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Sustainable Development and Energy Matrix in Latin America

The universal clean energy accessibility

Konrad Adenauer Stiftung

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SUSTAINABLE DEVELOPMENT AND ENERGY MATRIX IN LATIN AMERICA:

THE UNIVERSAL CLEAN ENERGY ACCESSIBILITY

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Presentation EKLA-KAS

Dr. Christian Hübner
Head of EKLA-KAS

Freedom, justice and solidarity are the basic principles underlying the work of the **Konrad Adenauer Foundation**. The KAS is a political foundation, linked to the Christian Democratic Union of Germany (CDU). With more than 80 offices abroad and projects in over 120 countries, our goal is to make a unique contribution to the promotion of democracy, the rule of law and a social market economy. To foster peace and freedom we encourage a continuous dialog at the national and international levels as well as the exchange between cultures and religions.

Alongside the country-specific programmes provided by the country offices of the KAS in Latin America, there are cross-border regional programmes with separate thematic focuses. One of these is the **Regional Programme Energy Security and Climate Change in Latin America (EKLA)** which has its headquarters in Lima, Peru. The regional programme EKLA has been designed as a dialogue platform, in order to provide impetus for political decision-making processes. The programme understands itself as a consultative centre for the coordination of the individual KAS country projects on the Latin-American continent and supports the country projects with its expertise and network on the subject. Assuming the role of an initiator and consultant, it aims at complementing the activities of the country programmes by means of regional networks and the provision of know-how and thus, enhancing their impact. The programme organizes events on the regional level where experts and participants from the Latin American countries have the opportunity to exchange ideas.

The global economy and society faces enormous ecological challenges. There is a need to react to climate change and the shortage of resources as well as to the growing demand for energy, especially in emerging countries. Over the past years KAS has already embraced these issues, however, the enormous importance and the urgency to react to the demands led to the establishment EKLA-KAS, which has the ability to concentrate exclusively on these subjects. The Latin American region is ideal for the implementation of environmental projects due to the abundance of green energy sources such as sun, water, geothermal energy, wind, and biomass. To explore and develop this potential will help Latin America satisfy its growing energy demand. In order to exploit the full ecologic potential of the continent, it is necessary to understand the current state of environmental policies in Latin America. Hence, the KAS supports this study, organized by our partner the **International Law Center (CEDIN)**, aiming to facilitate the access to information. A better understanding of the peculiarities of the **Sustainable Development and Energy Matrix in Latin America** opens up a whole new range of opportunities for cooperation and exchange of best practices. Within the framework of this project, a range of events were organized in Belo Horizonte, Brazil, where experts from different institutions in Latin America discussed the topic together with students and legal professionals, creating an opportunity for law students to discuss climate and energy issues, a topic still uncommon in the basic program of legal training, but that has been receiving increasing attention from young professionals.

We hope that this report aids the process of developing an action plan to ensure access to energy as a way of achieving the objectives set by Sustainable Development Goals. The main goal is to examine the current developments on access to renewable energy and the existing energy development projects in specific countries, as well as their possibilities for improvement. We would like to thank CEDIN for their important actions in international law and especially for the partnership in the composition of this document, as well as all the researchers and authors who contributed to this publication. We wish you all a pleasant reading!

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INTRODUCTION

Climate change brings a profound challenge to the development models of contemporary societies, historically dependent on the use of fossil fuels. The paradox between the necessary protection of the environment and the current dominant energy matrix implies, therefore, a timely reflection on the application of renewable forms of energy. The case of Latin America is paradigmatic, since its energy matrix is composed mainly of clean and renewable sources, derived from the abundance of water resources. While this characteristic seems to distinguish the region, it is not exempt from the problems inherent to the constant growth of energy demand.

In this context, this book aims not only to understand the role of environmental regulation and institutions in Latin America, but also to analyze the sustainable development of the region´s countries. So how to maintain the dialectic between economic growth and sustainable development? How to ensure that the benefits of economic development reach the entire population, with the lowest possible environmental cost? How to understand the strategic peculiarities of each of the region´s countries in this project´s implementation?

This set of challenges has led to the division of this work into two parts: the first one intends to demonstrate the complexity of the problem at the regional level and the solutions addressed by the Law and by specialized regional organizations. In the second part, we analyze concrete examples of how the issue is treated in specific countries of Latin America.

