, with an average of 1,452 kboe/d (40 percent of total consumption), supplied mostly by renewable energy (43.4 percent), electricity (22.3 percent), and oil products (16.5 percent).

The second-largest consumer remained the transportation sector, with an average consumption of 1,132.3 kboe/d (31 percent of total consumption), mostly sourced by oil products (81.1 percent). The residential sector followed with a consumption of 446.2 kboe/d (12 percent of total consumption), supplied almost equally by renewable energy (38.4 percent), electricity (34.4 percent), and oil products (26.3 percent).

Table 20

Consumption by Sector and Source

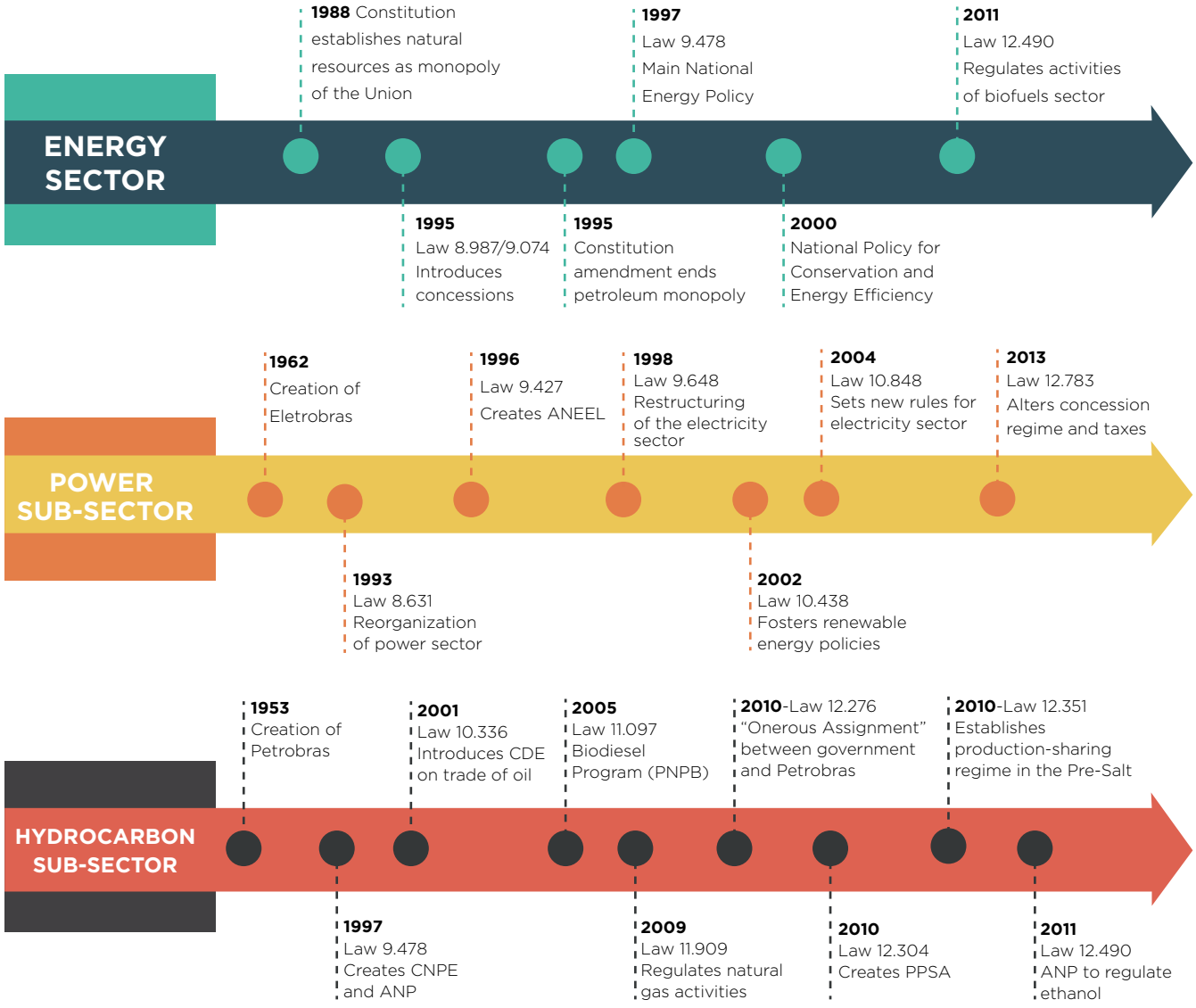
Source/Sector	Industry	Transport	Residential	Commercial	Others
Coal	7.6%	0%	0%	0%	0.7%
Oil Products	16.5%	81.1%	26.3%	11.4%	78.5%
Natural Gas	10.2%	3.4%	0.9%	2.8%	3.4%
Renewable Energy	43.4%	15.2%	38.4%	1.6%	10.9%
Electricity	22.3%	0.2%	34.4%	84.2%	6.4%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Own calculations based on IEA energy balances.

Institutional Evolution of the Energy Sector

Figure 9

Historical Evolution of the Regulatory Framework in the Power and Hydrocarbon Sectors



Source: Own elaboration.

The history of the energy sector in Brazil is divided into three phases. The first lasted from the early 20th century to the mid-1950s, when Petrobras and Eletrobras were established. The second lasted from the mid-1950s to 1997 and the reforms liberalizing the economy. The last phase runs from 1997 to the present.

Early Years Up to the 1950s

In the early decades of the 20th century, nations around the world began to realize the significance of oil production as an essential input to industrial development. The Brazilian government started by granting private citizens the right to extract oil and bitumen for use in street lights. However, not many investments were made, as national companies lacked access to technology and financing, and multinational companies dominated the sector. The stock market crash of 1929 and the Great Depression had severe effects on the Brazilian economy: coffee exports plummeted, the country's gold reserves were depleted, and it became apparent that the country needed to develop the energy sector to fulfill its domestic industrialization program.

