

# Energy and Development in South America: Conflict and Cooperation

*Edited by Cynthia J. Arnson, Claudio Fuentes,  
and Francisco Rojas Aravena  
With Jessica Varat*

First South American Energy Summit © Eduardo Morales/epa/Corbis  
Front Row L-R- Colombian President Álvaro Uribe, Chilean President Michelle Bachelet,  
Bolivian President Evo Morales, Venezuelan President Hugo Chávez,  
Brazilian President Luiz Inácio Lula da Silva

Back Row L-R- Uruguayan Vice-President Rodolfo Nin Novoa,  
Ecuadorian President Rafael Correa, Guyanan Prime Minister Samuel Hinds

Oil Rig in Stormy Sea © Steve Bloom/Getty

# Contents

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- 1 Introduction**  
Cynthia J. Arnson and Jessica Varat, Latin American Program, Woodrow Wilson Center
- 9 Energy and Development in South America**  
José Miguel Insulza, Secretary General, Organization of American States
- 13 Energy Integration in Latin America: Limits and Possibilities**  
Francisco Rojas Aravena, Secretary-General, Facultad Latinoamericana de Ciencias Sociales (FLACSO)
- 19 The Crisis in the Argentine Energy Sector and its Regional Impact**  
Thomas A. O’Keefe, Mercosur Consulting Group
- 27 Chile’s Choices: Securing Supplies and Maintaining Growth**  
Oscar Landerretche, Universidad Técnica Federico Santa María
- 35 Venezuela: Energy, the Tool of Choice**  
RoseAnne Franco, PFC Energy
- 41 Diversifying the Energy Matrix: The Case of Brazil**  
Sergio Trindade, SE2T International

- 49**    **Energy and Bad Luck in Bolivia**  
Humberto Vacaflor, *Siglo 21*
- 55**    **Oil and the Transformation  
of the Ecuadorian State**  
Walter Spurrier Baquerizo, Grupo Spurrier
- 61**    **Energy, Development,  
and Regional Integration**  
David Mares, University of California, San Diego
- 73**    **Author Biographies**

# Diversifying the Energy Matrix: The Case of Brazil

*Sergio C. Trindade*

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This essay reflects my own experience with energy, development, technology, and environment issues in Brazil and elsewhere, with specific reference to Brazil's development and the role of energy services.

## THE ENERGY-DEVELOPMENT NEXUS

The word energy is synonymous with development, and it is also one of the main economic factors of production. Developing societies are constantly increasing their energy use, and there is a clear correlation between Gross Domestic Product (GDP) and energy consumption. Interestingly, it takes twice the amount of energy to produce a unit of GDP in the United States than in the European Union, areas with similar levels of development.<sup>1</sup> This suggests that one way a country can expand its access to energy resources is by using them more efficiently. Energy access can also be expanded through the integration of the electricity, oil, and gas infrastructures. Although there are elements of energy integration in South America, much work remains to be done. Another dimension of the energy-development nexus is the opportunity provided by a growing energy industry for increasing the country's knowledge base and improving the quality of its human capital.

As a child in Brazil spending summers on the remote farm of my maternal grandfather in Abaeté, Minas Gerais, I found that all gasoline was imported from the United States and sold in 5-gallon or smaller cans to fuel the commonly-used old Model-T cars. Lighting was provided by kerosene lamps and firewood was the fuel for cooking. Corn was ground with energy from a water wheel. As a teenager I would visit my grandfather's new farm, which was still off the grid. Fortunately, there was a small Pelton-wheel generator, which provided some lighting from the running water that was dammed during the day and allowed to run in the early hours of the evening.

When visiting my paternal grandmother's urban house in Ouro Preto, Minas Gerais, a warm bath was available only if the charcoal-fired stove was on, since the hot water pipe ran through the oven. Since Ouro Preto can be chilly in July, the oven had to be lit almost all day long to cope with warm baths for the whole family. I also remember how our fuel system arrived at the house—on a group of charcoal laden mules. A few years later, this same house had been converted to Liquefied Petroleum Gas, delivered in 13-liter containers on the back of a pickup.

Today, these same areas that had such limited access to energy services—transportation, lighting, heating, cooling and rotary motion—are all grid-connected and served by a liquid fuels infrastructure. They are now generating a much higher GDP than in the past. It took vision, leadership, and political will to arrive at the place that we are today in Brazil. This was often achieved by using each and every energy development opportunity to absorb knowledge for future energy initiatives.