I

LATIN AMERICA: AN OVERVIEW

In Latin America, the dilemma between economic growth and environmental protection is clear, which represents a major challenge for countries, both normatively and institutionally. Despite all the advances in International Environmental Law, in the sense of promoting sustainable development through agreements and regulations that limit emissions of pollutants and environmental degradation, some countries continue to exploit their natural resources in a predatory manner, in favor of economic growth.

In this context, this first part of the book proposes a reflection on the nature of the right of access to energy and seeks to analyze the international legal framework on the environment and the way it has been internalized and applied in Latin America. This process, probably composed of advances and setbacks, is not immune to the occurrence of socio-environmental conflicts. That is why institutions such as OLADE and ECLAC have been carrying out studies and initiatives to support and promote sustainable development in Latin American countries, which could be enhanced by the region's energy integration.

ACCESS TO ENERGY AS A HUMAN RIGHT

Adrien Robadey[1]

Bruno de Oliveira Biazatti[2]

Abstract: Access to electricity is indispensable for the full exercise and enjoyment of certain human rights, especially economic and social rights. The International Law of Human Rights guarantees, among others, the rights to health, to development and to adequate housing. For the full realization of these rights, access to reliable and affordable energy is necessary. Therefore, this paper aims to identify elements that corroborate the existence of a human right to energy, even though such right is connected with the protection of other rights. In order to achieve this end, the States practices and the work of specialized human rights bodies will be analyzed.

Keywords: Human right to energy - Right to development - Right to adequate housing - Right to health - Prohibition of discrimination - Prohibition of inhuman and degrading treatment.

Introduction

Folole Muliaga was a schoolteacher living in New Zealand. She was terminally ill with obesity-related heart and lung diseases and using an electrically powered home oxygen machine to breathe. She died on 29 May 2007 less than three hours after the electricity supply of her home was disconnected due to debts owed to the power company Mercury Energy. The coroner responsible for examining Mrs. Muliaga's death, Dr. Gordon Matenga, reported that "the cessation of oxygen therapy and the stress arising from the disconnection have contributed to her death".[3]

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3 "Cutting power 'a factor in Muliaga death'", *Stuff*, 23 September 2008. Available at: <http://www.stuff.co.nz/national/640942>. Access on: 16 October 2016; "Woman on life support dies after power cut off", *The Guardian*, 30 May 2007. Available at: <https://www.theguardian.com/world/2007/may/30/1>. Access on: 16 October 2016; "Woman on oxygen dies after power cut off", *NBCNews*, 30 May 2007. Available at: <http://www.nbcnews.com/id/18932496/ns/world_news-asia_pacific/t/woman-oxygen-dies-after-power-cut/#.

The case of Mrs. Muliaga reveals that access to electricity is much more than a privilege for those who can pay for it. Access to power can be a relevant condition for the realization of several human rights. Yet, worldwide, approximately 1.5 billion people have no access to power at all and about 3 billion rely on traditional biomass for cooking and heating[4]. People deprived of reliable electricity suffer health impacts of inefficient combustion of solid fuels in poorly ventilated buildings, as well as the economic consequences of inadequate power availability for income-generating activities and for other basic services such as health and education[5].

No one can deny that the supply of energy is not an ordinary service. As such, the access to electricity can be found as a right in the constitution of some States, namely Nicaragua[6], Democratic Republic of Congo[7] and Maldives[8]. Moreover, the *Johannesburg Declaration on Sustainable Development*, which was adopted at the World Summit on Sustainable Development on the 4th September 2002[9], considers energy access a "basic requirement"[10]. The *Additional Protocol to the American Convention on Human Rights in the Area of Economic, Social, and Cultural Rights (Protocol of San Salvador)* states that "everyone shall have the right to live in a healthy environment and to have access to basic public services"[11]. Although the Protocol does not define what "basic public

WAP5qegrLIU>. Access: 16 October 2016.

4 United Nations Secretary-General. *Advisory Group on Energy and Climate Change, Energy for a Sustainable Future, Report and Recommendations*, New York, 28 April 2010, p.7.