Establishment of the National Council of Petroleum (CNP)

The first major Brazilian legislation in the oil sector was adopted in 1938 (Decree 395), when President Vargas sought to advance Brazil's industries by intensifying governmental controls, and in particular by creating a domestic oil industry and only allowing national companies to have refineries. In 1939, he established the National Council of Petroleum (Conselho Nacional do Petróleo, or CNP), which fostered the creation of research agencies and led to the discovery of new reserves, a fact that generated great national pride. Overall, this period was characterized by the aim of transforming an incipient and informal oil sector into a more professional and structured industry. For example, by the 1940s CNP oil production still supplied less than 10 percent of domestic consumption.

1950s to 1997: Energy Expansion to Support Economic Development

Creation of Petrobras (1953)

Owing to the extended fuel shortages and large imports caused by World War II, petroleum was one of the priorities in the constitutional debates of the 1950s. Energy nationalism shaped the discourse and led to greater state control over most aspects of the sector. In 1953, Petrobras was established as the company to develop the domestic supply of petroleum and control a national oil monopoly on behalf of the state.

The company was created by Law 2.004 (October 3, 1953) and incorporated on March 12, 1954, with the assets from the CNP, inheriting two refineries, the Mataripe (BA) and Cubatao (SP). In May 1954, Petrobras commenced operations, producing 2,663 barrels, equivalent to 1.7 percent of domestic consumption. The same law stipulated that the oil monopoly would be supervised by the CNP.

The creation of Petrobras originated with a democratic process and was summarized by President Vargas as follows: "It is therefore with great satisfaction and patriotic pride that I sanctioned the bill approved by the legislature, which is a new milestone in our economic independence." President Vargas also created other national companies in strategic sectors such as mining (CVRD 1942, later Vale) and the national development bank BNDES (1952).

During the 1950s and 1960s, the company achieved significant growth. This included building its first refinery, which allowed the country to improve its self-sufficiency in oil products, and introducing in 1961 the concept of "from the well to the service station." In 1967, the company focused on transforming naphtha into ethane, leading the way to developing a domestic petrochemical sector. In 1968, Petrobras made its first offshore oil discovery in Sergipe, part of the shallow continental shelf, and created Cenpes (Centro de Pesquisas Leopoldo Américo Miguez de Mello) to meet the country's technology demands. This later became Latin America's biggest research and development center.

From 1964 to 1985, the country was governed by a military regime. There was strong economic development during the early years of the regime, leading to an increasing demand for petroleum products. In the early 1970s, Brazil's GDP was growing at around 10 percent annually, and Petrobras followed the same expansion pattern, making large investments in R&D, growing the downstream sector, and going international.

In 1976–1979, the government signed the first contracts (based on risks) with the private sector, and several national and international oil companies began oil explorations in Brazil, although with only low levels of activity. These included Shell, Exxon, Texaco, BP, ELF, Total, Marathon, Conoco, Hispanoil, Pecten, and Pennzoil, as well as local companies such as Camargo, Correa, and Paulipetro. However, the establishment of the new constitution in 1988 restricted these activities and discontinued this type of contract.

Creation of Eletrobras (1962)

In 1961–1962, legislation was introduced establishing the state-owned holding company Eletrobras. The company was originally proposed in 1954 by then-President Vargas to develop a solid electricity sector in Brazil in response to the country's rapid urbanization and industrialization. At the beginning of the 1950s, a few foreign companies dominated the electricity market in the main Brazilian cities.

Following the introduction of Law 3.890-A (April 25, 1961), Eletrobras started its operations on June 11, 1962, under President Goulart, after several years of deliberations in the National Congress.

Following a series of institutional reforms in several sectors of the Brazilian economy to reduce the size of the government, in 1995 President Cardoso included Eletrobras in the National Privatization Program (PND), but later Presidents Lula and Rousseff removed the company and several of its affiliates, including Chesf, Eletronorte, Eletrosul, and Furnas.

Eletrobras now has a total generation capacity of 42,987 MW (34 percent of the national capacity) and owns about half the transmission lines in the country with tensions greater than 230kV. The company also has significant investments planned for new generation and transmission, including large projects such as the Belo Monte hydroelectric dam complex. The company also supports several strategic government programs, such as the program for fostering alternative electric power sources (Proinfa), the Rural Electrification Program, and the National Program for the Conservation of Electric Power (Procel).

Establishment of the Pro-Álcool Program

Brazil has a long and established program of systematically using ethanol from sugarcane for automotive fuel. Starting in the 1930s (Decree 19.717/1931 established 5 percent mandatory acquisition of ethanol for all imported gasoline) and continuing until the 1970s, hydrated ethanol was converted to anhydrous ethanol to be blended with gasoline. In 1933, President Vargas created the Sugar and Alcohol Institute (Instituto do Açúcar e do Álcool, or IAA) to regulate the activity and set production quotas and norms (Decree 22.789 of June 1, 1933, created IAA, and Decree 22.981 of July 25, 1933, created its regulations).

Following the oil crises of the early 1970s, the government introduced an aggressive program to reduce the country's dependence on imported fuels, and Decree 76.593 (November 14, 1975) created the National Alcohol Program (Programa Nacional do Álcool, or Pro-Álcool), the largest transportation fossil fuel substitution initiative in the world. The program started by fixing a 4.5 percent ethanol mixture in gasoline, with the ultimate goal of a 20 percent mixture, but this percentage varied considerably over the decades. (For example, blending reached 46 percent in 1942–1946, during World War II, due to limitations on fuel imports, and during the period of low international prices in the 1950s and '60s, blending ranged from 3 percent to 7 percent.)