In the 1950s, an assessment of hydropower resources—the so-called Canambra project—was carried out in part by Brazilian engineers.<sup>2</sup> The knowledge and expertise they gained was disseminated and multiplied through education, training, and hands-on experience and coaching. This core group was behind the development of Centrais Elétricas de Minas Gerais (CEMIG), the electrical utility company of Minas Gerais, in many ways a model utility provider in Brazil. They were later responsible for the development of the Furnas power system, another model of well-run utilities in Brazil.<sup>3</sup> Additionally, they and their disciples were critical to the implementation of the Itaipu dam project and power generation system on the Brazilian-Paraguayan border, currently the largest hydropower complex in the world, though it will soon be overtaken by the Three Gorges system in China.

Parallel developments took place in other parts of Brazil, resulting in a large and integrated electrical grid that today serves the majority of the population. Human capital developed to such a high degree that Brazilian companies have been engaged in electricity grid design and construction in a number of other countries. An electricity research and development center—Centro de Pesquisas Elétricas (CEPEL)—was developed by the state power company Eletrobrás and has provided knowledge and services to equipment manufacturers and utilities in Brazil and elsewhere.

Brazil has also progressed in the area of liquid fuels for transportation and industry. Five decades ago foreign geologists concluded that there was no economically recoverable oil in Brazil. Now the country is self-sufficient in oil and possesses the world's top deep offshore oil exploration and exploitation technologies. Again, the country seized opportunities to learn and knowledge was generated via experience, research, development, and technology transfer. Petrobrás established a petroleum research and development center—Centro de Pesquisas e Desenvolvimento

Leopoldo Américo Miguez de Mello (CENPES)—which played a crucial role in developing the technology that allowed the discovery of immense oil deposits off the Brazilian coast in 2007. Similarly, Brazil has become, together with the United States, a leader in the production and use of biofuels, especially ethanol. In Brazil, ethanol is made from sugarcane and is currently the cleanest commercially available fuel. It has achieved the highest displacement level of gasoline of any biofuel in the world today (50 percent). Consequently, Brazilian ethanol mitigates greenhouse gas emissions and improves local air quality. Once again, a technology center—Centro de Tecnologia Canaveira (CTC)—was established by the private sector to generate and disseminate knowledge via experience, research, development, and technology transfer that resulted in Brazil becoming the most cost-efficient bio-ethanol producer in the world. Brazilian companies are consulting for, designing, and building ethanol plants in Brazil and elsewhere. In Brazil, food and fuel crops are growing simultaneously, and sugar cane workers are the second best paid agricultural workers.

Still, some 10–15 million Brazilians are off the grid in remote—and some not so remote—areas where the low population density does not justify extending the grid. This situation has allowed for creative solutions, such as public and private programs to provide modern energy services to settlers on land reform projects in the remote northern region of Mato Grosso. One type of arrangement, described as a Regional Market Management Organization (RMMO), served family plots of approximately 50 hectares. The RMMOs surveyed the areas and, together with the settlers 1) defined what energy services were needed to add value to local production; 2) established what local natural resources could provide energy (biomass, solar, wind, and small scale hydro); and 3) developed business plans that allowed suppliers of energy conversion equipment to see the disparate universe of potential buyers in a focused and aggregated way. The approach was fully integrated, guided by the demand for energy services and included financing schemes appropriate to the settlers' ability to receive loans.

### **BARRIERS TO THE AVAILABILITY AND USE OF ENERGY TO PROMOTE DEVELOPMENT**

Since governments play a role in development—either by creating an enabling environment for private capital to invest in energy development or by assuming such a role themselves—vision, leadership, and political will are all necessary to assign national priority to energy among the multitude of development goals a society may have.

Up until the 1960s the environment—air, water, and soil—was not really a meaningful consideration for development in Brazil. In the 1930s, the Getúlio Vargas administration began a process of systematic development, which was increased in the 1950s during the administration of Juscelino Kubitschek and further expanded during the period of military rule (1964–1985). Thus, irrespective of the political regime—civilian dictatorship, democratic rule, or military dictatorship—there was continuity of political will in Brazil to build up the infrastructure necessary for development, namely electric power, liquid fuels, roads, ports, and telecommunications.

During most of this time, the Brazilian state was the driving force behind development initiatives. But over the past fifteen years there has been a transition toward an ever-increasing role for private enterprise in the Brazilian energy sector. Funding for these endeavors came from the financing of multilateral banks, international private lending, and the Brazilian government's equity and debt financing. Yet these funding packages often faced obstacles due to poor credit ratings, a history of defaulting on sovereign debt, and other risks. The severe inflation that afflicted Brazil for some forty years starting in the mid-1950s added to the difficulties the country had to overcome. These problems were gradually resolved as the country improved its infrastructure and generally honored its loan repayment commitments.

