

## **Hydroelectric Power Plants And Environmental Sustainability. Should Hydroelectric Power Be Considered A Strategic Energy In Brazilian Contemporary Scenary?**

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### **Abstract**

This article intends to discuss the hydroelectric power under the perspective of bio-based-economy and Kyoto Protocol, focus on the climate changing, in response for the natural resources usually threatened by world economic growth pressure. The Brazilian biodiversity is one of the largest and richest areas on Earth and this circumstance puts the country on the world spotlights. Brazil energy matrix is greatly based on hydroelectric power, characteristically based on renewable and clear energy system that seems to be in consonance with the Kyoto Protocol. However, the hydroelectric systems have a collateral harmful effect: the great flooded area dimension<sup>1</sup>. Indeed, natural ecosystems and the living organisms are the success keys for the new products and new industrial processes in an eco-efficiency manner to prevent the depletion of natural resources. Brazilian bio-based-economy is much more driven towards bio-fuel production and agricultural production performance increase than to other industrial sectors. Some steps have also been taken towards genetic engineering and genomic development.

Brazil seems to be against the flow when neglecting biodiversity to a secondary plan. In fact, the economic growth at any cost, seems to be the driven force by the Brazilian energetic sector trade, in contrast to the contemporaneous economic aspects that have been driven by biological forces. While developed countries have been prepared to enter the sustainable era supported by bio-based-economy in any industrial sector<sup>2</sup>, Brazil has been driven by a dilemma: either grow at any cost or preserve biodiversity. Biodiversity<sup>3</sup> is the barn of living organisms in equilibrium ecosystems that may provide the tools for sustainable industrial products, processes and production systems. In fact, it is a strategic resource that will provide subsidies to a sustainable industrial sector for chemicals, plastics, food processing, textiles, pulp and paper, mining, metal refining, energy and others.

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<sup>1</sup> It is not only the serious environmental problem caused by the flooded territory, which implies in biodiversity loss, but it also generates a drastic social problem for people who live in the surrounding areas, especially the indigenous population and the local traditional dwellers, contributing to disaggregate social-environmental laces, and even to lose traditional knowledge.

<sup>2</sup> Developed countries have articulated policy and investment to incentive the introduction of paradigm shift technology into industrial sector based on biotechnology/ bioprocess development and bioproducts to improve product quality/ performance, reduce cost and cause lesser environmental damage. In fact, bio-based-economic is based on eco-efficient bio-processes and renewable bio resources that precedes a great knowledge on biodiversity, ecology, biology and biotechnology. Many research and development have been done in these areas to support a sustainable industrial sector. Developed countries seem to be ahead this process as they can be benefited from science as well as an industrial supply base which are essential to develop a strong industrial biotechnology research and development.

<sup>3</sup> Biodiversity – “The variation among living organisms from all sources (land, water, air) including diversity within species, between species and between ecosystems.

## **1. Introduction**

Nowadays, the world concerns range from promoting economic growth without damaging natural environment to minimizing its harms. It is a paradox circumstance which becomes more evident, as far as the world economic growth rate demands more energy from the electric system, especially pulled by industrial sector and population electricity consumption. The abusive natural resources depletion and the fuel fossil energetic matrix, adopted since the final of 19<sup>th</sup> century, has also contributed to environmental damages. Many of the atmospheric pollutants are due to fuel fossil combustion, especially during the 20<sup>th</sup> century, the *Petrochemical Age*<sup>4</sup>, which provided a great amount of synthetic chemicals for useful industrial and consumption products, besides fuels for economic activities, transportation and heating. Indeed, the global warming scenario has a great participation of developed countries in their industrialization processes<sup>5</sup>. International scientific community has forecast climate changing and has defended the use of alternative, renewable, clean matrix energy instead of the fuel fossil matrix model, since 1997, under the Kyoto Protocol agreement<sup>6</sup>. In fact, the development and environmental concerns were in the international agenda since World Commission on Environmental and Development, created in 1972, when a study was developed which resulted in a Report named “*Our Common Future*”, in 1987. But it was only in the United Nations Conference on Environmental and Development, UNCED<sup>7</sup>, in 1992, that the climate change obtained a great repercussion. It is well settled among scientific communities that the fight against climate change goes along with the sustainable development and respect to biodiversity for leaving a healthy and viable world for the next generations. Sustainability has pressured economic sector through bio-based economy: since commodities products, as liquid fuels based on biomass crop, until value-added products likewise chemicals and materials, relied on living cells<sup>8</sup> to improve production and product quality. Actually, industrial biotechnology has increased its spectrum, firstly applied in the pharmaceutical and agriculture sectors, it has expanded towards other industrial sectors<sup>9</sup>, such as textile and material. In fact, bio-based industrial products will be a response for global environmental awareness and for the Earth survival. In this sense, bio processes and bio products will have a greater visibility and penetration in market, as these goods will be in harmony with international agreements concerning about climate change.