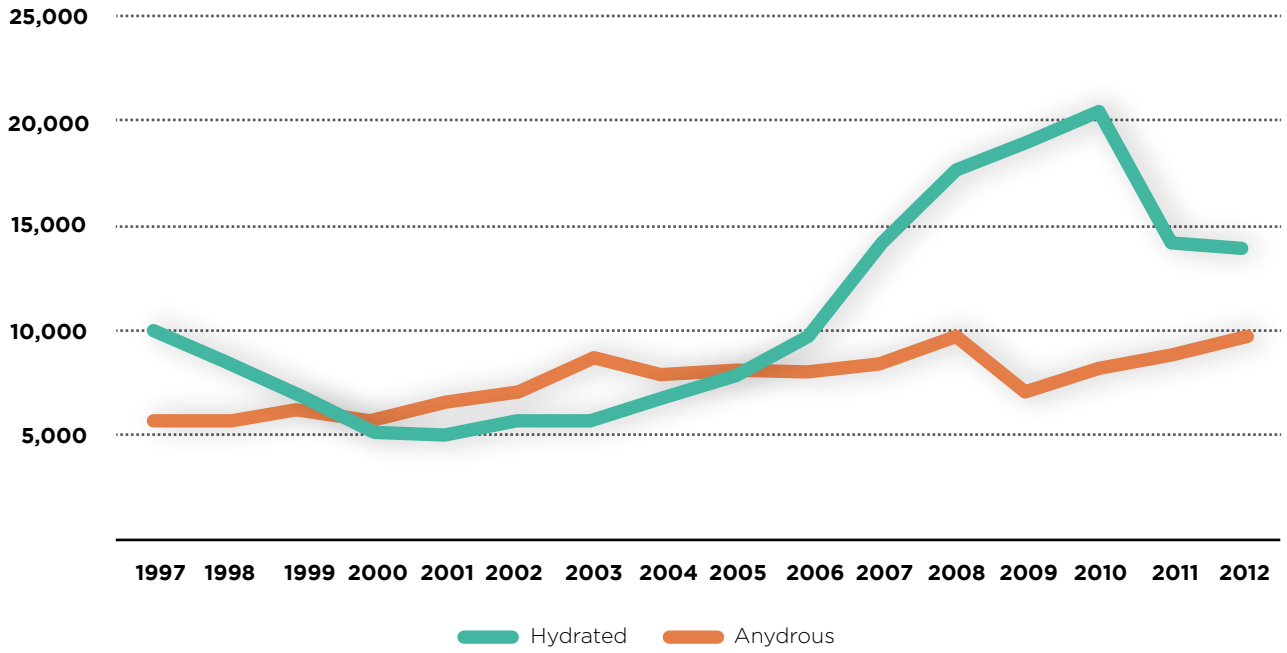
Decree 83.700/1979 included the expansion of sugarcane fields and, for the first time, the requirement to produce and use hydrated ethanol (E100) as a substitute rather than a gasoline additive. The new policy required passenger cars to be built to run on ethanol, and led to a nationwide distribution network to supply ethanol at all service stations. In 1984, ethanol-burning cars accounted for about 95 percent of total production.

In the late 1980s and the 1990s, the Pro-Álcool Program was affected by a decline in international oil prices and a strong demand for sugar, which made exports more attractive. The program was deregulated by the government, most of the incentives were removed, prices were liberalized, and production quotas were removed. In 1990, the IAA's roles were transferred to the newly established Inter-Ministerial Sugar and Alcohol Council (Conselho Interministerial do Açúcar e do Álcool, CIMA), and in 1997 the CNPE and ANP became the policy and regulatory authorities respectively.

Following the deregulation of the fuel market, the country was able to leverage several aspects of the Pro-Álcool Program, such as the well-established logistics network of distribution and retail sites, the investments in research and development, the development of a sustainable fuel for transportation, and the improvement of trade balances. Moreover, the introduction of flex fuel cars provided flexibility for consumers and consolidation for car manufactures, who could combine the previously separate assembly lines for the two types of fuel. The flex fuel cars also brought stability back to the market and increased consumers' confidence. Following the reduced production levels of the late 1990s, ethanol production grew during the following decade.

Figure 10

Ethanol Domestic Production (thousand cubic meters)



Source: ANP (2013).

The challenges now facing the ethanol industry in Brazil are related to the price structure—although ethanol prices are deregulated throughout the value chain, they are affected by the domestic prices of the gasoline used by Petrobras, and by weather-related events that can affect production. The integration of the global markets and the development of second- and third-generation biofuels that are economically viable and allow large-scale commercialization will also contribute to further scaling up of the production of biofuels.

Constitution of 1988

Following the 1985 transition out of the military regime, the country started a congressional process to write a new constitution. On October 5, 1988, the new constitution was approved by Congress, introducing significant changes to social, labor, civil rights, economic, and institutional legislation.

Implications for the Energy Sector. Broadly speaking, the new constitution strengthened the role of the state and expanded its legislative powers to reflect the democratic values of the new era. On the energy side, the new constitution established a monopoly over the exploration of subsoil and over mining and petroleum-related economic activities. Most of the implications for the oil, gas, and electricity sectors were described in Articles 175, 176, and 177.

Moreover, Article 25, Paragraph 2 says, "The states shall have the power to operate, directly or by means of concession, the local services of piped gas, as provided for by law, it being forbidden to issue any provisional measure for its regulation."

Other passages of the constitution relevant to the energy sector are Article 173, which says, "The direct exploitation of an economic activity by the States shall only be allowed when necessary for national security requirements or for a relevant collective interest, as defined by law," and Article 174, which declares that the states will exercise the functions of monitoring, providing incentives, and planning, as normative and regulatory agents of the economic activities. Article 174 also confirms that the planning activities of the state cannot be delegated.

The 1988 constitution also introduced new economic, financial, and taxation regimes that affected the electrical sector. Examples include the termination of the compulsory loans to Eletrobras (to come into effect after five years), the immediate extinguishing of the Imposto Único sobre Energia Elétrica (IUEE), increases in the corporate tax rates, and the introduction of a fee to provide financial compensation ("royalties") to benefit the municipalities of areas inundated. These legislative changes and new charges increased the operational costs of the companies in the power sector, hampering their financial capacity to dedicate resources to future investments.