5 *Ibid.*

6 Nicaragua. *Constitution of 1987 with Amendments through 2005*, 1 January 1987, art.105. This provision states the following: "It is the obligation of the State to promote, facilitate, and regulate the provision of basic public services of energy, communications, water, transportation, road infrastructure, ports, and airports to the people, and access to these is their inalienable right."

7 Democratic Republic of Congo. *Constitution of the Democratic Republic of the Congo*, 18 February 2006, art.48. This provision states the following: "The right to decent housing, the right of access to drinking water and to electric energy are guaranteed. The law establishes the conditions for the exercise of these rights."

8 Maldives. *Constitution of the Republic of Maldives*, 2008, Section 23(g). This provision states the following: "Every citizen is entitled to the following rights pursuant to this Constitution, and the State undertakes to achieve the progressive realisation of these rights by reasonable measures within its ability and resources: [...] the establishment of an electricity system of a reasonably adequate standard on every inhabited island that is commensurate to that island".

9 *Johannesburg Declaration on Sustainable Development*, World Summit on Sustainable Development, UNDoc. A/CONF.199/20, 4 September 2002.

10 *Ibid.*, para.18. The *Johannesburg Declaration* states the following: „We welcome the focus of the Johannesburg Summit on the indivisibility of human dignity and are resolved, through decisions on targets, timetables and partnerships, to speedily increase access to such basic requirements as clean water, sanitation, adequate shelter, energy, health care, food security and the protection of biodiversity".

11 *Additional Protocol to the American Convention on Human Rights in the Area of Economic, Social, and Cultural*

services" means, it would be surprising if it didn't encompassed access to electricity. In the European continent, the *Charter of Fundamental Rights of the European Union* determines that "[t]he Union recognizes and respects access to services of general economic interest as provided for in national laws and practices, in accordance with the Treaties, in order to promote the social and territorial cohesion of the Union"[12] [Emphasis added]. In the case *Municipality of Almelo and others v. NV Energiebedrijf Ijsselmij*, the European Court of Justice ruled that supply of electricity is a "service of general economic interest".[13]

Taking into account these particularities of the distribution of electricity, the present paper aims to describe the access to energy not just as a service, but as a right necessary to achieve the full realization of other human rights. We will discuss the impacts of the lack of energy in the implementation of five rights: right to development, right to an adequate standard of living - right to adequate housing, right to health, prohibition of discrimination and the prohibition of inhuman and degrading treatment.

1. Access to energy as a way to achieve the realization of certain human rights

There is no human right to electricity independently guaranteed in any human right instrument. Despite that, Stephen R. Tully explained that even if energy access is not recognized as a human right itself, energy access is a prerequisite for realizing several interrelated human rights: "Electricity properly cooks and refrigerates food (thus realizing the right to adequate food), provides sufficient heating, cooling and lighting (realizing the right to housing), and ensures safe environmental conditions within both households and workplaces (realizing the right to health)"[14].

In the same line, Carmen G. Gonzalez wrote that while no international court has yet ruled that the lack of power is a human right violation, electricity

Rights (Protocol of San Salvador), Organization of American States, Doc.A-52, 16 November 1999, art.11(1).

12 *Charter of Fundamental Rights of the European Union*, Official Journal of the European Union, C326/391, 2 6 October 2012, art.36.

13 *Municipality of Almelo and others v. NV Energiebedrijf Ijsselmij*, European Court of Justice, Case C-393/92, 27 April 1994.

14 TULLY, Stephen. "The Contribution of Human Rights to Universal Energy Access", *Northwestern Journal of International Human Rights*, Vol.4, no.3, 2006, p.547.

is essential for cooking, lighting, heating, refrigeration, sanitation, health care, and the pumping of clean water for drinking, bathing and crop irrigation[15]. Hence, "[...] access to energy is implicit in a variety of existing human rights obligations, including, the rights to life, health, food, water and an adequate standard of living".[16]

The WEHAB[17] Working Group also corroborates this rationale. In its 2002 report, one can find the following conclusion: "Although energy itself is not a basic human need, it is critical for the fulfillment of all needs. Lack of access to diverse and affordable energy services means that the basic needs of many people are not being met"[18]. Likewise, the report of the World Energy Assessment stated:

> Energy services are a crucial input to the primary development challenge of providing adequate food, shelter, clothing, water, sanitation, medical care, schooling, and access to information. Thus, energy is one dimension or determinant of poverty and development, it is vital. Energy supports the provision of basic needs such as cooked food, a comfortable living temperature, lighting, the use of appliances, piped water or sewerage, essential health care (refrigerated vaccines, emergency and intensive care), educational aids, communication (radio, television, electronic mail, the World Wide Web), and transport. Energy also fuels productive activities, including agriculture, commerce, manufacture, industry, and mining. Conversely, lack of access to energy contributes to poverty and deprivation and can contribute to economic decline.[19]

Accordingly, we will now address in detail some of the rights that are closely related to the right to energy: (1.**1**) right to development; (1**.2**) the right to an adequate standard of living - right to adequate housing; (**2.3**) right to health; (**1.4**) prohibition of discrimination; and (1**.5**) prohibition of inhuman and degrading treatment.

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15 GONZALEZ, Carmen G. "Energy Poverty and the Environment". *In* GURUSWAMY, Lakshman (ed.). *International Energy and Poverty: The emerging contours*, Abingdon: Routledge, 2016.

16 *Ibid*.

17 WEHAB stands for Water, Energy, Health, Agriculture and Biodiversity.

18 WEHAB Working Group. *A Framework for Action on Energy*, 2002, p.7. Available at: <http://www.iisd.ca/wssd/download%20files/wehab_energy.pdf>. Access: 16 October 2016.

19 WORLD ENERGY ASSESSMENT. *Energy and the Challenge of Sustainability*, New York: United Nations Development Programme, 2000, p.44.

1.1 The Right to Development

The right to energy is inherent to the right of development. In 1986, the United Nations General Assembly adopted the Declaration on the Right to Development[20]. The right to development is defined at the article 1 of the Declaration as "an inalienable human right by virtue of which every human person and all peoples are entitled to participate in, contribute to, and enjoy economic, social, cultural and political development, in which all human rights and fundamental freedoms can be fully realized"[21]. According to this definition, it is almost impossible to achieve the right of development for someone who does not have access to energy. Indeed, it is undeniable that energy is a necessity to participate in, contribute to and enjoy economic, social, cultural and political development.

Throughout other articles of the Declaration it is possible to feel that access to energy is a need and that States have to provide people with. The article 2(3) exposes that "States have the right and the duty to formulate appropriate national development policies that aim at the constant improvement of the well-being of the entire population and of all individuals, on the basis of their active, free and meaningful participation in development and in the fair distribution of the benefits resulting therefrom"[22].

If the right to energy can be qualified as a social, cultural or economic right, the disrespect by the States in providing energy to all individuals should be seen as an obstacle of the development. Therefore, States have the obligation to eliminate this obstacle so as to respect the non-binding standards of the 1986 Declaration. Article 6(3) expressly corroborates this conclusion: "States should take steps to eliminate obstacles to development resulting from failure to observe civil and political rights, as well as economic, social and cultural rights"[23].

The most relevant article of the Declaration of the Right of Development concerning energy access is Article 8:

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20 *Declaration on the Right to Development*, GARes.41/128, UNGAOR, 1986.

21 *Ibid.*, art.1.

22 *Ibid.*, art.2(3).

23 *Ibid.*, art.6(3).

> States should undertake, at the national level, all necessary measures for the realization of the right to development and shall ensure, inter alia, equality of opportunity for all in their access to basic resources, education, health services, food, housing, employment and the fair distribution of income. [...] Appropriate economic and social reforms should be carried out with a view to eradicating all social injustices[24].

Therefore, States should not only undertake measures to ensure to all individuals their access to basic resources but they also have to ensure the equality of opportunities between all individuals of the State, whether the individuals come from the cities or the countryside. Indeed, according to Arjun Sengupta, "the Declaration on the Right to Development is founded on the notion that the right to development implies a claim to a social order based on equity. Several of its articles call for equality of opportunity, equality of access to resources, equality in the sharing of benefits and fairness of distribution, and equality in the right to participation"[25].

