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Challenges and Opportunities for Sustainable Development in the Brazilian Electric Sector

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Abstract: *The aim of this paper is to present the challenges and opportunities for sustainable development in the Brazilian electrical sector. The methodology consisted of multiple case studies using semi-structured interviews followed by focus groups with key leaders (presidents, directors or senior managers) from each of the 19 institutions participating in the Brazilian Forum of Environment of the Electric Sector (FMASE), and the two main leaders of FMASE, totaling 40 interviews. FMASE is the main representative entity of the Brazilian electrical sector regarding the improvement of environmental and social issues relating to the energy industry in proposing integrated solutions for sustainable development. It brings together entities of all elements of the Brazilian Electric Sector: generation, transmission, distribution, marketing and consumption. The relevance of this study is given by the fact that the chain of production of electricity is one of the visible themes in any environment in which sustainability is a concern. This study presents a set of challenges and opportunities for the Brazilian electric sector in relation to climate change, expansion of generation, clean energy matrix, environmental licensing, regulatory issues and industry energy efficiency, as well as the context considered by FMASE to validate and prioritize these challenge and opportunities*

Keywords: *Sustainability, Development; Environment; Electric Sector*

I. Introduction

About 70% of Brazilian production capacity consists of hydroelectric power plants of large, medium-size and Small Hydroelectric Stations (SHS) [1]. In general terms, hydro power demands lower costs in operational aspect. In 2009, Brazil produced 2% of all electricity in the world, in a list where the United States accounted for more than 20% of the production [2]. The renewable sources of the Brazilian energy matrix establish the country as one of the leaders in the production of energy from non-fossil source – a country in a unique position to be a global role model of clean energy matrix This article presents the results of a multiple-case study that researched the opportunities and challenges of the Brazilian Electric Sector for Sustainable Development for the 19 Sector entities that comprise the Forum of Environment of Electric Sector (FMASE), which brings together all electric sector activities, such as generation, transmission, distribution, marketing and consumption and represents almost the entire chain of production and consumption of electrical energy that circulates in the National Interconnected System (Sistema Interligado Nacional – SIN). The FMASE is an entity recognized by the parties as the main interlocutor of the electricity sector that seeks the improvement of environmental and social issues relating to the energy industry in Brazil

II. Materials and methods

The research method adopted in this study was the multiple case studies [3]. In order to collect information from 19 entities of the Brazilian electric sector, there were semi-structured interviews that combined open and closed questions, where the participant had the opportunity to discuss the proposed topic. The principal leaders (presidents, directors or senior managers) from each of the 19 institutions participating in the FMASE, as well as the two main leaders of FMASE, were interviewed, totaling a sample of 40. The interviews were guided by a predefined set of questions that were previously sent to the respondents. Later, during the interviews, each issue was addressed personally with the 40 leaders.The questionnaire adopted for the interviews was structured in four blocks of information broken down as follows:

1. Economic and Environmental Characterization of the Electric Sector - Economic characterization, Social and environmental characterization
2. Economic and Social and Environmental Regulations Affecting the Industry - Institutional roles in the sector; Breakdown of main points (Legislation regarding the Brazilian electric sector; Conservation areas and protected areas; Solid waste; Socio-economic register; Environmental education; Dam safety; Macro-zoning of ecological-economic of the Amazon; and Climate change
3. Industry Practices for Sustainable Development - Practices for the treatment of social and environmental impacts; Major changes in technology and management for the sector; Practices related to renewable

energy; Practices for the treatment of social and environmental impacts of processes and facilities; Development practices of suppliers; and Certification initiatives and industry self-regulation adopted by the electric sector

4. Challenges and Opportunities for the Sector in the Path for Sustainable Development - Climate change; Generation expansion; Clean electric matrix ; Environmental licensing; Regulatory framework; and Energy efficiency.