Regulatory Aspects: Price Deregulation of Refined Products

In the 1990s, Brazil began introducing a gradual and progressive price and margin liberalization in the downstream sector, which led to the current situation in which prices are based on market conditions and defined exclusively by the economic agents.

The main actions and legislations leading to full price deregulation were as follows:

Table 21

Actions and Legislations towards Price Deregulation

Date	Pricing Decisions
1990s	•Lubricants and kerosene are liberalized for end consumers (1991) •Gasoline for airplanes is leberalized for end consumers (1993)
1996	•Liberalization of ethanol and gasoline for end consumers
1997	•Establishes period of 36 months to conclude liberalization of all prices of oil products •ANP takes over activities performed by Departamento Nacional de Combustíveis (DNC) •Asphalt is liberalized to end consumers
1998	•Establishes new price structure for crude oil and oil products •Starting August 1, 1998, prices for oil products fluctuated according to international conditions •Liberalization of LPG for end consumers
1999	•Liberalization of gasoline and fuel oil at refinery gates
2000	•Establishes date of December 31, 2001, to conclude liberalization process (Law 9.990/ 2000) •Liberalization of naphtha for petrochemicals at refinery gates
2001	•Final liberalization and deregulation of oil products on January 1, 2002 •Introduction of Contribuição de Intervenção no Domínio Econômico (CIDE, Law 10.336/2001) •Companies are allowed to produce, sell, import and export refined products in Brazil

Source: Own elaboration.

Moreover, as part of the deregulation process, ANP has taken on an increasingly broad oversight role regarding the supply of products, price monitoring, and construction and operation of activities of commercialization (Laws 9.478/1997, 9.847/1999, 11.097/2005, and 12.490/2011).

From 1997 to Today: Reforms for the 21st Century

In the late 1980s and early 1990s, Brazil faced challenging economic conditions. The country confronted near-stagnation in real income per capita, high inflation fed by indexation, low economic growth, and recurring balance-of-payments crises. In 1994, the country stabilized the economy with the "Real Plan" developed by then-Finance Minister Henrique Cardoso, who later as president promoted a series of far-reaching initiatives to implement fiscal austerity, reform the financial system, modernize the state, and reduce the size of government.[2] The reforms started with Presidents Collor and Cardoso, who led two rounds of privatization in core sectors of the economy such as telecommunications, energy, and mining, which required the establishment of solid and transparent regulatory frameworks for the new market-oriented economy. The National Privatization Program (PND) established by Law 8.301 in 1990 was one of the main legislative actions to enable these reforms.

In 1995, an important piece of federal legislation introduced greater liberalization to the energy sector by allowing the government to work with private and public companies to promote activities in the oil and gas sector.[3] Although the 1988 constitution reaffirmed the state's monopoly in this sector, Amendment 9 (November 9, 1995) altered Article 177 and enacted several reforms, including relaxing Petrobras's monopoly and permitting the federal government to contract with either private or state-owned companies to carry out research, exploration and production, refining, transportation, and distribution of hydrocarbons, and import and export of oil.

Two years later, in 1997, a new milestone was achieved. President Cardoso's reforms introduced the concession system and eliminated the Petrobras monopoly. The federal government did keep a majority voting share (51 percent) in the company, but it permitted private and public companies to explore the country's reserves. The same year, Brazil became a net exporter of crude oil, which gave the country great pride.

Law 9.427 (December 26, 1996) created ANEEL (the electricity sector regulator), and Law 9.478 (known as the Petroleum Law, August 6, 1997) disposed of the activities related to the petroleum monopoly, created ANP, and created CNPE as a new policy-setting inter-ministerial committee to advise the president on the energy sector. The following table summarizes the main changes introduced by Law 9.478/1997 to the oil and gas market:

[2] These reforms were also consistent with Brazil's admission to the World Trade Organization (WTO). The country has been a member of the WTO since January 1, 1995, and a member of GATT since July 30, 1948.

[3] The constitutional amendment also assured that foreign investors in Brazil would receive the same legal treatment as local investors in most economic sectors, and prohibited any form of discrimination not foreseen in the law. At that time, the sectors with restriction on foreign investors were health, mass media and telecommunication, aerospace, rural property, and maritime and air transport.

Table 22

Changes Introduced by Law 9.478/1997

Activity	Sub-Sector	Before 1997	After 1997
Exploration*	E&P	Petrobras	Competitive market
	Geological Survey	Petrobras	Proprietary surveys (SPEC)
	Databank (Geological and Geophysical)	Petrobras	ANP's Shared National Database
Midstream	Refining	Petrobras (excpet Article 43, Law 2000/53	Competitive market under ANP authorization
	Transportation	Petrobras	Unbunduling Open access New agents
	Import and Export	Petrobras	Free under approval: ANP (petroleum) and MME (gas)
Downstream (Oil Products and CNG)	Wholesale	208 distributors	315 distributors under ANP authorization
	Retail	"Brand fidelity" 23,900 service stations	Indepentent retailers ANP authorization 85,390 service stations

*Union monopoly: concession and authorization granted by the state.

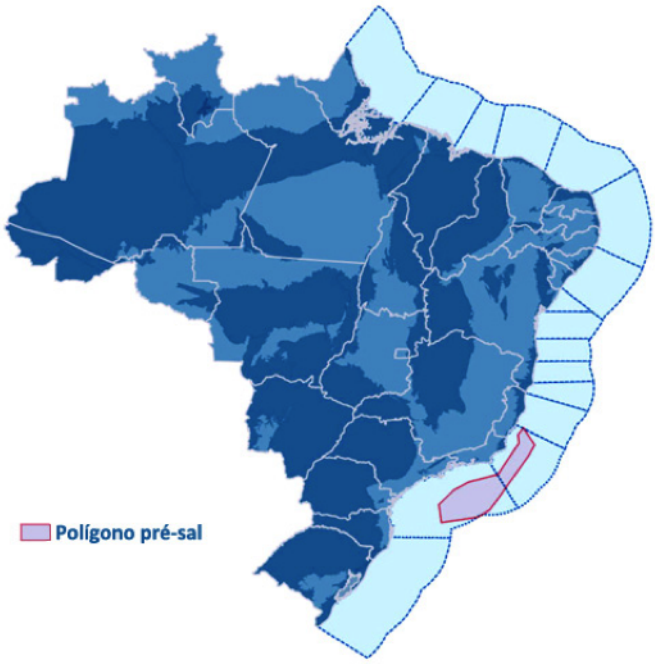
Source: ANP (2013).