1.2 The Right to an Adequate Standard of Living - Right to Adequate Housing

As codified in the article 11(1) of the *International Covenant on Economic, Social and Cultural Rights* (ICESCR), contracting States "recognize the right of everyone to an adequate standard of living for himself and his family, including adequate food, clothing and housing, and to the continuous improvement of living conditions"[26]. Hence, the human right to adequate housing derives from the right to an adequate standard of living.

According to the Committee on Economic, Social and Cultural Rights, this particular human right "[...] should be seen as the right to live somewhere in security, peace and dignity"[27]. It refers not just to housing, but to adequate housing, meaning that the shelter must provide "[...] adequate privacy, adequate

[24] *Ibid.*, art.8.

[25] SENGUPTA, Arjun. "Conceptualizing the right to development for the twenty-first century", p.69. *In* PILLAY, Navi (ed.). *Realizing the Right to Development: Essays in Commemoration of 25 Years of the United Nations Declaration on the Right to Development*, New York: United Nations, 2013.

[26] *International Covenant on Economic, Social and Cultural Rights*, 3 January 1976, 993 UNTS 3, art.11(1).

[27] *Committee on Economic, Social and Cultural Rights. General Comment No. 4: The right to adequate housing, UNDoc.*E/1992/23, 1991, para.7.

space, adequate security, adequate lighting and ventilation, adequate basic infrastructure and adequate location with regard to work and basic facilities all at a reasonable cost"[28]. Thus, an adequate house must contain certain facilities essential for health, security, comfort and nutrition, including "[...] energy for cooking, heating and lighting"[29]. This rationale reveals that in order to fully achieve the right of adequate housing, it is necessary to ensure energy supply.

The United Nations High Commissioner for Human Rights also corroborates the codependency between energy and adequate housing. In its Fact Sheet no. 21,[30] it indicated that "[a]dequate housing must provide more than four walls and a roof. A number of conditions must be met before particular forms of shelter can be considered to constitute 'adequate housing'. These elements are just as fundamental as the basic supply and availability of housing"[31]. In light of that, the High Commissioner explained that a "[...] housing is not adequate if its occupants do not have safe drinking water, adequate sanitation, energy for cooking, heating, lighting, food storage or refuse disposal".[32][Emphasis added].

Besides, several States reported to the Committee on Economic, Social and Cultural Rights measures related to the univerzalization of access to energy as a means to achieve the full realization of the right to adequate housing. The Philippines, for example, mentioned its Slum Upgrading Program, which entails the on-site improvement of occupied urban lands through the "introduction of roads or alleys and basic services such as water and electricity"[33]. Similarly, Morocco pointed out to its programmes on access to public services for people living in shantytowns in rural or urban areas. The housing strategy adopted on behalf of these communities aims to guarantee access to basic network facilities, such as "drinking water, sewage facilities, electricity, telephone and the Internet"[34]. Furthermore, in order to fullfill its

[28] *Ibid*.

[29] *Ibid*., para.8.

[30] United Nations High Commissioner for Human Rights. *Fact Sheet No 21: The Right to Adequate Housing*, 2014. Available at: <http://www.ohchr.org/Documents/Publications/FS21_rev_1_Housing_en.pdf>. Access: 15 October 2016.

[31] *Ibid*., p.3.

[32] *Ibid*., p.4.

[33] Committee on Economic, Social and Cultural Rights. *Combined second, third and fourth periodic reports submitted by Philippines*, UNDoc.E/C.12/PHL/4, 7 September 2007, para.670.

[34] Committee on Economic, Social and Cultural Rights. *Fourth periodic report submitted by Morocco*, UNDoc.E/C.12/MAR/4, 24 March 2014, para.153.

obligation to ensure adequate housing for the returning inhabitants in the Chechnya, Russia reported the refurbishment of 32 dormitories, which serve as temporary housing. It stated that "[a]ll dormitories are equipped with gas and electricity, transported water and heating systems"[35]. In its initial reports, China said that in order to solve the problems of inadequate living conditions in the rural areas, the Government is implementing a plan to, *inter alia*, "supply electricity to the great majority of poor homes"[36]. In 2013, Italy described its policy on facilitated fares for domestic electricity. Italian authorities estimate that 3.5 million households may be eligible to the program[37]. Lastly, Guyana[38] and Angola[39] reported their infrastructure improvements regarding electricity transmission.