After the interviews with the leaders, based on the previous survey performed by the above questionnaire, four focus groups were conducted with these leaders, moderated by one of the authors of this article, with the aim to reach consensus on prioritizing the challenges and opportunities for the Brazilian electric sector to a sustainable development.Based on information obtained in interviews with key leaders of the participating entities of FMASE, similar responses were grouped into each of the four blocks of the questionnaire, with their respective frequencies presented and discussed in four focus groups involving leaders of FMASE's entities. In these focus groups, the topics were proposed, approved and prioritized by these leaders, generating a set of considerations and proposals presented below [4].

III. Challenges and opportunities in the Brazilian electrical sector towards sustainability

3.1. With regard to climate change

Globally, the energy sector is of paramount importance to the issue of climate change, since the production and energy use accounted for 64.4% of total emissions of greenhouse gases (GHGs) from the planet in 2005 (gases included CO2, CH4, N2O, PFCs, HFCs and SF6 [5]. According to FMASE, Brazil accounted for only 6.5% of global GHG emissions, with deforestation accounting for 64.1% of national emissions. In turn, the national electric power generation accounts for only 2.1% of emissions of greenhouse gases produced in the country (Energy Research Company – EPE, 2012). This index reflects the high degree of renewable sources in the Brazilian energy matrix. In other words, the challenge of the Brazilian electric sector on this issue is to keep a balanced energy matrix, aligning electro energy security and balanced fares in a low carbon economy, based on the following points of consideration:

a. The power industry supports the adoption of voluntary actions without abandoning the principle of common, but differentiated, responsibilities between developed and developing countries. The counterpart would be the mitigation mechanisms (such as Nationally Appropriate Mitigation Actions - NAMAs, Protocol of Kyoto Clean Development Mechanism – Mecanismo de Desenvolvimento Limpo - MDL, Emission Reductions from Deforestation and Degradation – REDD) and other mechanisms that can be created.
b. Brazil must recognize its efforts in having developed and maintained an energy matrix based on 89% renewable sources while the world average is 18% [6];Negotiations should exploit this comparative advantage of Brazil. In this sense, the entities participating in FMASE propose the creation of a Renewable Electricity Seal (on the production side) and a Seal of Electricity Development (on the consumption side), both internationally recognized, which specify the content of energy sources used in the production of Brazilian products. The seal will certify renewable energy of domestic products produced with a significant percentage of renewable sources.
c. Change in the planet's climate may adversely affect agriculture, livestock and public services, especially those associated with operating the electric distribution system of generation and transmission.

To keep the high share of renewable sources in the Brazilian energy matrix, in accordance with the National Plan on Climate Change [7], the participants of this study consider it necessary that the Government implement the following actions:

a) Within the electric sector:

- Expand, support and maintain effective networks for monitoring hydrological variables, weather and climate to enable further prospective studies.
- Promote better understanding and communication with society about the benefits of hydroelectric plants, which currently represent the basis of the Brazilian Electric Sector, and other renewable sources such as wind farms and biomass.
- Similarly, promote clarification for society on the thermonuclear power that, in spite of the radioactive wastes produced that are not renewable, does not emit greenhouse gases.
- Review the priority for implementation of small stream hydroelectric plants, recognizing that storage reservoirs play a fundamental role.
- Prioritize the deployment of small stream hydroelectric plants for small hydropower requirements up to 50 MW.

- Promote the sustainable use of river-water potential (more than 100 GW) concentrated in the Amazon, as well as harnessing the great potential of still-untapped unconventional renewable sources such as wind farms and biomass at sites where such sources are viable.
- Develop legal regulations that close domestic legal gaps on topics related to climate change, such as governance, administrative and legislative competences, voluntary and mandatory targets and economic instruments.

o **Externally to the electric sector:**

- Advocate for urging the implementation of mitigation mechanisms like NAMAs that allow emission reduction targets proposed by the State that have as one of the counterparts an effective access to resources that will be available for the implementation of all renewable and non-emitting GHG.
- Treat thermal plants and their emissions as an additional source in the Brazilian energy matrix, indispensable to the energy security of the system. Consider incentives for clean technology transfer, rather than penalties, within the concept of "Environmental Credit History," since the planning of the sector already includes minimizing the operation periods of thermal plants.
- All trading should prevent the establishment of commitments that result in raising electricity rates to Brazilian consumers.
- It is of interest to the electric sector to simplify, improve and continue the further implementation mechanisms, especially the Clean Development Mechanism (Mecanismo de Desenvolvimento Limpo - MDL).