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<sup>4</sup> The age of fossil fuels and petrochemicals has created a great global economic dependence on fossil carbon sources, due to low prices and abundance, at the beginning of these ages, were the principal factors to the world fuel fossil energetic matrix in the present days. These dependence and conventional industrial processes have launched massive pollutants into atmosphere, water and soil and have also heavily contributed to the emissions of greenhouse gases responsible for climate changes.

<sup>5</sup> The greenhousing gases effect has risen due to an anthropogenic gases increase, such as the large amount of carbon dioxide launched into the atmosphere, resulting from the fuel fossil matrix model itself

<sup>6</sup> The discussions dragged on as late as 2005, when it was finally implemented with 183 countries signing the agreement and charging the developed countries with heavier burden from 150 years of industrial activity, under the principle of “*common but differentiated responsibilities*” ([http://unfccc.int/kyoto\\_protocol/items/2830.php](http://unfccc.int/kyoto_protocol/items/2830.php)). So, it was only in 2005 that Kyoto Protocol has entered into force.

<sup>7</sup> In 1992, at the United Nations Conference on Environmental and Development, also known as the Earth Summit Conference held in Rio de Janeiro, discusses United Nations Framework Convention on Climate Change, UNFCCC, for stabilizing greenhousing, GHG level concentration to allow sustainable development, food security and a natural adaptation of ecosystem to the new climate conditions. The resulting documents were on the Agenda 21, the Rio Declaration on Environmental and Development, the Statement of Forest Principles, the United National Framework Convention on Climate Change and the United Nations Convention on Biological Diversity.

<sup>8</sup> Living cells are concerned to moulds, yeasts, bacteria and enzymes.

<sup>9</sup> New fibers for building materials, furniture, comforters, based on lumber, cotton and silk and other kinds of fiber sources to increase functionality.

Besides that, there is a usual consensus about the benefits brought by biotechnology use in contrast to conventional industrial process, particularly concerning about conversion energy, product purity, lowered energy consumption and reduced residual wastes. Indeed, European Industrial Biotechnology Agenda has considered a Plant Genomics and Biotechnology Platform “*towards a zero waste, emission neutra bio-based economy where biomaterials such as fine chemicals and pharmaceuticals will be produced from renewable, plant - based materials, reducing greenhouse emissions and waste*” (Anthony M., 2004). United Kingdom (UK) and United State of America (USA) have appeared as the major global players<sup>10</sup> in bioscience sector due to their great economic and political articulations and supports, as well as their great infrastructure on science and industrial supply base. In fact, biotechnology industries emerge into the contemporary scenario as an important tool to face the 21<sup>st</sup> century challenges: sustainability, competitiveness and economic growth.

## **2. Bio-Based-Economy and Hydroelectric Power Plants: sustainability or cleanliness energetic systems**

The use of biological organisms by human civilization is as old as human society itself. In fact, old fermentation processes have used them for producing wine, beer, cheese and others. But, it was only after the 1970s that the use of biological organisms for commercial ends arises strongly in economic activities<sup>11</sup>, as a new great opportunity to business. The advance in science and new techniques in biological areas, known collectively as genetic engineering, has influenced the economic sector nowadays. These techniques are the start point of a set of other techniques<sup>12</sup> that have come up, as a tool for biological industrial processes. Innovations brought by these techniques allow the manipulation of genetic structure of organisms by adding new genes to increase and even to perform new functions. Biotechnology has provided a large range of opportunities to industrial and commercial activities from agriculture to pharmaceutical needs, as well as any kind of industrial processes such as chemicals, textiles, mining and etc. As a tool of sustainability, the biotechnology opportunities begin to arise the interest of private venture capital in other areas, different from medical and information capital, principally because the great challenge for the 21<sup>st</sup> century will be driven by sustainability and economic growth.

