REVISTA CATALANA DE DRET AMBIENTAL Vol. VI Núm. 1 (2015): 1 – 29
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PROSPECT OF TRANSITION INTO SUSTAINABLE ENERGY: AN ANALYSIS OF BRAZILIAN ENERGY PROGRAMS

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Received: April 1st 2015 / **Accepted:** May 15th 2015

ABSTRACT: The cause of many environmental problems currently discussed may be imputed to current standard of production and consumption of energy, which is not consistent to the sustainable development's concept. On the other hand, energy is a key element of modern society and, without an adequate supply, its development will be limited. Thus, it is clear that the demand for energy, particularly in development countries, shall grow in coming years; so it is up to policy makers to develop mechanisms and encourage a transition into renewable (or sustainable) energy sources. At that point, the Environmental Law must operate along with the policy makers, by coordinating the necessary means to achieve predetermined goals, through public policies and programs – which are generically composed of command and control instruments and economic instruments. This study aims to illustrate those challenges with the discussion of two public programs implemented in Brazil for those purposes: "Light for All" and "Program of Incentives for Alternative Energy Sources" – PROINFRA.

KEY WORDS: Transition — Sustainable Energy — Developing Countries — "Light for All" — PROINFA.

1. INTRODUCTION

Energy is usually seen as a central issue to modern societies, especially regarding their development process. Even though it is not an end in itself, the services provided by an adequate supply of energy can be translated into lighting, heating, cooling, communication and transportation, among other services that highly improve life conditions. Education and health are better provided with energy availability. Likewise, it is recognized that an adequate supply of energy is essential for industrial growth, and encourages economic activities of higher added value, both in urban and rural areas, that produce higher income and create better jobs[1].

Still, it is estimated that currently 1.3 billion people around the world have no access to electricity and 2.6 billion people rely on traditional biomass to basic activities, such as cooking[2].

In Brazil, in 2012, exceeding the estimates of the government itself, a survey carried out by the Brazilian Electricity Regulatory Agency (ANEEL) pointed out that one million homes still had no access to electricity[3].

That means the energy consumption tends to increase significantly, especially in developing countries. It is estimated a growth of 35% in the consumption in order that people meet their basic human needs by 2040[4], and also improve their life standards.

[1] WEHAB Working Group. (2002, August) A Framework for Action on Energy. Retrieved 19 June 2014, in <http://www.un.org/jsummit/html/documents/summit_docs/wehab_papers/wehab_energy.pdf>.

[2] International Energy Agency. (2013) World Energy Outlook. Retrieved 17 June 2014, in <http://www.iea.org/publications/freepublications/publication/WEO2013_Executive_Summary_Portuguese.pdf>.

[3] AMATO, Fábio. O Globo. (16 December 2012) Brasil tem mais de 1 milhão de residências sem luz, diz ANEEL. Retrieved 18 June 2014 in <http://g1.globo.com/economia/noticia/2012/12/brasil-tem-mais-de-1-milhao-de-residencias-sem-luz-diz-aneel.html>.

On the other hand, the cause of many contemporary environmental problems – from air pollution at the local level to climate change resulting from the increasing atmospheric concentrations of greenhouse gases (GHG) – can be attributed to our current patterns of production and consumption of energy. The wide use of fossil fuels since the Nineteenth Century led to an increase of about 30% in the atmospheric concentration of carbon dioxide (CO_2). In 2012, the energy sector itself accounted for 41% of CO_2 emissions; however, the patterns of consumption of energy also relate closely to emissions from other sectors, among which we emphasize the industry (20%) and the transport sector (22%)[5]. Still, the global energy matrix is largely dependent on fossil fuels, and the petroleum is the most important energy resource in the world, accounting for about 33.1% of global energy demand.

The climate change problem calls for a reduction in energy consumption so scholars and public policy makers debate the different policy choices and instruments to foster both innovation, which means the incorporation of invention into new technologies, and diffusion of such efficient technologies[6]. Part of the debate focus on the "energy paradox" meaning "the idea that consumers undervalue cost savings from investment in energy efficiency"[7] and may be induced to consume more energy due to lower costs.

Regardless of this caveat, this paper assumes the need to foster the diffusion of energy efficiency and the increase in the use of sustainable sources, while access to energy use by people and communities excluded from it is increased. These aims would help to reconcile the environmental goal of emission and impacts reductions to the social goal of improved access to energy.

The challenge described makes a case for a transition into renewable energy – or, more specifically, "sustainable energy" – around the world. However, the development of renewable energy sources needs support until they can compete with those conventional

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[4] ExxonMobil. (2014) The Outlook for Energy: a View to 2040. Retrieved 17 June 2014 in <http://cdn.exxonmobil.com/~/media/Reports/Outlook%20For%20Energy/2014/2014-Outlook-for-Energy-low-resolution.pdf>.

[5] FOSTER, Vivien; BEDROSYAN, Daron. World Bank Group. (2014) Understanding CO_2 Emissions From The Global Energy Sector. Retrieved 18 June 2014 in <https://openknowledge.worldbank.org/bitstream/handle/10986/17143/851260BRI0Live00Box382147B00PUBLIC0.pdf?sequence=1>.

[6] JAFFE, A. B; STAVINS, R. N., "The energy paradox and the diffusion of conservation technology", in *Resource and Energy Economics*, n. 16, 1994, p. 92.

[7] LEARD, Benjamin. Consumer heterogeneity and the energy paradox. Retrieved 21 January 2015, in <http://www.econ.iastate.edu/sites/default/files/benjamin_leard_jmp_0.pdf>.

fossil fuels[8]. That is especially true in developing countries that may have access to a range of technologies that were not available to developed countries in the past, but the switch from less efficient or more pollutant sources to more efficient ones requires the implementation of domestic or/and international programs.

This paper analyses two programs adopted in Brazil, a great example of an emerging developing country, with regards to its contribution to an energy transition for the implementation of sustainable development and for the pursuit of electricity universalization. Such analysis aims to illustrate the difficulties to implement a right to sustainable energy as claimed in international documents such as "The future We Want", adopted as a Declaration of the United Nations Conference on Sustainable Development, in 2012[9].