At the end of the interviews, it became clear that members of FMASE are aware of the important role that the electric sector has in expanding the infrastructure needed for sustainable development of the country. To this end, interviews suggested a set of actions that need to be implemented in reference to climate change issues:

a. Periodic preparation and dissemination of emission inventories, if possible, including a broad approach to the energy value chain.
b. Expansion of conservation programs and energy efficiency use.
c. Promotion of scientific research and education by public and private agencies.
d. Prospective studies of the potential storage reservoirs to be used in mitigating or adapting to the effects of climate change and the integration of intermittent sources of energy such as wind farms.
e. Development of studies on anthropogenic GHG emissions from hydroelectric reservoirs.
f. Investments in R&D for studies related to the effects of and adjustments to climate changes

1.2. With respect to the generation expansion

In any scenario that is projected for Brazil, the need for expanding the supply of electricity is common to all sectors of Brazilian society and economy. It is understood that the strategy of expanding production of electricity to Brazil should be considered a fundamental instrument of social and economic development and based on three axes:

Axis 1 – Conventional hydroelectric sources

The circumstances surrounding the approval of hydroelectric projects has led to the adoption of mostly "trickle of water" projects; that is, plants with no reservoir. Thus, recent years have seen a gradual loss of sensitive regulation of the reservoirs. The area ratio/average power of new plants is 0.06 km²/MW, while in 2007 the average was 0.51 km²/MW [8].

The hydroelectric reservoirs are fundamental to other energy sources as a complement and provide back-up assurance to seasonal or intermittent sources such as biomass and wind. On the other hand, they act in synergy with thermal plants, resulting in reduced fuel costs.

Given that, we also provide complementary regional expansion projects, which have the following emphases: North: hydropower; Northeast and South: wind; Southeast and Midwest: biomass

Axis 2 – Unconventional renewable sources (new renewable)

Unconventional renewable energy, particularly wind, biomass, small hydroelectric plants and, soon, the sun, should play a key role in maintaining the share of renewable in the Brazilian energy matrix. To this end, there is complementary capability both regionally and seasonally from these sources with hydroelectric power, generating more energy during the dry period, preserving the reservoirs.

The Brazilian wind potential was inventoried at 143,000 MW with towers 50 meters tall in 2001. With current technology of wind turbines more than 100 meters tall, this potential may be greater than 300,000 MW, almost three times the current installed capacity of the Brazilian electrical system [9].

These results in the present condition of complementary sources, which optimize the use of tanks and reduce the risks associated with dry periods. Dams, the main source of electricity in the country, create the base, using the other sources to adjust the demand. The reservoirs of hydroelectric plants and transmission network are used to modulate the production of biomass energy and wind power. Unlike other countries, backups, which are usually

based on thermal sources that operate with low efficiency due to the need of frequent activation and deactivation, are not required.

Axis 3 - Thermoelectric sources (natural gas, coal and nuclear)

The optimal expansion of a power generation system is a mix of hydroelectric and thermal sources because they are complementary. On one hand, thermal power plants contribute for operation security when hydric systems are unfavorable, on the other hand hydroelectric plants allow to reduce operation costs of the thermal plants when hydric systems are favorable (in the case of Brazil, most of the time).

The thermal power plants are triggered every time unexpected events occur. These same triggers could not be made by renewable sources (wind and small stream hydroelectric plants), because these sources cannot be dispatched – which means, that they operate when conditions are favorable.

