**Energy Policy, Climate Change and Financial Crisis**

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**The return of the role of the State in energy-related issues**

The aim of this article is to provide a current panorama of the energy policy in Brazil and its relation with the perspective of South American energy integration. Consequently, this study does not focus on a complete or neutral analysis, but on certain aspects considered most relevant as opposed to exposing details on all technical feasible energy sources that are not always financially relevant. In this context, special attention should be given to the impact caused by the sharp rise of oil prices, the subsequent drop of prices due to the world financial crisis that reached Latin American in 2009, and the relatively recent raise of the oil barrel. The counterpoint of this impact is the discovery of the Pre-Salt Petroleum region.

Among the primary energy sources, hydroelectricity, petroleum and natural gas play the most important role in current integration and potential. These sources have been the object of a wide range of specific studies. In the current situation, alternative sources have gained significance, particularly biofuel and especially Brazilian ethanol. These sources have been the target of intense recent international controversy due to the raise in global food prices that is hypothetically caused by the competition of biofuel and, in the case of Brazil, contributing to deforestation of the Amazon.

In the global scenario, we have witnessed the re-emergence of national State intervention in the economy as a consequence of the global financial crisis. This situation is not new, considering that the oil shocks of 1973 and 1979 led to national energy policies and energy planning by governments to assure petroleum supply and the development of other conventional and alternative sources.

In the second half of the 1980s, there was a drop in the price of petroleum that led to the reduction of the role of the State in energy, leaving the responsibility to the market. In the 1990s, for various reasons, there was a growth of policies labelled neo-liberal. In the world and in Latin America, there was a regulation and privatization of energy companies that were previously state-owned. This situation is now reverted within a new, much more complex scenario, which varies from one country to another, that cannot be reduced to a simple return to the previous status.

**The energy policy and petroleum**

The recent panorama shares some similarities with the oil shock; the raise of international prices of the oil barrel that ranged from US$ 1 and US$ 2 until 1973 only to reach a staggering US$ 40 in 1979 that was maintained for some time. In the second half of the 1980s, the price dropped suddenly and fluctuated erratically in the 1990s. In 1999, the price of the oil barrel was a mere US$ 10, but surpassed US$ 70 in 2006 and almost reached US$ 140 in 2008. In nine years, the price of petroleum was multiplied by 14 and almost doubled in two years, subsequently dropping to less than US$ 50, which was maintained during 2009 only to rise sharply again.

In the last years, natural gas has been the cause of problems between Russia and Europe, between Argentina and Chile, and recently, between Bolivia and Brazil. In the case of electricity, serious rationing occurred in 2001 for many months in Brazil and California due to lack of sector regulation.

The deregulation of energy was an integrating part of the liberalization process of the economy from the standpoint of financial globalization, which is at the root of the global crisis that started in the USA in 2008 and worsened in 2009, reaching South America and Brazil in particular.

In relation to energy, the effects of the financial crisis were added to the environmental crisis triggered by climate change and the subsequent global warming that was intensified by gases such as carbon dioxide produced in the burning of fossil fuels. The greenhouse effect became a huge international political problem with a solution that involves choices of society considering that companies cannot solve this problem singlehandedly. The Nobel Peace Prize of 2007 awarded to the Intergovernmental Panel on Climate Change (IPCC) was the outcome of the Fourth Evaluation Report published at the start of 2007 that caused immense worldwide concern.

The impact of high international prices of the oil barrel in the global economy affected South American countries although, today, petroleum participation in the economy is less than during the oil shock period of the 70s. In the global scenario, this participation in the cost of goods in general was reduced by half in comparison to the same period.

The following factors contributed to the issue of petroleum:

a) Predictions of reduced global production, although, in South America, there have been important discoveries in the Brazilian Pre-Salt region and the growth of consumption, especially in developing countries, prompted by China.

b) Global geopolitical instability, especially in the Middle East, a petroleum production area, and high dependency of OECD countries (Organization for Economic Co-operation and Development), mainly of the USA, on petroleum imports.

c) The global financial crisis that started in the USA in 2008 and impacted South America in 2009.

d) Environmental pressures, especially in relation to carbon dioxide emissions from combustion of petroleum by-products that intensify the greenhouse effect and contribute to global warming.

Geopolitical instability linked to petroleum areas is empirically substantiated by the conflict in Iraq, occupied by North American forces, by the Arab-Israeli conflict and by the tension between USA and Iran due to the uranium enrichment project. Rebellions are common in Arab countries, starting in Egypt and culminating in Libya, leading to the intervention of the USA, France, England, Italy and other countries commanded by NATO.

The outbreak of the financial crisis in the USA spread throughout the world. The North American government was forced to intervene in the economy in order to save large companies from bankruptcy, as in the case of the nationalization of General Motors. The Nobel Prize of Economy of 2008, Paul Krugman recommended the return of the Keynesian-type economic policy, while, in mid-crisis, Francis Fukuyama – who became famous in 1989 when he wrote an article that proclaimed the end of history with the fall of the Berlin Wall – defended a policy with more market and less State.