Once basic rules and contracts were developed, including the establishment of independent regulatory agencies, the increased private investment overcame the bottlenecks in the energy and other types of infrastructure. There is, however, uncertainty about the future role of the government and the regulatory agencies, which could make private capital hesitant to invest in energy and infrastructure in general. As a result, there are concerns about the availability of power in the decades ahead if the needed investments do not occur in a timely fashion. Financing energy development is likely to remain a difficult task and, given the scale and level of risk involved, will require a diverse portfolio of public and private sources, including national, foreign, and multilateral funding.

Beginning in the 1970s, environmental rules and regulations gradually began to play an increasing role in energy investment in Brazil. These are sometimes seen by investors as unnecessary barriers that consume time and resources for little benefit. The environmental authorities, however, have different views. Hydropower development, for example, requires the flooding of extensive areas, which can cause the destruction of habitats and other ecological damage; consequently, environmental permits are quickly becoming harder to obtain. In addition, sugar cane harvesting in Brazil is traditionally preceded by a controlled

burn of the fields to facilitate manual cutting, an activity that employs a large number of people. This operation emits soot particles into the air and can be a cause of public health concerns. In the state of São Paulo, such burning will be phased out gradually over the next fifteen or so years, which will expedite the mechanization of sugar cane harvesting and lead to the loss of hundreds of thousands of jobs. Obviously, environmental requirements introduce a level of uncertainty that may make potential investors think twice before committing resources to a project. But overall, environmental requirements help guide the design and implementation of sound, sustainable projects.

### **PUBLIC POLICIES AND ENERGY COOPERATION OR CONFLICT IN THE MEDIUM- AND LONG-TERM**

Energy-related development projects that occur in areas that are shared by two or more countries might raise their own types of problems, based on the state of relations between the interested countries. When Brazil began planning the Itaipu hydropower project—which involved a large dam—it could have, in theory, been built entirely in Brazil. Nevertheless, the decision was made to build it on the border with Paraguay. This required the negotiation of a bilateral treaty between two countries of considerably different sizes, making the process of negotiation difficult. Paraguay's total consumption of electricity at the time of these discussions was equivalent to one half the output of one of the eighteen turbines that were eventually installed. Thus, the bulk of the electricity generated at Itaipu would be, and is, consumed by Brazil. However, the treaty gave both countries the same number of turbines. There was also a disparity between the electricity frequency used by each country. Paraguay insisted that all of its nine turbines should generate power at fifty cycles. Brazil countered with a proposal to convert the whole country of Paraguay to sixty cycles, with Brazil paying for the conversion. But the Paraguayans were adamant about their position. Ultimately Brazil yielded and used the opportunity to build—learning in the process—a High Voltage Direct Current System (HVDC). This allowed for the electricity generated by the Paraguayan turbines at fifty cycles to be purchased by Brazil, as agreed upon in the treaty, converted to direct current, transported 1,000 kilometers to São Paulo and reconverted there to sixty cycle electricity. Similar cooperation schemes were devised by Brazil and Argentina and Brazil and Uruguay, allowing for the exchange of electricity between the existing grids in the three countries.

Another cooperation scheme that has recently been tested concerns oil and gas cooperation between Brazil and Bolivia. A natural gas pipeline was con-

structed to transport Bolivian gas to Brazil, and it became operational while Petrobrás, the Brazilian state-owned oil company, managed the Bolivian gas fields. Upon assuming power, President Evo Morales of Bolivia decided to change the government's relationship with Brazil and change the framework for energy investment, with the aim of regaining national ownership of oil and gas assets. Petrobrás had been operating most of the refining capacity of Bolivia, in accordance with a contract that Bolivia revoked. The decision to change the existing policy, and the contracts derived from it, in order to maintain national ownership of energy assets will certainly discourage future foreign investment in energy in Bolivia.