1.3. With respect to a clean energy matrix

The following are required to maintain a national clean energy matrix:

- Incentives for tax relief and special tax regimes for an economy with cleaner energy and climate policies that create competitive advantages in a low carbon economy, including manufacturers of power generation equipment and service providers related to implementation of the facilities. These incentives should be reduction or exemption of taxes.
- Implementation of procedures for integrating the tools of planning and environmental management regarding: economic-ecological zoning, watershed plans, in regional and sectoral strategic environmental assessments, plans for economic and social development planning, cities statutes, integrated environmental assessment of watersheds (unregulated) and their relationship to decision making in the licensing process.

1.4. With respect to environmental licensing

Relevant challenges regarding permitting procedures:

- Ensure transparency and quality in all stages of the licensing process, including strengthening the environmental agencies.
- Mix the procedures, better defining the requirements that involve the cycle of environmental permits considering time and cost predictability.
- Provide an environmental license to proceed with the project after all legal conditions have been met.
- Change the rules of environmental crimes so that public officials who deal with environmental authorizations or permissions may only be punished in case of fraud.
- Improve other environmental management tools (economic instruments, environmental quality targets) as a contribution to the efficiency of licensing.
- Change the paradigm in dealing with environmental disputes, which tend to accumulate and derail the construction of hydroelectric plants.

1.5. With respect to regulatory matters

The regulatory framework for the electricity sector demands constant improvements in order to meet the needs of the parties involved, among which are:

- Create, by law, the Strategic Reserve Potential of Hydraulic Engineering, which aims to ensure that areas with potential for hydro generation in the country are effectively used for the production of electricity, and to ensure the land necessary for the associated transmission is available. With this, Brazil enforces the strategic advantage of its large hydro potential.
- Regulating Article 231 of the Federal Constitution on the use of water resources, including hydroelectric potential on Indian lands as well as prospecting and exploitation of mineral wealth.
- Develop specific regulatory milestones for compensation and mitigation measures

1.6. In relation to energy efficiency

As important as increasing the supply of renewable energy is to increase the efficiency of energy consumption generated. Initiatives underway in Brazil will avoid an increase of 8.3% expansion in 2030, equivalent to 109 TWH.The cost of additional energy obtained through energy efficiency - energy saved - must be competitive and lower than the marginal cost of expansion (which represents only 20% of value paid by the consumer). The main barrier that inhibits the behavior of private agents to delay investments in energy conservation is the fact that these initiatives provide rates of return below those of other initiatives that competes for the same resource internally (expansion in production, introducing new technologies that increase competitiveness of the product etc.)

IV. Conclusions

The data collected through the application of this case study with the FMASE, representative body of the Brazilian Electric Sector in relation to the improvement of environmental and social issues relating to the energy industry in proposing solutions together for sustainable development, through semi-structured interviews and analyses, provide the basis for the expansion and generalization of the challenges of the Brazilian electrical sector in sustainable development.As shown in this study, the main challenges of sustainable development for the Brazilian Electric Sector are in the areas of climate change, expansion of generation, clean energy matrix, licensing, regulatory and energy efficiency.It was observed that most of the analyzed companies share similar challenges in terms of practical application, systems and management models to stimulate sustainable development.At the end of the interviews, it was observed that the power sector is committed: to provide energy security and to provide sustainability and universal access to energy in support of Brazilian public programs of social inclusion and combating poverty; to promote the "new economy" since the power input is critical to the stimulus of production and for social inclusion, in this case, including through direct action to combat poverty; to highlight the contribution of the sector in the design and implementation of policies and as social and environmental program pioneers in the recent history of Brazil, showing the commitment of the electricity sector with the continuity of these actions; to strengthen the position of the Brazilian electric sector as a global benchmark in setting up a renewable energy matrix that is, above all, sustainable and supported by good practice in social management of the enterprises of the sector; and to address, as protagonists, the challenges and opportunities that are already part of reality in the electricity sector in building a sustainable reality.

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