Undoubtedly, bio-based-economy, especially the biotechnology industry congregates the concerns at Lisbon, Barcelona, Gothenburg and Kyoto Protocol, as far as these agreements involve employment, economic growth and sustainability. Bio-based-economy uses the carbon cycle and the bio-resources (sunlight, water, agriculture, forest and marine) and eco-efficient processes (including bioprocesses). Biological production systems became highly efficient, due to the natural evolution over million of years, which have resulted in renewable, biodegradable, and recycled material and bioorganic chemical syntheses, with minor contribution to the generation of greenhouse gases. For that reason, bio-products and bioprocesses achieve cleaner production and support sustainable industrial growth and

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<sup>10</sup> Developed countries, in particular USA and UK, have driven their efforts towards the biotechnology industries, introducing a paradigm shift into their industries.

<sup>11</sup> Newer industries, such as microelectronics, telecommunications and biotechnology, are less dependent on resources rather than the traditional industries that use traditional processes.

<sup>12</sup> The modern biotechnology uses a combination of technological sets such as genetic engineering; culture of recombinant microorganisms, cells of animals and plants; metabolic engineering; hybridoma technology; bioelectronics; nanobiotechnology; protein engineering; transgenic animals and plants; tissue and organ engineering; immunological assays; genomics and proteomics; bioseparations and bioreactor technologies, (Gavrilescu and Chisti, 2005). Indeed, it could be summarized in four fields: genetic engineering, protein engineering, metabolic engineering and biochemical (also known as bioprocess or biotechnology engineering) as suggested by Gavrilescu and Chisti (2005).

employment, besides improving quality of life and an environment-friendly interface. Industrial sustainability is supported by three pillars, known as *'the three bottom line'*: economic viability<sup>13</sup>, environmental compatibility<sup>14</sup> and social responsibility<sup>15</sup>, in Apud OECD (2001), published in *Contributing to Sustainable Development – A Management Primer* (www.shell.com). In this context, sustainable economic growth represents access to jobs, income and also access to goods and services, as well as an opportunity to increase the standard living level, but without depletion of natural resources. Accordingly to OECD (2001, 15), *'Excellent environmental performance is meaningless if no wealth is created. Wealth in a destroyed environment is equally senseless. No matter how wealthy, a society fundamentally lacking in social equity cannot be sustained'*.

Indeed, the Brundtland Commission defines sustainability concept as *'development that meets the needs of the present without compromising the ability of future generations to meet their needs'* (World Commission on Environment and Development Report, 1987).

Industrial sustainability seems to be the driven force for the present and near future while at the same time, it represents challenges and opportunities for the sector activities, especially towards the chemical sector. As a matter of fact, the use of environment implies in providing knowledge for innovations to be applicable to sustainable production<sup>16</sup> which is found in biomimicry<sup>17</sup> approach, it allows the production of *'products and processes found in natural ecosystems and organism that live in them'* (OECD, 2000). The industrial biotechnology adapts and modifies biological organisms; processes, products and systems found in nature form to produce goods and services for social demands. In this sense, biotechnology has a great potential to support industrial sustainability. Biotechnology is much more than an alternative for growing; it is a reality that will have a great influence in any economic sector. Meanwhile, the chemical sector is ahead of the process, specially the pharmaceutical industries, in which private initiative has been investing large sums in research and development in life sciences. This step leads towards an enzyme industry that turns its attention to environment for producing new compounds, as well as the biopharmaceutical industries. In this perspective, biodiversity is considered a strategic resource for the future industry, as far as biological concerns are brought into industrial competitiveness.

Brazil energy matrix is greatly based on hydroelectric power, considered to be a clean renewable kind of energy, but it causes a great loss of biodiversity, due to the flood areas, which impacts negatively the environment. In this context, Brazilian industrial energetic sector seems to be out of the concept of industrial sustainability, once it neglects the environment jeopardizing aspects.

Otherwise, hydroelectric performance, based on river flow and levels to be exploited, may be questionable as they hinder expansion capacity. Besides that, the period of drought may affect the energy supply. Brazilian energy supply faced a crisis in the early 2001, due to the long period of low rains, which depleted the level of dams. People of the Brazilian southwest area faced energy blackout that harmed the regional economic growth, and even threatened the national one. Many measurements had to be taken to save energy, from domestic energy to saving time zones.

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<sup>13</sup> The utilization of natural, financial and human capitals to generate value, wealth and profits.

<sup>14</sup> The utilization of cleaner manners to manufacture more eco-efficient products and processes to minimize pollution, depletion of natural resources and the loss of biodiversity and wildlife and ecosystems.