In another effort to foster cooperation, the Latin American Energy Organization (OLADE) hired me in 1992, at the behest of the Group of Three,<sup>4</sup> to help Colombia and Venezuela negotiate a gas interconnection between the two countries, at that time governed by Presidents César Gaviria and Carlos Andrés Pérez, respectively. Originally, gas was to flow from Venezuela to Colombia, with the flow to be reversed at some point in the future. A methodological framework was offered for the two countries to engage into negotiations. The deal ultimately fell through because President Pérez was forced from office in Venezuela in 1993 and President Gaviria became too preoccupied with the guerrillas in Colombia. The pipeline was eventually built—work was completed by 2007—but given the current state of relations between President Hugo Chávez of Venezuela and President Álvaro Uribe of Colombia, it may be some time before gas flows in either direction.

Brazil's prominence in biofuels, especially ethanol, and the policies of its foreign ministry have led to a number of bilateral agreements between Brazil and its neighbors as well as between Brazil and countries in Africa and Asia, to support the development of domestic ethanol markets. Brazil has also attempted to negotiate a plan with Venezuela to develop ethanol production, to promote agricultural growth and job creation in rural areas of Venezuela and to begin introducing ethanol-gasoline blends into the Venezuela domestic market. However, the deal eventually fell through due to a change of heart on the part of the Venezuelan government. It was influenced by Fidel Castro's position on biofuels, which condemns the notion of competing with food crops by converting agricultural commodities to fuel.

The Brazilian foreign ministry (Itamaraty) has promoted ethanol cooperation agreements with other countries in the Western hemisphere, especially in Central America and the Caribbean, most notably with Haiti and the Dominican Republic. However, the most interesting initiative stems from the

author's July 26, 2001, recommendation to President Fernando Henrique Cardoso that Brazil and the United States promote domestic biofuel development, especially ethanol, in third markets throughout the world. This Memorandum of Understanding was signed in March 2007 by Presidents Lula and Bush and is being implemented gradually, beginning with four countries: the Dominican Republic, Haiti, El Salvador and St. Kitts and Nevis.

The U.S. sugar quota can be a barrier to promoting sugar cane-based ethanol production cane in countries that benefit from the quota. As an instrument of U.S. foreign policy, the sugar quota allows select countries to sell sugar in the U.S. market at the U.S. domestic price, which can be two or three times the price of sugar on international markets. Those groups that have access to the U.S. market and control scarce land and other inputs for sugar cane production may feel little inclination to switch to ethanol. Ethanol, after all, has to compete with gasoline in price. If sugar producers can continue to enjoy the high profit margins offered by the U.S. quota, even producers with high costs have little incentive to shift to ethanol.

## CONCLUSION

Wars over sovereignty are ultimately wars over natural resources, including energy resources, as well as political and economic power. Brazil shares borders with all but two countries in South America—Chile and Ecuador. Brazil settled its 16 thousand kilometers (ten thousand miles) of shared borders through diplomatic negotiations. Throughout its history as an independent country, the only real war between Brazil and a neighboring country was the Paraguayan War of the nineteenth century (1864–1870). Reacting to a Brazilian incursion into Uruguay, Paraguayan leader Francisco Solano López attacked Brazil in 1864 and Argentina in 1865. Brazil was joined by Argentina and Uruguay in defeating Paraguay.<sup>5</sup>

The Brazilian experience is one of transforming conflict into cooperation via diplomatic action. The development of hydropower from shared river basins such as the basins of the Uruguay, Paraguay, and Paraná rivers in Argentina, Uruguay, and Paraguay is a concrete example of the Brazilian approach. Conflicts with Bolivia over the commercial deals between Petrobrás and the Bolivian government concerning oil and natural gas resources did not result in warfare. Rather, the disputes were handled with patience and diplomacy. The Paraguayan desire to extract more rent from Itaipu will be addressed through diplomatic channels. The zigzagging relationship with Chávez's Venezuela on



oil, gas, and ethanol matters is again being handled with patience and diplomacy. Brazil's experience demonstrates that when a country is significantly larger than its many neighbors, sustainable peace and cooperation in exploring resources of joint interest is best achieved via diplomatic negotiation.

## NOTES

1. See José Miguel Insulza, "Energy and Development in South America," in this volume.
2. Canambra Engineering Consultants Limited is a consortium of international engineering companies whose experts were tasked with carrying out a survey of energy resources in Brazil in the 1950s. [Eds.]
3. Furnas is the largest power utility company in Brazil.
4. The Group of Three (G-3) is a Free Trade Agreement involving Mexico, Colombia and Venezuela, signed on June 13, 1994, which entered into force on January 1, 1995.
5. To understand this episode, one must recall that there were long-standing disputes between these four countries over their boundaries and navigation rights on the large rivers of the region and mutual interference into the internal affairs of each other, and that Solano López had great ambitions to extend power and influence in the region.