Finally, in relation to the last factor, participation of primary renewable sources, especially hydroelectricity, is greater in South America than in other continents. Furthermore, biofuel is widely consumed in Brazil, where participation of renewable sources is 47%, which includes hydroelectricity generation and biofuel, while world participation is 13% and 6% in OECD countries. Greenhouse gas emissions in Brazil, however, are mainly the result of deforestation.

**Greenhouse gas emissions and climate change**

Non-renewable sources are responsible for greenhouse gas emissions, with the exception of nuclear energy that occurs through the fusion of uranium and not through combustion, as occurs with carbon, petroleum and natural gas. Renewable sources (bottom of the figure) do not emit greenhouse gases or, as in the case of alcohol and hydroelectricity, emit small quantities of greenhouse gases. In the case of biofuel, carbon dioxide emitted during combustion is reabsorbed from the atmosphere through the plant growth process. In Brazil, however, half the firewood and vegetable coal comes from deforestation, and vegetable coal is used in the steel industry. Emission from liquids, as in the case of alcohol, is restricted to diesel supply of tractors and trucks in sugarcane cultivation. In the case of hydroelectric plant, the research group of the COPPE (*Instituto Alberto Luiz Coimbra de Pos-graduação e Pesquisa de Engenharia*) conducted measurements in various national reservoirs that showed carbon dioxide and methane emissions although, in general, contributions of these plants is less than that of thermoelectric plants.

According to a 2007 IPCC report, global growth of greenhouse gas emissions was 70% between 1970 and 2004. Of these emissions, CO2 emissions grew 80% and represented 77% of anthropogenic emissions in 2004. The highest growth rate of emissions between 1970 and 2004 was in the energy sector (145%), followed by the transport sectors (120%), industry (65%) and land use and deforestation (40%).

The meetings of the UN Convention on Climate Change, in Copenhagen, Denmark, at the end of 2009, represented a frustrated hope of reaching a consensus for more effective commitments to reducing total greenhouse gas emissions, considering that they contribute to atmospheric warming near the earth´s surface and cause climate changes with consequences that can be very serious for humanity.

According to the 2007 IPCC report, some hopeful facts were presented, although they were not enough to assure a satisfactory solution, especially in relation to atmospheric concentration of carbon dioxide. The new North-American position is encouraging, with President Barack Obama, representing a positive advancement in comparison to the George W. Bush administration. Nonetheless, the North-American proposal to reduce CO2 emissions in 2020 to 17% less than emissions produced by the country in 2005 is far lower than the goal set by the Kyoto Protocol, which in 1990 applied a defined percentage reduction for each country and stipulated a deadline between 2008 and 2012 for achievement of these goals. The current proposal of the USA is also lower than the proposal of the European Union and the country continues to reject the Kyoto Protocol.

The commitment of limiting global temperature to 2° C in relation to the temperature of the pre-industrial era is encouraging. The Brazilian position in the Copenhagen Conference included this limitation, which implies a huge effort to reduce emissions of rich countries and to control emissions of developing countries.

An important issue is the controversy on the adoption of obligations of developing countries in relation to emissions. The argument to adopt these measures is the growth of emissions in developing countries, especially China and India, but *per capita* values of CO2 emissions of developed countries continue to be far above that of developing countries.

In Brazil, the creation of the National Climate Change Plan of the President Lula administration proved encouraging and defined goals for the reduction of deforestation that is responsible for a greater part of Brazilian emissions. Approval of this plan by the Brazilian Congress had a positive repercussion on the Meeting of the UN Convention of Climate Change, although there were few solid results in Cancun - 2010.

The bad news is that there has been increased participation of fossil fuels for electricity generation according to the Brazilian forecast. On the other hand, increased alcohol production and consumption of ethanol in cars that surpasses gasoline consumption is very favourable, despite the alcohol production crisis in 2011 that dramatically reduced ethanol consumption.

The map in figure 1 shows the difference of primary energy supply in various global regions. South America and Africa are in the lowest supply level, between 100 and 600 million tonnes of oil equivalent (toe), in contrast with North American, Europe and Asia, with supply rates that range from 2.320 to 2.960 million tonnes of oil equivalent.

**Global Primary Energy Supply**

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**Energy development in Brazil and present and future renewable sources**

The population of Latin America is approximately 7% of the world population, while primary energy supply of Latin America is 4.4% of world supply, which shows an inequality. In the case of primary energy sources (IEA, Key World Energy Statistics, Paris, 2007), participation of Latin America in world energy production varies depending on the source:

* + 9.0% petroleum
	+ 4.9% natural gas
	+ 1.4% coal
	+ 0.8% nuclear

 - 20.7% hydroelectricity.