Recent Reforms Following the Discovery of Pre-Salt Reserves

The rise in oil prices and the discovery of large hydrocarbon deposits off the Atlantic coast prompted the federal government to introduce further regulatory changes to the petroleum sector. These deposits, known as pre-salt polygon, are located 300 kilometers offshore under a 2,000-meter-thick layer of salt. They measure about 800 kilometers by 200 kilometers, totaling 149,000 square kilometers. Estimates of the total pre-salt reserves vary widely, but it is thought they could reach 100 billion barrels of oil equivalent.

Figure 11

Offshore Boundaries and Pre-Salt Area



Source: ANP (2013).

In 2010, following a long legislative process, President Lula signed three laws approved by Congress for establishing a new regulatory framework in the Brazilian oil and gas sector. These laws created the following:

- Production-Sharing System (PSA Law)
- Pré-Sal Petróleo S.A.(PPSA)
- A new onerous assignment regime

Production-Sharing System (PSA Law). The introduction of the Production-Sharing Agreement (PSA) regime was an important component of Law 12.351 (December 22, 2010). In this legislation, the federal government argued that PSAs were more suitable for large but low-risk reserves (e.g., the pre-salt polygon), while concessions were better for smaller, more risky activities.

This new legislation presented the PSA regulatory regime for the pre-salt areas and strategic areas, providing that the union, represented by the MME, enters into agreement directly with Petrobras, with or without a prior public bidding procedure being conducted by ANP. Under the PSA, Petrobras is the operator of all blocks and has a minimum participation interest of 30 percent in new consortiums; the remaining 70 percent may be contracted to other companies through the bidding process. In practice, this percentage can be expanded, as the company can also participate in the bidding procedures. The CNPE will recommend to the president when to use each type of agreement.

It is important to mention that the introduction of the PSA Law did not alter the concession regime, which remains the official form of contract for areas outside the pre-salt area. Indeed, the concession regime still regulates 98 percent of the oil exploration area in Brazil's 27 sedimentary basins. Within the pre-salt polygon, however, the new regime applies not only to the stratigraphic horizons beneath the layer of salt, but to the particular geographic region regardless of depth.

The PSA Law also created a social fund as a source for regional and social development. This fund will finance programs for reducing poverty and improving development in such areas as education, public health, science and technology, culture and sports, the environment, and mitigation of climate change. Its income is from two sources: a part of the signing bonus paid by each company or consortium that wins the bid for the production sharing agreement; and royalties and resources from trading oil and gas produced under the production-sharing system.

Creation of Pré-Sal Petróleo S.A (PPSA). The 2010 legislation also provided for the incorporation of a new public company, Empresa Brasileira de Administração de Petróleo e Gás Natural S.A. (PPSA), to be fully owned by the union and the MME, to represent its interests and supervise the contracting companies (Law 12.304, August 2, 2010; later regulated by Decree 8.063/2013).

PPSA will take part in the Operating Committee, with half of its members having voting rights and veto powers, and in the consortium that carries out the operations under the PSA, although it will neither bear the costs and fees nor partake in gains from the activities. The new legislation also stipulates that PPSA will have no responsibility for the execution of the activities of exploration, development, and production, or trading of petroleum, natural gas, or other fluid hydrocarbons (Article 2).

According to this legislation, PPSA will: (i) submit all relevant information to ANP to perform its regulatory activities; (ii) monitor and audit operating costs and capital expenditures; (iii) approve qualified expenditures for the costs of oil recovery; and (iv) perform technical and economic analyses of plans and programs to be executed in each PSA. In sum, PPSA will play an active role in the PSA decision-making process in which high-level technological and operational complexity will be reviewed and decided on.

On administrative matters, the board of directors of PPSA will consist of five members to be nominated by the Ministries of Mines and Energy, of Finance, of Planning, and of Civil Housing and appointed by the president. On October 14, 2013, MME announced engineer Oswaldo Pedrosa Junior as the first president of PPSA.

Introduction of a New Onerous Assignment Regime. The third component of the 2010 regulatory reforms was the authorization of the "onerous assignment" of exploration and the transfer of rights from the federal government to Petrobras with the purpose of attracting new investment and capitalizing the company (Law 12.276, June 6, 2010).

Through this regime, the government remained Petrobras's main shareholder, with the majority of the voting rights (increasing its share, in fact, from 41 percent to 48 percent), but allowed the company to attract new investments through a public offering. In September 2010, the company raised $70 billion on the international market, in the largest international share sale in history.

As part of the "onerous assignment" process, specific areas and fields were identified, and the oil price per barrel (an average of $8.51/boe) and volumes were set for specific fields (e.g., South Tupi, Florim, Franco, Tupi NE, South Guara, and Franco were all definitive, and Petrobras a contingency) so that Petrobras could explore and produce up to 5 billion barrels of oil equivalent over the 40-year term of the contract (which could be extended by a maximum of five years).

To validate the transaction volumes, ANP contracted with an independent technical provider. The results were presented in the report "Review and Evaluation of Ten Selected Discoveries and Prospects in the Pre-Salt Play of the Deepwater Santos Basin, Brazil." Finally, under the Onerous Assignment Contract, Petrobras cannot transfer any of these rights.