2. SOCIAL AND ECONOMIC DEVELOPMENT AND ENERGY USE INCREASE

The challenge for the energy sector in Brazil is to achieve an economic development that may cause an increase in energy consumption but the current pattern of its consumption is also the cause of many environmental problems. Although its energy matrix is predominantly based on hydroelectricity there has been a substantial increase in the use of fossil fuels power plants in the last years[10]. In addition, it is planned to increase the generation capacity through the construction of big hydroelectric plants that create many social and environmental impacts.

There are claims that this challenge may follow a Kuznets curve, regarding the environmental impacts of energy use in the process of countries development. According to that claim the development process is composed, in general, of three phases: i) the evolution from traditional to industrial society, when energy consumption increases; ii) the maturing of the industrial society, a moment of energy consumption

[8] GOLDEMBERG, José. Instituto de Energia e Ambiente da Universidade de São Paulo. (2002) The Brazilian Energy Initiative. Retrieved 23 June 2014, in <http://www.iee.usp.br/biblioteca/producao/2002/Artigos%20de%20Periodicos/goldembergsecondnewsletter.pdf>.

[9] United Nations. The Future We Want. Retrieved 19 June 2014, in <http://www.un.org/disabilities/documents/rio20_outcome_document_complete.pdf>.

[10] GOLDEMBERG, José and LUCON, Oswaldo. "Energy and environmental in Brazil", in .*Estudos Avançados*, n. 21, 2007, pp. 7-20.

peak; and iii) the evolution from industrial to information society, when the services sector stands out from others. As services are less energy-intensive, the energy consumption tends to decrease[11].

It is important to explain that the Kuznets curve originally referred to the hypothesis, defined by Simon KUZNETS in the fifties that inequality tends to rise when countries begin to grow but then decreases after the process proceed[12]. The curve is then shaped as an inverted U. In the nineties, a similar analysis was formulated for the issue of environmental degradation, arguing it would rise at a first phase of economic growth but, at some point, it would decrease. Then, economic growth would be a solution rather than a treat to environmental protection. That analysis is referred as Environmental Kuznets curve[13]. The critics to this analysis points the move of pollutant and natural resources intense activities to less developed countries, that would explain the curve but not solve the problem of the maintenance of pollutant activities in the globe. In addition, there are environmental problems that cannot be reverted, like the loss of biodiversity and climate change. Besides, the goal of sustainable development claims that developing countries should not follow exactly the same path developed countries followed in the past and must show concern to the environment along the whole process.

With regard to energy, the path described above is not universal as energy intensity of economic activities varies across countries and over time. It is possible that a country learn from the experiences of others and, thus, it may skip some stages of the development process as presented, avoiding some environmental impacts related to an intermediate stage of technological advances. In this sense, we talk about leapfrogging, which is the expression related to the idea that developing countries currently have access to a range of technologies that were not available to developed countries in the

[11] International Atomic Energy Agency. *Brazil: A Country Profile on Sustainable Energy Development*, 1st edition, IAEA, Vienna, 2006, p. 89.

[12] KUZNETS, S. "Economic growth and income inequality", in *The American Economic Review*, v. XLV, n. 01, 1955, pp. 01-28.

[13] STERN, D. "The rise and fall of the environmental Kuznets curve", in *World Development*, v. 32, n. 08, 2004, pp. 1149-1439.

past[14]. The leapfrogging results from the adoption of energy efficient technology and innovation that promotes a decrease of the energy intensity of production.

Since the relationship between primary energy uses and economic activity is complex and relates to social and economic changes, a decrease of energy intensity may also result of structural economic changes that increase energy efficiency. In order to skip the energy Kuznets curve, it is necessary to decouple energy use and economic growth, what means pursuing growth and development and reduction of energy use simultaneously[15].

Leapfrogging relates to the assumption that developing countries consume less energy today then industrialized countries at the same income level did in the past or/and experience the same one percent of economic growth with a lower growth in energy consumption than the last did in the past. That would happen as a result of innovation, meaning the availability of new technologies[16].

However, the mere availability of these technologies is not a sufficient condition for its adoption by the developing countries, given their high costs and, in many cases, the existence of an energy-intensive infrastructure.

In an extensive study about leapfrogging in different countries in ten years, Professor Arthur VAN BENTHEM found that the income elasticity of energy demand, *i.e.*, the analysis of the level of energy consumption for different countries that experience the same level of economic growth, is higher for the developing countries than for the developed countries in the past. His conclusion is that leapfrogging may have occurred but was offset by other factors. Those may be related to the fact that less developed countries today consume a more energy intensive bundle of goods and services compared to rich countries in the past (cars, computers, air travel i.e.) or that they are not cost-effective in developing countries in the absence of appropriate incentives or even environmental and regulatory constraints[17]. Nonetheless, as leapfrog can occur, the implementation of programs to induce it is crucial. Often this process relies on

[14] Arthur Van Benthem, 'Has Energy Leapfrogging Occurred on a Large Scale?' (2010) SSRN <http://ssrn.com/abstract=1698238> accessed 28 April 2014.

[15] International Atomic Energy Agency, *Brazil: A Country Profile on Sustainable Energy Development* (1st, IAEA, Vienna 2006) 89.

[16] VAN BENTHEM, Arthur. (2010) Has energy leapfrogging occurred on a large scale? Retrieved 28 April 2014, in <http://ssrn.com/abstract=1698238>.

[17] Ibid.

international cooperation that may be related to technology transfer, but not necessarily. International organizations can help the development of renewable energy by the dissemination of successful practices and technics, promoting research and specific investment[18].

If we consider that the development process has a necessary link to the improvement of life conditions of the poorest groups, there are other set of questions concerning the substitution of energy sources that can be considered as examples of leapfrog[19].

As we know, the poorest communities depend essentially on the wood as an energy source. However, firewood consumption is considerably harmful, both to the health of users and to the environment. Indeed the use of solid biomass pressures forests and pollutes both indoors and outdoors atmosphere as a result of its significant emissions of greenhouse gases. It is also estimated that indoor pollution caused 2.5 million premature deaths in 2002[20]. Thus, the replacement of the firewood by other fuel, even if fossil, like LPG (liquefied petroleum gas), would have a positive effect with regard to both objectives considered here: the improvement of quality of life and the reduction of greenhouse gases emissions[21] and allows a conclusion that there is not exactly a trade-off between public policies for poverty eradication and for combating environmental problems.