One of the main judicial decisions on the right to housing is the case *Government of the Republic of South Africa and Others v Grootboom and Others*, ruled by the South African Constitutional Court on 4 October 2000. Mrs. Irene Grootboom and the other respondents were evicted from their informal homes situated on private land earmarked for formal low-cost housing. They appeared before the judiciary requesting for an order compelling the government to provide them with adequate basic housing until they obtained permanent accommodation. Although the Constitutional Court concluded that the obligation to provide access to adequate housing depends on context, and may differ from province to province, from city to city, from rural to urban areas and from person to person, it expressely mentioned that this right may entail "access to services such as water, sewage, electricity and roads".[40] [Emphasis added].

Accordingly, access to energy is necessary to ensure the correct application of the right to adequate housing, and the right to adequate housing is essential

[35] Committee on Economic, Social and Cultural Rights. *Fifth periodic report submitted by the Russian Federation*, UNDoc.E/C.12/RUS/5, 25 January 2010, para.272.

[36] Committee on Economic, Social and Cultural Rights. *Initial report submitted by People's Republic of China*, Addendum, UNDoc.E/1990/5/Add.59, 4 March 2004, para.109.

[37] Committee on Economic, Social and Cultural Rights. *Fifth periodic report submitted by Italy*, UNDoc.E/C.12/ITA/5, 10 October 2013, para.455.

[38] Committee on Economic, Social and Cultural Rights. *Combined second to fourth periodic reports submitted by Guyana*, UNDoc.E/C.12/GUY/2-4, 15 July 2014, paras.332 and 346

[39] Committee on Economic, Social and Cultural Rights. *Combined fourth and fifth periodic reports submitted by Angola*, UNDoc.E/C.12/AGO/4-5, 3 July 2014, para.181.

[40] *Government of the Republic of South Africa and Others v Grootboom and Others,* Constitutional Court of South Africa, Case CCT 11/00, 4 October 2000, para.37.

to guarantee the right to an adequate standard of living, which is explicitly guaranteed by the *Universal Declaration of Human Rights*[41] and the ICESCR[42]. Therefore, the right to energy should be considered as a human right throughout the right of adequate housing.

However, article 11(1) of the ICESCR rules that "[t]he States Parties will take *appropriate steps* to ensure the realization of [the right to an adequate standard of living]"[43] [emphasis added]. This particular wording indicates that the right to an adequate standard of living - and consequently the right to housing - is subject to a progressive realization, meaning that constraints due to the limits of available resources can restrict the immediate full implementation of this right. Thus, the full realization of the right to housing can be achieved progressively in time[44]. Despite that, the Committee on Economic, Social and Cultural Rights determined that "[...] steps towards [the full realization of the right] must be taken within a reasonably short time after the [ICESCR]'s entry into force for the States concerned. Such steps should be deliberate, concrete and targeted as clearly as possible towards meeting the obligations recognized in the Covenant"[45]. Therefore, regardless of the state of development of any country, there are certain steps which must be taken immediately,[46] especially because a general decline in living and housing conditions, directly attributable to policy and legislative decisions by a State, and in the absence of compensatory measures, would be inconsistent with the obligations under the ICESCR[47].

1.3 Right to Health

Health is a fundamental human right indispensable for the exercise of other human rights. It is recognized in numerous international instruments, such as the *Universal Declaration of Human Rights*[48], the ICESCR[49], the *International*

41 *Universal Declaration of Human Rights*, GARes.217A, UNGAOR, 1948, art.25.

42 *International Covenant on Economic, Social and Cultural Rights*, 3 January 1976, 993 UNTS 3, art.11(1).

43 *Ibid.*

44 Committee on Economic, Social and Cultural Rights. *General Comment No. 3: The nature of States parties' obligations*, 14 December 1990, UNDoc.E/1991/23, paras.1 and 2.

45 *Ibid.*, para.2.

46 *Ibid.*, para.10.

47 *Ibid.*, para.11.

48 *Universal Declaration of Human Rights*, GARes.217A, UNGAOR, 1948, art.25(1).

49 *International Covenant on Economic, Social and Cultural Rights*, 3 January 1976, 993 UNTS 3, art.12(1).