Energy as Enabler of National Development (Local Content)

The Local Content (LC) initiative is part of a national policy to foster economic growth and the development of local suppliers. In the electricity sector, local content policies have been used, particularly over the past five years, to foster the wind energy industry by requiring companies installing wind turbines to source most of the turbine components from local suppliers. In 2012, BNDES introduced a methodology to finance wind turbine installation that requires at least 70% of parts and components of a wind turbine to have been locally produced and sourced. Similar, though less stringent, rules exist for the production of solar PV panels, regulating the share of glass, backsheet, EVA, or junction box that is produced in Brazil of a given panel.

In the petroleum sector, the LC initiative has been used to allow locally established goods and service providers—international or domestic—to participate in the supply chain at a competitive level. The system is intended to foster national industry growth, technological development, and skilled labor.

LC is not new to the oil and gas industry, and it has increased over time. Since the first bidding round in 1999, under the concession system, ANP has used LC as a ranking criterion when assessing proposals. Until Round 4 (2002), LC percentages were not required. In Rounds 5 and 6 (2003 and 2004), however, ANP established minimum percentages based on whether blocks were onshore, offshore in shallow water, or offshore in deep water. As of Round 7 (2005), contracts included minimum and maximum LC percentages for a set of items used in the development phases. These have been relatively stable in subsequent bidding rounds, including the first pre-salt bidding in 2013.

To ensure compliance with LC requirements, ANP monitors concessionary investments and activities regularly. Since 2007, it has used a certification system under which accredited firms are responsible for measuring and certifying the contents of goods and services on the basis of a government-created initiative called the Brazilian Program for Mobilization of the Oil and Gas Industry (Programa de Mobilização da Indústria Nacional de Petróleo e Gás Natural, PROMINP). In 2011, there were 21 ANP-accredited certification firms, which have issued more than 7,500 certificates to more than 400 local providers.

The government is also taking steps to foster the development of suppliers while reinforcing LC policies. The 1997 legislation led to the creation of the CTPETRO fund for investing in oil R&D activities and established the obligation for the most productive oil concessionaries to invest a portion of their total revenues in R&D programs.

Another initiative is REPETRO, a special tax regime adopted for operators and suppliers in the oil and gas sector to redress some of the international competitive disadvantages imposed on domestic suppliers by Brazil's complex tax systems and making them eligible for special financing terms from BNDES.

Research and Development (R&D)

Since 1988, the country has included a compulsory R&D investment clause in the concession contracts, and ANP forms such contracts on behalf of the union with the winning companies in the exploratory block bidding. The clause establishes that concessionary companies must invest in R&D to a value equal to 1 percent of the gross revenues generated by high-profitability or high-production volume fields (those that would be subject to "special participation"). It places the following conditions on resource allocation:

- Up to 50 percent of the total can be invested in R&D in the concessionary company's own facilities, its affiliates, or national companies
- At least 50 percent of the obligation value must be invested in R&D institutions accredited by ANP (Resolution 34/2005 and Technical Regulation 6/2005 establish the criteria for this accreditation)

According to ANP, from 1998 to 2013 the required R&D investments totaled about $3.9 billion (R$8.7 billion) for all the companies operating in Brazil.

By 2014, ANP had accredited 354 research centers and 73 institutions in Brazil to receive these investments. Most were federal and state public universities in several states around the country and listed on ANP's website. Research topics include both technical topics (e.g., exploration, production, or stratigraphic research) and multidisciplinary topics (e.g., sustainable development, innovation, and economic development). ANP monitors the use of these resources and the adequacy of the investments in relation to the technological development goals and the creation of new solutions for the oil, natural gas, and biofuels sectors.

The sector is also eligible for other incentives for technological and scientific research, as presented in Laws 10.973/2004 and 11.540/2007, which apply to other sectors of the Brazilian economy.

Recent Reforms in the Electricity Sector

In the 1990s, the government carried out a series of reforms designed to boost the competitive dynamics and efficiency of the electricity sector, reduce the risk of electricity shortfalls, and attract private funding to finance the expansion of the country's installed capacity. A secondary objective was to reduce Brazil's public sector debt and open the economy consistent with WTO principles after the country became a member on January 1, 1995.

During the 1960s and 1970s, electricity tariffs were calculated according to historical costs of power generation, transmission, and distribution, which were updated and calculated on the basis of service costs (cost plus regulation, with a certain guaranteed remuneration). Moreover, until 1995 the tariffs were equal for similar types of customers regardless of their locations. All commercial customers in the country had the same tariffs, and all residential customers had the same tariffs. The institutional reform introduced by Law 8.631/1993 eliminated this equalization among other important changes to the electric sector.[4]

In 1993, the introduction of the National Electricity Transmission System (Sistema Nacional de Transmissão de Energia Elétrica, or SINTREL, Decree 1.009, December 22, 1993; regulated by Portaria 337, April 22, 1994)[5] restructured the system and gave independent power producers (IPPs) open access to the transmission grids—that is, IPPs could generate their own electricity and share the excess with the grid. Moreover, Decree 915

[4] Before passing this legislation, the government promoted a special study called REVISE (Revisão Institucional do Setor de Energia Elétrica) in 1987–1988 that made technical recommendations to reform the sector, including opening it to private investors. While not all the recommendations were implemented, they became the basis for the restructuring of the sector.

[5] Portaria 337/1994 was later replaced by Portaria 459/1997, which made access to the transmission and distribution system free to all participants.

(September 1993) introduced more open relationships between concessionary companies and auto-producers. Finally, a few years later the government launched a privatization program focused on distribution utilities that allowed it to use cash proceeds from the asset sales to pay down external debt.

As part of these reforms, the Brazilian electricity sector was restructured to promote market competition and attract private investment and to break up the generation, transmission, and distribution activities traditionally performed by state companies. The reforms were initiated by the RESEB project (Reestruturação do Setor Elétrico Brasileiro, or Restructuring the Brazilian Electricity Supply Industry) led by the MME with an international consulting company that introduced new concepts to the industry, such as creation of IPPS, free access to transmission and distribution companies, and the creation of free consumers that could identify and select their own suppliers. In the mid-1990s, Laws 9.074 (1995) and 9.427 (1996) introduced the main elements of the reform of the electricity sector.