The shifting from traditional biomass for domestic use to more efficient fuels such as LPG, kerosene, natural gas or electricity as a result of income growth is referred in the literature as "energy ladder" or fuel switching[22].

Both the challenges of promoting leapfrogging for the reduction of energy intensity of the development process and promoting the energy ladder require public policies concerning these various aspects of the energy sector.

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[18] As is the purpose of the International Renewable Energy Agency. See 3, below.

[19] GOLDEMBERG, José. "Technological leapfrogging in the developing world". in *Georgetown Jornal of Internationbal Affairs*, v.12, 2011, pp.135-141.

[20] HELTBERG, Rasmus. World Bank Group. (2003) Household fuel and energy use in developing countries: a multicountry study. Retrieved 20 September 2014, in <https://esmap.org/sites/esmap.org/files/Report_FuelUseMulticountryStudy_05.pdf>.

[21] ABRAMOVAY, R; MORELLO, T. F.; SCHMID, V., "Rompendo com o trade-off entre combate à pobreza e mitigação do efeito estufa: o caso do consumo domiciliar de energéticos no Brasil", in Motta, R. S. (Ed.), *Mudanças do clima no Brasil: aspectos econômicos, sociais e regulatórios*, 1st edition, IPEA, Brasília, 2011, p. 91.

[22] Ibid, p. 11.

Environmental policies, in general, depend on a proper proportion between command and control and economic instruments as well as on appropriate levels of accountability allowed by information and public participation. Command and control instruments are those that set specific regulations, rules, procedures and standards for certain economic activities and their noncompliance results in the imposition of sanctions, in order to ensure the fulfillment of the objectives of the policy[23]. Economic instruments can be defined as those instruments that act directly on the costs of production and consumption of a good or a service as a way to induce the behavior of economic agents in the required direction[24], in accordance with the public policy's goal.

Policies for renewable energy often parallel climate change policies in view of the common goal of reducing GHG emissions and increasing the use of cleaner energy sources and rely on regulatory measures combined to some command and control and economic instruments. Those policies usually rely on direct subsidy or tax on pollution sources. The subsidies may be directed to capital investment on renewable energy or for renewable energy use, or to consumers for acquisition of equipment compatible to those energy sources. Also cap-an-trade rules, that create markets for some kind of emission permits and also on Renewable Portfolio Standards (RPS) are defined in energy policies and programs. This last concerns the requirement of a certain percentage of electricity to be generated from renewable sources. There is a mix of economic instruments to incentivize such as the subsidies and cap-and-trade in order to reduce the energy costs for some social groups or reduce the costs of policy compliance and command and control tools as the RPS[25].

3. THE EVOLUTION OF THE DISCUSSION AT THE INTERNATIONAL LEVEL AND 2012 AS THE INTERNATIONAL YEAR OF SUSTAINABLE ENERGY FOR ALL

Recognizing those assumptions, the regulation of the energy issue has evolved in International Environmental Law, meeting the evolution of the concept of sustainable

[23] Ibid.

[24] DE OLIVEIRA NUSDEO, A. M., "O uso de instrumentos econômicos nas normas de proteção ambiental", in *Revista da Faculdade de Direito da Universidade de São Paulo*, 2006, pp. 357-378.

[25] PALMER, K.; PAUL, A.; WOERMAN, M.; STEINBERG, D. C., "Federal policies for renewable electricity: impacts and interactions", in *Energy Policy*, v. 39, i. 07, 2011, pp. 3975-3991 and SOARES, Cláudia D.; SILVA, Suzana T. Direito das energias renováveis. Coimbra: Almedina, 2014, p. 21.

development in the regulation of the environmental issue from the United Nations Conference on the Human Development, held in Stockholm, in 1972. Its Declaration[26] did not mention specifically the subject, although it recognizes the importance of the development of science and technology to tackle environmental problems and also the importance of international cooperation from developed to developing countries.

In the following decade, however, the energy issue received due attention. Example of that is the outcome document of the United Nations Conference on New Sources of Renewable Energy[27], held in Nairobi, in 1981, wherein recognizing the importance of developing new renewable energy sources to meet the needs of the continuous socioeconomic development of developing countries, while distancing from the heavy dependence of national economies on fossil fuels. The Nairobi Program of Action for the Development and Utilization of New and Renewable Sources of Energy was adopted as a recognition of the urgent need for measures to facilitate the transfer and adaptation of technology from developed to developing countries, This program specifically enumerates the transfer, adaptation and application of technologies that are already in a mature stage of development (including solar and wind energies) as one of the major areas of public policies to be adopted, by creating procedures for a broad transfer of technologies to all countries, under conditions of mutual benefit and considering the particular needs of each, which involves, as it seems, the concept of leapfrogging.

Some years later, in 1987, the report developed by the World Commission on Environment and Development, entitled "Our Common Future", devoted an entire chapter to the debate on energy[28], recognizing its indispensability for human survival itself, in addition to their well-being. It also states that the development of a country requires a growing supply of energy services, however, this should be done in a safe, reliable and appropriate way to the environment, and that there is a deep connection between the choices made within the energy issue and environmental public policies implemented by the government. Given the environmental problems in production and

[26] United Nations. Declaration of the United Nations Conference on Human Environment. Retrieved 02 June 2014, in <http://www.unep.org/Documents.Multilingual/Default.asp?documentid=97&articleid=1503>.

[27] United Nations. *Report of the United Nations Conference on New and Renewable Sources of Energy*, United Nations, New York, 1981.

[28] Comissão Mundial sobre Meio Ambiente e Desenvolvimento. *Nosso futuro comum*, Editora da Fundação Getúlio Vargas, Rio de Janeiro, 1991, pp. 186-229.

energy use, the report mentions that the government should implement actions to promote the use of energetic efficient technologies, in order to enable economic growth, in particular with regard to productivity, without incurring environmental risks.