<sup>15</sup> Ethical behavior aligns to responsible care, in the business management.

<sup>16</sup> Biotechnology does not only avoid pollutants but it also prevents pollution as it produces lesser toxic waste and fewer emissions, besides offering a highly efficient processes reducing costs, as it operates at lower temperatures in comparison to the traditional processes.

<sup>17</sup> It is the scientific name for the industrial production systems that imitate nature.

Besides that, the scientific communities have forecast the scarcity of water resource<sup>18</sup> and have announced that the freshwater resources need to be protected in order to face water supply<sup>19</sup> crisis in an early future. Accordingly to the World Water Vision Report, the water crisis is related to the water consumption per capita increasing, the spatial and temporal changes in water availability in economic sectors. In reality, study points out that 66% of total water withdrawals is used by irrigation (90% related to arid regions), 10% and 20% is used respectively in domestic consumption and in industrial activities and 4% is evaporated from reservoirs. (Shiklomanov, 1999). World Water Council states that crisis is due to mismanagement of water: *'But the crisis is not about having too little water to satisfy our needs. It is a crisis of managing water so badly that billions of people – and the environment – suffer badly.'* (<http://www.worldwatercouncil.org/index.php?id=25>). Indeed, the increased water domestic consumption does not only affect the industrial and agriculture development, but also impacts the aquatic ecosystems and other dependent species. Furthermore, people are unaware about of water saving and consequently, water is wasted as long as it seems not to be limited, which contributes to a real scarcity prospect.

Brazil plays a special role in the world hydrological system. About 12% of the total reservoir of fresh water in the world belongs to Brazil. Yet, Brazil possesses the largest reservoir of fresh water that is heterogeneously distributed. Approximately 80% of this reservoir is located in the Amazon region, where only 5% of Brazilian population lives in and the last 20% are distributed along the country among the rest of 95 % of the total Brazilian population ([http://ww.pennnet.com/display\\_article/344439/41/ARCHI/none/INDUS/1/Strong-growth-prospects-in-Brazilian-water,-wastewater-treatment-market](http://ww.pennnet.com/display_article/344439/41/ARCHI/none/INDUS/1/Strong-growth-prospects-in-Brazilian-water,-wastewater-treatment-market)). Indeed, Brazil has already exploited 12 different water basins in different regions with hydroelectric purposes, which impacts directly the regional ecosystem, climate and hydrological regimes. These modifications may aggravate and contribute for the hydrological disturbance: flood and drought areas.

Undoubtedly, the Brazilian relief profile, with small mountains and plateaus, favors the springs of rivers with a considerable amount of falls; it is the essential condition for the exploration of the potential hydroelectric system. Besides that, the predominant rainy climate contributes to keep water flows high, except to the Brazilian Northeastern region. In fact, in the early Brazilian industrial stage, the hydroelectric power plants were strategic for the national economic growth. But, at this time, the question is: should hydroelectric energy be considered strategic? It is known that the expansion capacity for hydroelectric power plant relies on the rivers regimes that, under certain circumstances, are limited. What should be done when the exploitation of the basins to generate electricity is no longer sufficient to respond the greatest demand for electricity? Even so, the water system seems to be a free resource, in case of water scarcity, the exploration of the hydroelectricity sector will compete with the water supply. This situation can trap Brazil in a dilemma. Furthermore, biodiversity as a tool for bio-based-economy, arises as a driven force in the economic scenario, as well as biotechnology. Is it worth to sacrifice a large amount of biodiversity area in favor of energetic capacity increase for a right economic growth?

### 3. Conclusion

Biodiversity and biotechnology are the real tools for the bio-based-economy and Brazil must be aware of the importance of these strategic points in order not to jeopardize its future. Brazil must make an effort to reduce the energetic dependence on the hydroelectric power plants and seek for other kinds of clean, renewable forms of energy to meet future supply needs.

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<sup>18</sup> Water resources refer to all water available for human use (domestic use), agriculture and industry activities.

<sup>19</sup> Water supply refers to water treated for drinking consume.

Developed countries have already recognized the strategic values of biodiversity and biotechnology for their economic growth. Indeed, global - articulated policies have been made in order to protect biodiversities in developing countries, which are the owners of the largest ones, due to their industrial development delay. Most developed countries are stimulating and implementing plans to bring biotechnological processes into their industrial sectors.

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