In early 2001, Brazil faced a severe drought and reduced reservoir levels caused by a shortage of rain. This led the government to intervene and introduce a compulsory rationing plan. Other structural factors also contributed to the rationing, such as low levels of long-term investment in the electricity system, which arose from short-term price volatility and a need for greater coordination among the main institutions in the sector. From June 2001 to February 2002, consumers were asked to reduce their electricity demand by 20 percent and to implement energy-efficiency measures; these actions too affected the scale and financial situation of the sector, especially the distribution sub-sector.

This situation caused the country significant distress, and in 2004 the government set out a new policy model to attract sustainable long-term investment to the electricity sector. The main pieces of legislations put in place by then-President Lula were Laws 10.847 and 10.848 on March 15, 2004. These were originally developed by former Minister of Mines and Energy Dilma Rousseff. The minister described these reforms as the “new model of the Brazilian electricity sector,” which created new institutions and introduced substantial reforms to strengthen the electricity sector in Brazil and make it more sustainable.

A list of the major laws applying to the electricity sector is presented in the table below.

Table 23

Major Laws in the Electricity Sector

Law Number	Date	Main Deliberations
8.631	March 4, 1993	Dealt with reform of tariffs, eliminating tariffs equialization and guaranteed remuneration. One of first legislations to reform the sector.
8.987	February 13, 1995	Introduced the "Concessions Act" through Law 9.074/ 1995 with market mechanisms (though not exclusive to electric sector).
9.074	July 7, 1995	Implemented several market mechanisms consistent with Law 8.987.
9.427	December 26, 1996	Implemented new institutional model, created ANEEL and also new economic and financial model.
9.478	August 6, 1997	Considered main National Energy Policy.
9.648	May 27, 1998	Established restructuring of Eletrobras and subsidiaries, created ONS, and introduced several reforms (altered Law 9.427).
9.991	July 24, 2000	Outlined compulsory investment in R&D and renewable energy sources.
10.295	October 17, 2001	Introduced National Policy for Conservation and Rational Use of Energy with mandatory energy efficiency standards.
10.433	April 24, 2002	Organized operations of the Wholesale Electric Energy Market (Mercadão Atacadista).
10.438	April 26, 2002	Created Proinfa: Program of Incentives for Alternative Electricity Resources (later altered by 10.762/ 2003 and 11.943/ 2009).
10.847 and 10.848	March 15, 2004	Major regulatory change focusing on supply and tariff terms and social inclusion.
11.488	July 15, 2007	Made adjustments to 9.427, 10.438, 10.848.
11.943 and 12.783	May 28, 2009 January 11, 2013	Dealt with renewal of concessions and tariff mechanisms and amended previous laws.

Power Generation Energy Auctions

As part of the power sector reforms of 2004 (Law 10.848), the government introduced several changes, including regular power generation auctions focusing on mid- and long-term contracts ahead of delivery. The reforms also included mandatory contracts for reliability purposes, and price and market competition to establish competitive generation prices (which would in turn be passed on to the tariffs). The new regime replaced the previous one that required the government to establish benchmark prices for energy tariffs, and it introduced four types of energy auctions:

- **New energy:** These are auctions for new power generation projects in which participants bid for the expansion of the National Interconnected System (Sistema Interligado Nacional, or SIN) to meet future growth in demand. The auctions take place several years ahead of delivery so that companies can compete with their projects in the development phase, before construction starts, and a competitive process can be established so that the end consumer benefits from the lowest price possible. This category also includes structural ("*estruturantes*") projects, which are considered by CNPE to be "strategic" or "of national interest" to reinforce the reliability of the electricity sector.
- **Existing energy:** These auctions apply to existing power generation installations and operations. They use market competitiveness to give the distribution system greater flexibility and to provide risk mitigation from the price and volume variations that result from changes in demand and the costs of new supply options. These auctions involve bidding for the right to deliver energy in the following years, in contracts of 3 or 15 years; they also include "adjustment" auctions for shorter periods of time to perform fine adjustments between contracts and loads.
- ***Reserve energy:*** This type of auction was introduced by Decree 6.353 in 2008, four years after the new regime began, to foster the expansion of specific fuel sources in the energy matrix. So far, the government has used this type of auction to boost the participation of renewable energy sources such as wind, biomass, and small hydropower generation. The legislation also allows for nuclear energy to be included in the reserve energy auctions.
- **Transmission:** In addition to the auctions for power generation, the country uses a similar process to promote the growth of transmission lines as part of the Rede Básica do Sistema Interligado Nacional. These are transmission lines equal to or higher than 230 kV; other transmission types that meet certain requirements are also eligible for these auctions (these are called Demais Instalações de Transmissão). This practice has allowed the expansion of the installed capacity in remote areas of the country using alternative sources of power generation.

The following chart illustrates the electricity market in Brazil, which is divided into two types: the Regulated Contracting Environment (RCE) and the Free Contracting Environment (FCE).

Figure 12

Electricity Market Contracting Environments

ccee
Câmara de Comercialização de Energia Elétrica

CCEE Chamber of Electric Energy Commercialization is a not-for-profit, private, civil organization part of ANEEL.

It was formed in 2004 to carry out the wholesale transaction commercialization of electric power within the Brazilian National Interconnected System (SIN).

Sellers
Power Generation, Independent Producers, Traders, and Own Producers

Regulated Contracting Environment (RCE)

Ambiente de Contratacao Regulada (ACR)

Contracts from auctions

- Distributors (captive consumers)
- Sellers establish contracts with all distributors
- Prices from the auctions

Free Contracting Environment (FCE)

Ambiente de Contratação Livre (ACL)

Contracts freely established

- Free and special consumers (specific requirements) and
- Traders that can sell to final consumers in bilateral contracts
- Prices agreed between parties

Source: Own elaboration.