In 1992, United Nations Framework Convention on Climate Change[29] signed at the United Nations Conference on Environment and Development, in Rio de Janeiro, stated the fact that human activities have substantially increased greenhouse gases concentration in the atmosphere, which added to the natural greenhouse effect, possibly lead to climate change on the planet and consequent negative effects. On the other hand, still in its preamble, this document recognizes the priority of developing countries in combating poverty and achieving sustainable development, for which an increase in energy consumption is needed – determining, then, the application of new technologies, especially with respect to energy efficiency, in order to control emissions of greenhouse gases. Similarly, among the principles set forth in Article 3, the document states that the measures adopted at the national level to protect the climate system against anthropogenic interference should be integrated into public policies on economic development.

Regarding specifically the energy sector, it is recognized as an important sector in which international cooperation is needed, including technology transfer, in order to reduce or prevent anthropogenic emissions of greenhouse gases, pursuant to Article 4, paragraph 1, letter "c", referring to the commitments agreed by both developed and developing countries.

However, as this document is a framework agreement, the signatory States should periodically organize a conference, called Conference of the Parties – COP, which would take the necessary decisions to promote its effective implementation. Thus, in 1997, it was drafted the Kyoto Protocol[30], which in its Article 2 provides that the measures to reduce emissions of greenhouse gases, integrated to the promotion of sustainable development, involve the adoption of public policies aimed at improving energy efficiency in relevant sectors of the national economies and the development of

[29] United Nations. United Nations Framework Convention on Climate Change. Retrieved 19 June 2014, in <https://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf>.

[30] Conference of the Parties to the United Nations Framework Convention on Climate Change. 1/CP.3: Adoption of the Kyoto Protocol to the United Nations Framework Convention on Climate Change. Retrieved 19 June 2014, in <http://unfccc.int/resource/docs/convkp/kpeng.pdf>.

renewable energy sources. Similarly, in enunciating the commitments adopted by developed and developing countries, in its Article 10, it is determined that they should formulate and implement policies containing measures to mitigate climate change and facilitate adaptation in case these changes happen. Also, those policies should involve, among others, the energy sector, in addition to the sectors of transport, industry, agriculture and waste treatment – sectors which, in a certain way, also relate to the energy issue.

Also written in 1992, the Agenda 21[31] attempts to identify the priority issues on which humanity should be concerned, as well as the resources and means to address them and the goals for the Twenty-first Century. Despite the lack of a chapter related to the energy issue, the issue permeates the entire document, which demonstrates its necessary integration with the entire development process, given that energy is not an isolated sector. In order to illustrate it, one of the chapters in which the relation with energy is analyzed more deeply is Chapter 4, which, in dealing with the change of production and consumption patterns, provides that a State can grow economically and, at the same time, reduce the consumption of energy and raw material. In this regard, it recognizes that not only the reduction in energy consumption contributes to mitigate environmental problems, but it can also increase productivity and industrial competitiveness, so that the government, in a partnership with the private sector, should adopt measures to promote the use of energy and natural resources in a cost-effective and environmentally healthy way, *i.e.*, in a sustainable way. It is emphasized the importance of adopting appropriate economic instruments to indicate to the market the environmental costs of energy consumption – which can be used, also, to influence a consumer behavior change and, therefore, the patterns of both production and consumption.

In its turn, Chapter 9 focuses on the protection of the atmosphere, including the concern with efficiency and consumption of energy in the discussion on the promotion of sustainable development, considering that if, on the one hand, energy is essential for social and economic development and a better quality of life, on the other hand, current patterns of production and consumption of energy cannot be sustained. Thus, the document states that the need to control atmospheric emissions of greenhouse gases should be based, increasingly, in the efficiency, production, distribution and

[31] United Nations. Agenda 21. Retrieved 19 June 2014, in <https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf>.

consumption of energy, with a growing reliance on energy systems that are environmentally healthy, especially, again, renewable energy sources.

Another important result from the 1992 Summit was the creation of the Commission on Sustainable Development. It is interesting to note that in its Ninth Session[32], held in 2000 and 2001, the aforementioned Commission on Sustainable Development expressly recognized that energy is a key issue in the implementation of sustainable development, and, as a result of a dialogue between different stakeholders, sustainable energy was defined "as having minimum impacts on social and environmental health". This definition excludes nuclear energy because of its long-lasting toxic substance's waste as well as large-scale hydropower and its major impacts on riverside communities. Despite being considered as renewable energy, these sources cannot be classified as sustainable energy: sustainability is a more restrictive requirement, which goes beyond the mere aspect of renewability of the energy source.

More recently, we had the United Nations Conference on Sustainable Development, held in 2012, again in Rio de Janeiro, at which it was adopted the document "The Future We Want"[33], indicating as the essential objectives of sustainable development: i) poverty eradication; ii) changes in the production and consumption patterns, towards a path of sustainability; and iii) proper management of natural resources; objectives which are considered the foundation of social and economic development.

Energy is a pervasive subject of the document, considered as a cross-sectorial issue, meaning a subject that integrates the various sectors. Thus, access to energy services is considered a key issue in the implementation of sustainable development, as they contribute to the eradication of poverty, improvement of health conditions, among other basic human needs. Still, according to the document, an adequate national energy matrix to meet the needs of a society in the development process should include the promotion of the use of renewable energy sources, as well as other technologies to reduce the emission of pollutants, in addition to a more efficient use of energy and the reliance on more advanced technologies, including cleaner fossil fuels and sustainable use of traditional energy sources.

[32] Commission on Sustainable Development. Report on the ninth session (5 May 2000 and 16-27 April 2001). Retrieved 19 June 2014, in <http://www.un.org/ga/search/view_doc.asp?symbol=E/CN.17/2001/19%20%28SUPP%29&Lang=E>.

[33] United Nations. The Future We Want. Retrieved 19 June 2014, in <http://www.un.org/disabilities/documents/rio20_outcome_document_complete.pdf>.

All the above mentioned documents recognize energy as a central issue in the development process, whose analysis must be integrated with social and economic aspects of each State, who is responsible for adopting the internal public policies that are required, although they attribute a particular importance to international cooperation, in financial, human and technological terms.

In 2009, it was created in Bonn, Germany, the International Renewable Energy Agency (IRENA). The agency creation was defined in the Conference on New Sources of Renewable Energy, held in Nairobi, in 1981. Its aims concerns specifically the cooperation for the development and spread of renewable energy and includes independent information disclosure, the creation of synergies, the sharing of knowledge and regulatory successful experiences and the promotion of cooperation at the national, regional and global level[34].