Convention on the Elimination of All Forms of Racial Discrimination[50], the *Convention on the Elimination of All Forms of Discrimination against Women*[51] and the *Convention on the Rights of the Child*[52].

The right to health does not necessarily entail a right to be healthy. It contains both freedoms and entitlements. The freedoms include the right to control one's health and body and the right to be free from interference, such as the right to be free from torture, non-consensual medical treatment and experimentation. On the other hand, the entitlements include the right to a system of health protection which provides equality of opportunity for people to enjoy the highest attainable level of health[53]. Also, the implementation of the right to health cannot be evaluated in abstract, but must take into account "both the individual's biological and socio-economic preconditions and a State's available resources"[54].

The supply of electricity directly impacts the realization of the human right to health, especially because arbitrary power disconnections, in particular when unannounced or unexpected, can expose the wellbeing of the population to distress. For example, people under intensive care, receiving emergency treatment, or undergoing life-saving surgery may be denied their right to life, particularly in hospitals with no alternative power sources. Medicines and vaccines that need proper and constant refrigeration can become useless with no electricity, exposing people, especially children, to preventable diseases. Lack of electricity can also affect water supply, interrupting services and compromising hygiene and sanitation in hospitals and homes[55].

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50 *International Convention on the Elimination of All Forms of Racial Discrimination*, 21 December 1965, 660 UNTS 195, art.5(e)(iv).

51 *Convention on the Elimination of All Forms of Discrimination against Women*, 1 March 1980, 1249 U.N.T.S. 13, arts.11(1)(f) and 12.

52 *Convention on the Rights of the Child*, 20 November 1989, 1577 UNTS 3, art.24.

53 Committee on Economic, Social and Cultural Rights. *General Comment No. 14: The right to the highest attainable standard of health,* UNDoc.E/C.12/2000/4, 11 August 2000, para.8.

54 *Ibid.*, para.9.

55 TULLY, Stephen. "The Contribution of Human Rights to Universal Energy Access", *Northwestern Journal of International Human Rights*, Vol.4, no.3, 2006, p.526.

1.4 Prohibition of Discrimination

The lack of energy can even configure a breach of the prohibition of discrimination. As defined in the General Comment no. 18, adopted by the United Nations Human Rights Committee, discrimination means

> [...] any distinction, exclusion, restriction, or preference based on certain motives, such as race, color, gender, language, religion, a political or any other opinion, the national or social origin, property, birth or any other social condition, that seeks to annul or diminish the acknowledgment, enjoyment, or exercise, in conditions of equality, of the human rights and fundamental freedoms to which every person is entitled.[56]

It is not difficult to see that the deprivation of power against a particular group can amount to discrimination. This particular issue was discussed by the Committee on the Elimination of Racial Discrimination in its 2007 concluding observations on Ukraine. Addressing the conditions of the Tatar population in the Autonomous Republic of Crimea (which was under Ukrainian control back then), the Committee highlighted that most Crimean Tatars have been excluded from the agrarian land privatization process and most of them live in settlements which lack basic infrastructure. It urged Ukraine to, *inter alia*, "[...] ensure that all [Crimean Tatars] have access to adequate housing and that those living in settlements have legal security of tenure and access to adequate infrastructure, including safe water, sewage systems, <u>electricity</u>, gas, heating, roads and transportation".[57] [emphasis added]

Thus, the Committee recommends the adoption of some measures in order to ensure an equal treatment of the Crimean Tatars in relation to the rest of the Ukrainian population. These measures - including the access to power - will guarantee the full and free exercise of the human rights and freedoms without any kind of harmful distinction.

Furthermore, the lack of affordable and reliable power among poor communities has disproportionate impact on women and girls. In places with no or insufficient electricity supply, women and girls are forced to spend

[56] Human Rights Committee. *General Comment No. 18: Non-discrimination*, 10 November 1989, UNDoc. CCPR/C/37, para. 6.