The electricity auctions in Brazil apply only to the RCE (i.e., captive) market called Ambiente de Contratação Regulada (ACR), which represents 70–75 percent of the country's load. The auctions are centralized to take advantage of economies of scale and are scheduled in advance at known intervals, usually two auctions a year. They establish the electricity to be delivered, usually three to fiveyears ahead of time, for contract periods lasting either 15 years (for thermal plants) or 30 years (for hydro plants).

On the other hand, free consumers operating in the FCE or Ambiente de Contratação Livre (ACL), who make up 25–30 percent of the load, procure their needs independently (including through the auctions, if they choose to), with prices and quantities traded freely between parties. Traders also participate in this market, reselling energy to end consumers.

In any case, both regulated and free consumers need to be 100 percent contracted—they will pay penalties if they are under-contracted—and registered with CCEE. The new regulations also contemplate other kinds of auction, such as special auctions for specific technologies driven by energy policy decisions and adjustment auctions for complementing the energy load for distributors by up to 1 percent of their loads.

Latest Developments in the Electric Sector

On September 11, 2012, the Brazilian government enacted Provisional Law (Medida Provisoria) 579 (converted to Law 12.783 on January 11, 2013), aimed mainly at reducing the electricity tariffs paid by end consumers.

The new legislation provided a reduction of sector charges and tariffs moderation for power generation, transmission, and distribution concessions, granting companies with concessions expiring between 2015 and 2017 the possibility of anticipating the renewal of the agreements on the basis of specific conditions set by ANEEL that relate mostly to economic and quality-assurance mechanisms. The new law allowed the federal government to extend maturing concessions for a maximum of 30 years (20 in the case of thermoelectric generation). After that, the concession reverts to the state, which can either run the utility itself or delegate the service by competitive auction.

While the main consequences of the new legislation have fallen on state-owned enterprises (mostly for generation and transmission), private-sector companies operating in these segments have also been affected. The reduction of electricity tariffs came against the background of a wider set of economic policy instruments introduced by the government to foster the competitiveness of the domestic industry and to ensure inflation is kept under control, allowing greater flexibility in monetary policy related to inflation targets. Moreover, the government expects the new legislation to improve conditions in several economic sectors, which in turn would positively affect employment and income levels.

Another change to be implemented in 2015 is the introduction of different tariffs according to the conditions of electricity generation—known as the "flag tariffs" for their use of three colors (red, yellow, and green). Prices for end consumers will change on a monthly basis (by pre-established amounts) depending mostly on the water levels in the reservoirs and the type of fuel used for generation (e.g., natural gas or coal). ANEEL will set the colors based on information provided by ONS using the marginal cost of operation (custo marginal de operação, or CMO) and its charges.

REFERENCES

Agencia Nacional de Energia Elétrica. 2013. *Relatorio ANEEL 2012.*

ANP. 2013. *ANP Statistical Yearbook 2013.*

BP. 2014. *Statistical Review of World Energy.*

Centro da Memória da Eletricidade. 2001. "Energia Elétrica no Brasil: Breve Histórico 1880–2001."

Dias Leite, Antonio. 2012. *Eficiência e Desperdício da Energia no Brasil.* Rio de Janeiro: Elsevier.

IEA. 2014. *World Energy Outlook 2013.*

Empresa de Pesquisa Energética. 2013. *EPE Balanço Energético Nacional 2013: Ano Base 2012.*

Giambiagi, Fabio, and Luiz Paulo Vellozo Lucas, eds. 2013. *Petróleo: Reforma e Contrarreforma do Setor Petrolífero Brasileiro*. Rio de Janeiro: Elsevier.

Gomes, Ieda. 2014. "Brazil: Country of the Future or Has Its Time Come for Natural Gas?" The Oxford Institute for Energy Studies.

Hernandez-Perez, Adriana. 2011. "Economics of Oil Regulation and the Brazilian Reform: Some Issues." Energy Policy 39(1), January.

IDB Energy Database. http://www.iadb.org/energydatabase.

Instituto Acende Brasil. 2012. "Leilões No Setor Elétrico Brasileiro: Análise e Recomendações."

Magalhães, Roberto, Helio Guedes, and Wellington Vasconcellos. "Conteúdo Local aplicado ao Setor de Óleo e Gás no Brasil." ONIP.

Maurer, Luiz, and Luiz Barroso. 2011. "Electricity Auctions: An Overview of Efficient Practices." The World Bank.

Meisen, Peter, and Jordi Hubert. 2010. "Renewable Energy Potential of Brazil." GENI—Global Energy Network Institute.

Ministério de Minas e Energia Brasil. 2009. "The Regulatory Framework of the Pre-Salt." Available at http://www.mme.gov.br/documents/10584/1657891/Pre-Salt_-_English_Version.pdf/23e45040-21ee-41c0-b72f-206132e6fa3b

OECD. 2008. "OECD Reviews of Regulatory Reform: Brazil—Strengthening Governance for Growth." doi:10.1787/19900481.

Tolmasquim, Maurício, and Helder Queiroz Pinto Junior. 2012. *Marcos Regulatórios da Indústria Mundial do Petróleo*. Rio de Janeiro: Synergia Editora.

Tolmasquim, Maurício. 2011. *Novo Modelo do Setor Elétrico Brasileiro*. Rio de Janeiro: Synergia Editora.

Tordo, Silvana, Brandon S. Tracy, and Noora Arfaa. 2011. "National Oil Companies and Value Creation." The World Bank.

Zacour, Claudia, Tatiana Zuma Pereira, Angela Lima Rocha Cristofaro, and Felipe Ferreira Francisco. 2012. "Petrobras and the new regulatory framework for the exploration and production of oil and natural gas in the Brazilian Pre-salt region." *Journal of World Energy Law and Business* 5(2): 125–138. doi:10.1093/jwelb/jws002.