At last, the General Assembly of the United Nations declared that 2012 would be the "International Year of Sustainable Energy for All"[35], and, later, that 2014 to 2024 would be the "United Nations Decade for Sustainable Energy for All". That was the starting point so that, until 2030, three objectives considered as fundamental were achieved: i) ensure universal access to modern energy services; ii) double the rate of improvement in energy efficiency; and iii) double the share of renewable energy in the global energy mix. In this sense, Ban-Ki Moon launched, in 2011, Sustainable Energy for All (SE4All), a program aimed at catalyzing this transformation toward a sustainable energy future, "by introducing new public-private partnerships built from constructive dialogue on policy, investment and market development by governments, business, civil society and international organizations"[36].

These goals must be achieved simultaneously, since they are complementary to each other as well as equally necessary. Thus, according to the United Nations Secretary-General, Ban Ki-Moon, these goals are intertwined, and, for instance, increasing the opportunities for technologies related to renewable and affordable energy helps to bring modern energy services to communities that had no access to them, the same way that

[34] International Renewable Energy Agency (IRENA) <http://www.irena.org/menu/index.aspx?mnu=cat&PriMenuID=13&CatID=9> retrieved 30 March, 2015.

[35] United Nations. A/RES/65/151: International Year of Sustainable Energy for All. Retrieved 20 June 2014, in <http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/65/151>.

[36] United Nations. Sustainable Energy for All: 2014 Annual Report. Retrieved 02 June 2015, in <http://www.se4all.org/wp-content/uploads/2015/05/SE4ALL_2014_annual_report_final.pdf>.

advances in energy efficiency help to lower the use of existing energy grid, thereby allowing to extend the energy services to more users.

Thus, what makes SE4All different and more likely to achieve these goals, according to its first Annual Report, is: i) a clear global vision and objectives that cut across all three pillars of sustainable development; ii) unmatched network of stakeholders, involving governments, business and civil society; iii) unparalleled convening power; iv) an ability to mobilize best practices and innovative solutions; v) a capacity to leverage large-scale investment; and vi) transparent tracking framework towards the three goals[37].

Also, these three goals – since energy is not a sector in itself – are considered to be closely linked to other development ones, such as poverty eradication and food security, in a way that Sustainable Energy For All reflected in the creation of other programs, such as the FAO multi-partner program "Energy-Smart Food for People and Climate"[38] that seeks to support stakeholders in improving energy efficiency, increasing the use of renewable energy and improving access to modern energy services specifically in agriculture, thus, aiming to bridge the transition into sustainable food and energy systems.

4. THE ENERGY ISSUE IN BRAZIL: AN INTEGRATED READING OF THE LIGHT FOR ALL AND PROINFA

Brazil is one of the BRICs' countries and an emerging developing country that has been a protagonist in environmental negotiations since it hosted the United Nations Conference on Environment and Development, in 1992. It has been an important player at Climate and Biodiversity international negotiations and, again, the host of the United Nations Conference on Sustainable Development, in 2012.

Brazilian environmental protection is stated at its Federal Constitution as well as in many States' Constitutions and its legislation addresses many environmental issues. On the other hand, it is a country of a relatively clean energy matrix and one the megadiverse countries in the world.

[37] Ibid.

[38] Food and Agriculture Organization of the United Nations. Energy-Smart Food for People and Climate: issue paper. Retrieved 01 June 2015, in <http://www.fao.org/docrep/014/i2454e/i2454e00.pdf>.

All those legal and environmental characteristics allow a question of how those international goals concerning sustainable energy are being implemented in the country. Also, despite being adopted prior to 2012, the two Brazilian programs that will be explained in this chapter, as read in an integrated way, aim the universal access to energy services, but also increasing the share of renewable energy, *i.e.*, the same objectives of the Sustainable Energy for All.

In this sense, currently, a major priority for Brazil's government is to meet the increase in energy demand fuelled by population and economic growth, but also to balance this goal with environmental and social priorities[39].

In the specific context of inequality in per capita energy consumption in Brazil, in addition to the alarming data about the lack of access to electricity, prepared by CENSO 2000, it was established on November 11, 2003 the National Program for Universal Access and Use of Electricity, which is known as "Light for All", by the Decree n. 4873[40]. This program was intended to provide, within five years, access to electricity to a portion of the Brazilian rural population that still did not have access to these services, by prioritizing: i) Municipalities with an attendance rate lower than 85%; ii) communities affected by dams; iii) essential services, such as public schools, health clinics and water supply wells; and iv) rural settlements.

It is a program of social development, because, by recognizing the importance of energy as a vector of development, it forces power utilities to include the rural population in the electricity supply network, at no cost to the communities that are served. Another interesting social aspect is that, since Brazil has joined the Global Village Energy Partnership (GVEP), the program is accompanied by an Integrated Action Plan to be implemented by each state, aiming to assist the families served to maximize the resources of electricity, which would allow their inclusion in a production chain, also in economic terms, and, thus, tie the energy issue to the national development process.

Initially budgeted at R$ 7 billion (amount which soon have been proved to be insufficient), this program should be funded by resources from the federal government, from economic subsidies provided by the Energy Development Account (as an acronym in Portuguese, "CDE") and loans at low interest rates contracted with the Global

[39] International Atomic Energy Agency.*Brazil: A Country Profile on Sustainable Energy Development*, 1st edition, IAEA, Vienna, 2006, p. 13.

[40] Decreto n. 4.873/2003, from November 11.

Reversion Reserve (as an acronym in Portuguese, "RGR") that are Electric Sector Funds, in collaboration with state governments and utilities, through their own resources or special lines of credit obtained with the *Caixa Econômica Federal* (CEF), a Public Federal Bank. These funds are released in accordance with the progress of implementation of each project, whose phases are predetermined in the program operating rules.

It is interesting to note that the CDE is an instrument of cross-subsidy, because a portion of its resources comes from tariff charge included in the fees for the use of the transmission or distribution system of electricity. It was created by Article 13 of Law n. 10438[41], in 2002, aiming to "promote universal access to electricity service throughout the national territory", in addition to "ensure the resources to meet the economic subsidy for the reasonableness of the tariff for supply of electricity to the low-income end-users".