Nuclear generation of electricity in Latin America, however, is less than 1% of world nuclear generation and is restricted to Brazil, Argentina and Mexico, while participation of hydroelectricity surpasses 20%. Brazil, Venezuela and Peru are among the ten countries with the highest number of hydric resources in the world (Chart 1).

 **Countries with highest number of hydric resources in the world**

 km3 / year m3 /year / inhabitant

 Brazil 8.2 🡨 48.3

 Russia 4.5 30.9

 Canada 2.9 94.3

 Indonesia 2.8 13.3

 China 2.8 2.2

 USA 2.0 7.4

 Peru 1.9 🡨 74.5

 India 1.9 1.8

 Congo 1.3 25.1

 Venezuela 1.2 🡨 51.0

 Ten Top 29.7 34.9

 World 43.7 7.2

Source: FAO, UN, 2003; Roberto D‘Araujo, Seminar on Energy Strategies, UFRJ, 2004

In relation to hydric resources *per capita*, Peru and Venezuela rank higher than Brazil and lower than Canada. In the case of installed hydroelectric generation capacity, the USA ranks first, Brazil comes third and Venezuela ranks third, while Peru is not even included in the list of the countries with greatest hydroelectric potential.

Major petroleum producers in South America are Venezuela and Brazil although there is a large gap between the first and second positions. Brazil is equal in exports, especially for heavy crude oil, with light crude oil imports needed for refining. The prognosis is that the Pre-Salt will completely change the position of Brazil.

The two main energy integration projects conducted in Brazil with South American countries are the binational plant of Itaipu – with Paraguay – the greatest electricity generator in the world with extensions of around 12 GW to 14GW, concluded in 2008, and daily imports of 30 million m3 of natural gas from Bolivia. These countries were the object of crises that have been solved between both countries.

The hydroelectric plant projects of Santo Antonio and Jirau, currently underway in River Madeira, near the border with Bolivia, allow new electrical integration possibilities. The original project discussed between Furnas and Eletrobras in 2003 minimally included a third plant of Bolivia and locks to allow Bolivia fluvial access to the Atlantic Ocean.

The absence of a regulation reservoir causes flow variations, which means that energy production of these plants is stabilized with the reservoirs of the hydroelectric plants of the interconnected system that accumulate water when the flow is high in order to compensate energy in the months of low flow, leading to reduced flooding of the area. Bulb turbines will be used, which could cause electric stability problems, although this issue can be solved in the near future.

New projects are currently being implemented, such as the hydroelectric plant of Belo Monte in the Northern Region that has been the object of some controversy.

Brazil consumes much of its solid biomass - firewood and vegetable coal for the iron and steel industry – liquid biofuel, namely alcohol, and currently runs a biodiesel programme.

There is an international debate that holds biofuel responsible for increased global food prices that affect poor populations. The Brazilian government responded to this issue correctly by choosing sugarcane alcohol. Ethanol production can be expanded in Brazil because sugarcane crops occupy 7 million hectares (7 Mha), of which 3 Mha are used for sugar and 4 Mha for alcohol production, while soy alone, most of which is exported, occupies 23 Mha. According to the IBGE (Brazilian Institute of Geography and Statistics), Brazil has 152 Mha of farmable land, of which 62 Mha are currently being used, and 177 Mha of pastures. Excluding the 440 Mha of native forest, there is 90 Mha for farming expansion without deforestation and without considering conversion of degraded pastures. Only a part of this land is adequate for sugarcane crops and is economically and socially feasible for biofuel, such as alcohol and biodiesel. Most biodiesel comes from soy which, contrary to sugarcane, promotes deforestation in the Amazon.

Alcohol from corn in the USA is subsidized. Contrary to Brazilian alcohol that is made from sugarcane, ethanol production in the USA affects the price of corn that subsequently reflects on other food products. Corn alcohol production requires the burning of combustion oil that is a by-product of petroleum. Sugarcane bagasse, on the other hand, is sufficient to produce the heat required for alcohol distillation and electricity for the plant, while any surplus is absorbed by the regional power grid. Consequently, alcohol produced in Brazil is more efficient in energy and environmental terms. Air capture of CO2 in the sugarcane growth process approximately equals its emissions in alcohol production and consumption. By replacing gasoline, the sugarcane solution is effective because it avoids the emission of gases that contribute to global warming.

The international market will only grow if subsidies from the wealthier countries become obsolete. The USA consumes a little more ethanol for automobiles than Brazil, but the percentage of ethanol in gasoline is low, while gasoline consumption continues extremely high: 10 million barrels/day or around 580 billion litres per year. The expectation is to increase this percentage to 20%. Considering there are 1.3 litres of alcohol for every litre of gasoline, this would result in around 150 Bl of alcohol per year, about 6 times more than current Brazilian production of 23 Bl/ year, which should be reached within a time frame of a few years. Although Brazil could export more alcohol, it would not be reasonable to supply the entire market, so other tropical countries are expected to assume the role of alcohol producers.