The program management is carried out by an inter-ministerial body, called National Commission for Universal Access (CNU). Its execution is carried out by the National Management Committee (CGN) and, locally, by the State Management Committees (CGEs). The representatives from civil society that are member of the Committee have an important role of identification of the demand and the supply potential of each region, thus guiding the adoption of adequate projects. Still, in order to provide transparency to the program, as well as to meet the demands fairly, interested parties should voluntarily formalize a request for the provision of the service. Also, the service priorities are previously established in its operating rules, binding for utilities at the local level.

In 2008, however, it was verified that the demand was higher than expected and, therefore, that the goal of universal access to electricity had not yet been reached, so the program was extended by two additional years, by Decree n. 6442[42] and, again, for another four years, by Decree n. 7520[43], in 2011. In this latest phase of the program, there is a preference for projects that meet the needs of: i) households to be benefited by "Brazil Without Misery" Program; ii) households that are located in Municipalities integrating the Program of Territories of Citizenship; iii) households located in rural

[41] Lei n. 10.438/2002, from April 26.

[42] Decreto n. 6.442/2008, from April 25.

[43] Decreto n. 7.520/2011, from July 08.

settlements, indigenous or quilombola communities[44] as well as other communities located in extractive reserves or areas of enterprise on generation and transmission of electricity; and iv) public schools, health clinics and water supply wells.

In 10 years of existence, according to data provided by the Ministry of Mines and Energy, the "Light for All" Program has led access to electricity to about 15 million Brazilians and it was projected that, by the end of 2014, over 280,000 households would be served[45]. However, as it was already mentioned, a survey, conducted by ANEEL with the utilities, pointed out that about one million households still do not have access to this service, making a new extension of the program likely, in order to achieve the goal of universal access.

It is also noteworthy that, in spite of predicting the possibility of meeting needs through decentralized energy generation, the program has focused, since the beginning, on the extension of existing distribution networks, considering this option to be less costly for utilities. At the current stage, however, this situation might change, considering that the communities not yet served are distant and sparsely populated, which would increase the cost of connecting the residences to the distribution network.

Only on February 12, 2009, attached to Administrative Rule n.º 60 from MME, it was published the Manual of Special Projects, which recognizes the technical difficulties of extending the electricity supply to the most distant communities and calls for projects based on decentralized generation of electricity or by the construction of small networks of distribution and use of renewable sources that are compatible with local conditions. The sources the manual highlights are: i) mini and micro hydropower plants; ii) hydrokinetic systems; iii) thermal power plants based on biofuels or natural gas; iv) photovoltaic solar power plants; v) wind turbines (as in the wind farms); or else vi) hybrids systems, resulting from the combination of two or more of the aforementioned energy sources.

The "Light for All" program illustrates the difficulties to reconcile the social goal of universalization to the environmental challenge to increase the use of alternative

[44] Quilombola communities are groups descending from outlaw slaves that settled in specific areas and maintained a traditional lifestyle.

[45] FARIELLO, Danilo. O Globo. (18 December 2013) Luz para Todos levou energia a 15 milhões, mas restam casas sem eletricidade. Retrieved 17 June 2014, in <http://oglobo.globo.com/economia/luz-para-todos-levou-energia-15-milhoes-mas-restam-casas-sem-eletricidade-11106359>.

sources. Although the use of those sources would be possible for the eligible communities, there was a preference for the simple extension of distribution grids.

That challenge does not result in a failure to expand renewable energy in the electricity matrix per se, because this goal may be pursued by policies and programs other than "Light for All". How is the goal of increasing alternative sources being pursued in the country? The answer requires an analysis of other program adopted in Brazil that could potentially deepen the access to sustainable energy.

According to the report of the 2013 National Energy Balance, Brazil is pointed out as a global example in the use of renewable energy, far outpacing the world average (overall, the national energy matrix is composed of 41% of renewable energy, while the world average is 13% and the average for developed countries is 8.1%; in its turn, considering only the matrix of electricity, the share of renewable energy reaches 79.3% versus the world average of 20.3%[46]).

However, a short analysis of Brazilian energy matrix indicates that it is largely dependent on hydroelectric plants.

Despite being, in fact, a renewable source of energy and considerably less polluting than other sources in power generation, the construction of large hydroelectric dams causes many social and environmental costs, which are not economically accounted by the utility company, but paid either by specific groups or by the entire society. The most important social impact is the resettlement of riverside communities, because of the flood of a large land area for the composition of its reservoir[47]. In the flooding, ecosystems are also affected, for instance, by the blockage of fish migration pathways and the consequent increase in other species, creating an imbalance. Other environmental impacts that may be mentioned herein are: blocked movement of migratory species; changes in turbidity and sediment levels to which species and ecosystems are adapted; deprivation of sediments and nutrients in downstream deltas and estuaries; fostering of exotic species that tend to displace local biodiversity; proliferation of human and animal disease vectors; and modification of downstream

[46] Ministério de Minas e Energia. (2014) Balanço Energético Nacional. Retrieved 19 June 2014, in <https://ben.epe.gov.br/downloads/S%C3%ADntese%20do%20Relat%C3%B3rio%20Final_2014_Web.pdf>.

[47] International Atomic Energy Agency.*Brazil: A Country Profile on Sustainable Energy Development*, 1st edition, IAEA, Vienna, 2006, p. 37.

water quality and flow patterns[48]. Moreover, the submergence of a large area of vegetation causes its decomposition and, consequently, the emission of greenhouse gases, especially methane, carbon dioxide and nitrous oxide.

At this point, some efforts occurred with the establishment of the Program for Energy Development of States and Municipalities (PRODEEM), in December 27, 1994. Taking into account that Brazil receives a large amount of solar radiation year-round, because of its geographical location, this program was meant to promote the supply of electricity to poor rural communities through the installation of photovoltaic panels at no cost to consumers. Such panels should be oriented to three basic functions: i) generating electricity in households; ii) heating water; and iii) generating electricity in public services.

In early 2002, there were about 3,000 communities using photovoltaic panels[49] and the installed capacity was 5.21 MW[50]. The costs of electricity generation by this source were estimated to be between US$0.12 and US$0.20/KWh and falling[51]. However, PRODEEM has failed to set a clear universalization target. Moreover, because of operational problems, this program was restructured and integrated to "Light for All", so that it could obtain the required financial and technical expertise for its maintenance.

Thus, it is necessary that the government adopts public policies that take into account the potential diversification of the national energy matrix, so that universal access to electricity could be conducted in a sustainable manner. Moreover, it is also necessary to pursue the goal of increasing the security of electricity supply.

That assumption leads to the analysis of one more national energy public program called Program of Incentives for Alternative Energy Sources - PROINFRA and its relation to "Light for All".

The PROINFRA was established by Law n. 10438[52], in April 26, 2002, subsequently revised by Law n. 10762[53], in November 11, 2003, and regulated by Decrees n.

[48] Ibid, p. 110.

[49] Ibid, p. 58.

[50] Ibid, p. 138.

[51] Ibid, p. 59.

[52] Lei n. 10.438/2002, from April 26.

[53] Lei n. 10.762/2003, from November 11.

4541/2002[54] and 5025/2004[55]. Its goal was the increase of the share of sustainable energy sources, produced in a decentralized way, in the Brazilian electricity matrix, by contracting projects of wind power, biomass and small hydropower plants, which should be implemented by Independent Power Producers – controlled or not by utilities.

It is interesting to note that wind power has been one of the fastest growing energy technologies around the world. However, investors have shown to be unlike to take the risks inherent in these projects, until the government guarantees some kind of initial subsidies. As a result the installed capacity in wind energy in Brazil is very low in relation to its huge potential. To expand the share of wind energy in Brazilian matrix, a national development of its technology is necessary, in order to consolidate the national industry for the supply of equipment for wind farms and the encouragement of participation from the private sector.

In 2001, it was already established a program to encourage the generation of electricity from wind. PROEOLICA was established by the Resolution n. 34 from the Board of Management of Electricity Crisis and it intended to promote a seasonal complementarity between hydroelectricity and wind energy, with a goal of contracting projects to install a capacity of 1,050 MW within two years. The acquisition by *Centrais Elétricas Brasileiras* – Eletrobras[56] of the energy generated for 15 years was ensured at a price specified in the resolution.

However, soon it was realized that the fixed price did not attract the necessary investments. In addition, the short deadline to meet the goal did not lead to the development of a viable national industry and, since there was only one supplier of wind equipment installed in the country, Wobben Wind Power, most of the equipment was imported from countries where this technology was already mature[57].

In its turn, PROINFA was developed also to meet a short-term goal, but only in a first stage: a goal of 3,300 MW of installed capacity by 2008, equally apportioned between wind energy, small hydropower plants and energy derived from biomass, with

[54] Decreto n. 4.541/2002, from December 23.

[55] Decreto n. 5.025/2004, from March 30.

[56] Eletrobras is Federal Public Utility Company that acts in generation, transmission and distribution of energy in the Country.

[57] FERREIRA, H. T., *Energia Eólica: Barreiras a sua Participação no Setor Elétrico Brasileiro*, IEE/USP, São Paulo, 2008, p. 55.

guaranteed purchase by Eletrobras of electricity generated for 20 years. The price was based on an average price the consumer paid for electricity. Besides, 50% of the contracted projects should involve Autonomous Independent Producers, defined in Article 3, §1º, of Law n. 10438, as a society that is not an utility of any kind nor is controlled by one. A second stage of the program was established. Once reached the target of the 3,300 MW of installed capacity a more ambitious goal would be pursued: with a goal to achieve the share of 10% of alternative sources in the national energy matrix within 20 years. However, in 2003, Law 10438 was altered by Law 10762 and the second stage of the program was suppressed, which substantially reduced its ambitiousness.

The contracts were signed, then, at a price based on the average cost of new and competitive electricity generation plants, considering specifically large hydropower plants (*i.e.*, with a greater than 30 MW capacity) and thermal power plants based on natural gas, plus an additional loan from the Account for Sustainable Development (CDE).

The National Bank for Economic and Social Development (called BNDES) played an important role through the provision of resources to finance the contracted projects. In 2005, BNDES has relaxed its conditions, by enabling the financing of up to 80% of the investments required, expanding the maximum amortization period from 10 to 12 years and requiring no mandatory requirement as the formation of a Specific Purpose Entity[58]. The rest of the investment required can be captured by the company through Loan-Participation Funds, the private equities, among which stands out the InfraBrasil.

Some problems have also been identified in PROINFA implementation. In its first stage, projects of 144 plants were contracted, totaling 3299.40 MW of capacity to be installed, divided into 63 small hydropower plants with a capacity of 1191.24 MW, 54 wind farms with 1422.92 MW and 27 biomass plants with a capacity of 685.24 MW[59]. However, in 2008, only 52 projects had started to operate for the generation of

[58] Banco Nacional de Desenvolvimento Econômico e Social. (2005) BNDES aprimora condições de financiamento do PROINFA. Retrieved 23 June 2014, in <http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Sala_de_Imprensa/Noticias/2005/20050323_not059_05.html>

[59] Ministério de Minas e Energia. (2010) O PROINFA. Retrieved 23 June 2014, in <http://www.mme.gov.br/programas/proinfa>.

electricity, totaling an installed capacity of 1,274 MW, *i.e.* only about 39% of the target initially drawn to be achieved that year[60].

The alternative that had sparked more interest from investors in the initial phase of the program was the generation of electricity from small hydropower plants, because these projects run fast and could be read for operation within two or three years. Furthermore, Brazil's high hydropower potential has led it to develop its own expertise and technologies concerning both the manufacture of mechanical and electrical equipment and the construction of hydropower plants themselves, with no need to import technologies[61].

On the other hand, with regard to wind power, despite the Brazilian potential being estimated to be about 300,000 MW, installed capacity currently represents only 1.1% of the national energy matrix[62]. As mentioned above, investors have shown to be unlike to undertake a new installation of wind farm in Brazil, until the government guarantees some kind of initial subsidies; however, even after the establishment of PROINFA, the cost of wind power generation, which is roughly R$ 200/MWh, remains as a major obstacle to the development of this alternative, because it is much higher than the cost of hydropower generation, even compared to small plants[63]. Part of this problem can be explained by the need to import the wind turbines and other equipment, given that the national industry is not enough developed so far.

At last, PROINFA did not attract many projects for power generation from biomass either. Considering the huge potential of energy cogeneration from bagasse of sugar cane in ethanol production – an important biofuel in the Brazilian scenario – which makes the plant to be self-sufficient in energy, but also considering that electricity

[60] GONÇALVES, José Alberto. Exame. (30 October 2008) Um caminho longo e ainda incerto. Retrieved 13 June 2014, in <http://exame.abril.com.br/revista-exame/edicoes/0930a/noticias/caminho-longo-ainda-incerto-396100>.

[61] International Atomic Energy Agency.*Brazil: A Country Profile on Sustainable Energy Development*, 1st edition, IAEA, Vienna, 2006, p. 72.

[62] Ministério de Minas e Energia. (2014) Balanço Energético Nacional. Retrieved 19 June 2014, in https://ben.epe.gov.br/downloads/S%C3%ADntese%20do%20Relat%C3%B3rio%20Final_2014_Web.pdf

[63] GONÇALVES, José Alberto. Exame. (30 October 2008) Um caminho longo e ainda incerto. Retrieved 13 June 2014, in <http://exame.abril.com.br/revista-exame/edicoes/0930a/noticias/caminho-longo-ainda-incerto-396100>.

generation is not the essential activity of this sector, long-term contracts with little economic attractiveness does not attract the producers[64].

We may conclude, then, that PROINFA is based on economic instruments of public policies. Among them, the feed-in tariffs stand out as the essence of this policy. Typically designed as a mechanism to accelerate investment in sustainable energy, the feed-in tariff offers a long-term contract to producers, based on the cost of generation of each technology. In PROINFA, according to Ordinance n. 45/2004, from the Ministry of Mines and Energy, the minimum price was R$117.02/MWh for energy from small hydropower plants, R$150.45/MWh for wind power and R$83.58/MWh for energy generated from biomass. As aforementioned, PROINFA also used the mechanism of subsidies to producers, through special credit lines offered by BNDES.

Still, despite the level of nationalization required by Article 3, I, "f" of Law n. 10438, was 60% (at first phase) and supposed to go up to 90% at the second phase among equipment and services, this level was difficult to be achieved, considering the low national productive capacity, since there was only one supplier of wind equipment installed in the country in the beginning of the program. Thus, tax incentives to bring the production chain of equipment into the country would also be important to reduce the costs of power generation.

Based on these problems, it is fair to say that when Sustainable Energy for All was implemented by United Nations, in 2012, despite the prior existence of these programs, Brazil was far from achieving the aforementioned goals of ensuring universal access to modern energy services – specifically considering electricity services, doubling the rate of improvement in energy efficiency and doubling the share of renewable energy in the global energy mix.

In part, it was because PROINFA has failed in adopt a proper proportion between command and control and economic instrument as well as an appropriate level of accountability allowed by information and public participation. For instance, we can point out that the program set aside the opportunity to adopt, for instance, a mechanism of Renewable Portfolio Standards (RPS), in which it would force utilities to purchase a

[64] DO VALLE COSTA, Claudia. *Políticas de promoção de fontes novas e renováveis para geração de energia elétrica: lições da experiência europeia para o caso brasileiro*, UFRJ, Rio de Janeiro, 2006, p. 137.

specific amount of electricity from alternative energy sources[65]. This mechanism would stimulate competition among sustainable energy producers and, consequently, reduce the generation costs. In this sense, a RPS makes it certain that a share of sustainable energy would be implemented, making it more likely that the objectives of this policy are achieved.

5. CONCLUSION

In 2012, the General Assembly of the United Nations stated three objectives to be achieved around the world by 2030: i) ensure universal access to modern energy services; ii) double the rate of improvement in energy efficiency; and iii) double the share of renewable energy in the global energy mix.

The fulfillment of those objectives requires the access to new technologies both to produce and to use more efficiently sources of energy considered sustainable. It may be the case of leapfrogging over stages of technology in order that developing countries develop under better environmental conditions than did developed countries in the past.

Concerning the universal access to electricity, aware of the inequality in per capita energy consumption, in addition to the alarming data about the lack of access to electricity, Brazilian government established the National Program for Universal Access and Use of Electricity – called "Light for All", in 2003. However, this policy does not integrate environment to its social and economic aspects, since it does not address the problem of Brazilian electricity matrix being largely dependent on large hydroelectric plants, which, despite being considered as a renewable source, are not sustainable nor exploited the vocation of the country for a wider range of sources. Therefore, the "Light for All" did not promote the implementation of sustainable development in Brazil, making it necessary to read this program in conjunction with other public policies and programs on sustainable energy.

In this paper, we had also focused on the Program of Incentives for Alternative Energy Sources – PROINFA –, established in 2002, and its results. Although it has promoted the construction of plants based on other renewable energy sources, this program is having some obstacles to meet its goals. For instance, in its beginning, PROINFA

[65]International Atomic Energy Agency.*Brazil: A Country Profile on Sustainable Energy Development*, 1st edition, IAEA, Vienna, 2006, p. 182.

contracted projects that would meet the target of 3300 MW, between small hydroelectric plants, wind farms and biomass plants; but in 2003 there was an installed capacity of only 1274 MW, 39% of that target.

Some problems can be pointed out in PROINFA, regarding the regulatory instruments that were chosen. In short: i) the low price fixed to energy generated from biomass did not attract the producers, considering that electricity generation is not the essential activity of this sector; ii) the price fixed to wind energy also did not make the investors more likely to take the risks of the installations of new wind farms in Brazil; iii) there was no efficient mechanism to bring the production chain of wind farm's equipment into the country; and iv) there was no command and control instruments to efficiently force the implementation of a share of sustainable energy in Brazilian energy matrix.

As we can see, PROINFA failed to adopt an adequate proportion between different instruments of public policies, and, as a result did not achieve its goals, even the more modest of its first stage. In addition, "Light for All" has not yet meet the goal of universal access to electricity, and, in 2012, one million homes still were not served.

This situation makes room to revisit public policies on energy transition in Brazil, considering the possible instruments and the Brazilian society peculiarities, so the country can meet those goals set by the General Assembly of the United Nations in 2012 and, thus, promote a sustainable way of development.

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