[57] Committee on the Elimination of Racial Discrimination. *Concluding observations: Ukraine*, 8 February 2007, UNDoc.CERD/C/UKR/CO/18, para.15.

hours each day in the time-consuming task of hunting for fuel and firewood for domestic needs, which is one of the main reasons that girls don't attend school. Women also face the risk of premature respiratory death given indoor air pollution from open fires and kerosene used for heating, cooking and lighting. Even the simple act of being outdoors at night comes with danger for them because there are no streetlights[58]. Accordingly, the *Convention on the Elimination of All Forms of Discrimination against Women* imposes to States parties the obligation to

> [...] take all appropriate measures to eliminate discrimination against women in rural areas in order to ensure, on a basis of equality of men and women, that they participate in and benefit from rural development and, in particular, shall ensure to such women the right: [...] To enjoy adequate living conditions, particularly in relation to housing, sanitation, <u>electricity</u> and water supply, transport and communications.[59] [Emphasis added]

Therefore, States have to take positive measures in order to eliminate the uneven burden traditionally placed on women and girls as a result of the lack of electricity.

1.5 Prohibition of Inhuman and Degrading Treatment

Can depriving someone of electricity amount to inhuman and degrading treatment? To answer this question, firstly, it is necessary to define "inhuman and degrading treatment". According to the Elements of Crimes for the International Criminal Court, the expression "inhuman treatment" relates to the infliction of "[...] severe physical or mental pain or suffering upon one or more persons."[60] On the other hand, a treatment can be considered "degrading", as defined by the European Court of Human Rights, when

[58] The Nigeria Network of NGOs. "An Open Letter on U.S. Energy Efforts in Africa – Nigeria", 25 November 2013. Available at <https://www.one.org/us/policy/an-open-letter-on-u-s-energy-efforts-in-africa/>. Access: 15 October 2016; TULLY, Stephen. "The Contribution of Human Rights to Universal Energy Access", *Northwestern Journal of International Human Rights*, Vol.4, no.3, 2006, p.539-543.

[59] *Convention on the Elimination of All Forms of Discrimination against Women*, 1 March 1980, 1249 U.N.T.S. 13, art.14(2)(h).

[60] *Elements of Crimes for the International Criminal Court*, Official Records of the Review Conference of the Rome Statute of the International Criminal Court, Kampala, 31 May - 11 June 2010, RC/11, p.14.

> [...] its object is to humiliate and debase the person concerned and [...], as far as the consequences are concerned, it adversely affected his or her personality in a manner incompatible with Article 3 [of the European Convention of Human Rights, which contains the prohibition of inhuman or degrading treatment]. [Degrading treatment] has also been described as involving treatment such as to arouse feelings of fear, anguish and inferiority capable of humiliating or debasing the victim and possibly breaking their physical or moral resistance or as driving the victim to act against his will or conscience.[61]

The relation between access to electricity and inhuman and degrading treatment was discussed in the case *Van Volsem v. Belgium*, before the former-European Commission of Human Rights. The applicant, Francine van Volsem, was a Belgian national who obtained the custody of her two children after her divorce. Given her depression and near-chronic respiratory problems, she was unable to hold a stable job. Hence, she relied her living on the alimony paid by her former husband and social security provided by the goverment. She lived in a half empty block of council flats, where everything, including the heating, ran on electricity. Moreover, considering that the building had been poorly built, the consumption of power was very high and, accordingly, the bills were very expensive.

Given this scenario, Mrs van Volsem soon became unable to meet the cost of her electricity bills. On 9 December 1983 - during the European winter - the electricity company cut off her power. Mrs van Volsem challenged such measure before the judiciary. The Brussels Tribunal of First Instance upheld her case and the electric power was restored, but subsequently, on 25 February 1988, the Brussels Court of Appeal authorized the electricity company to cut off the power again. The company so did on 14 May 1988, even if Mrs van Volsem was caring for her grandchild, who was suffering from respiratory difficulties and needed the home heating. After that, a bank intervened in the case and she could pay the arrears. On 15 September 1988, the company reconnected Mrs van Volsem's power, but at very low intensity.

Mrs van Volsem argued before the European Commission of Human Rights that the cutting off of power in the winter and the subsequent supply of a low power voltage amounted to inhuman and degrading treatment, because

[61] *Case of Keenan v. the United Kingdom*, Application no. 27229/95, ECtHR, 3 April 2001, para.110.

such measures deprived her and her family of the basic goods indispensable for living in human dignity. The Commission rejected her claim arguing that "in the case at issue, the cutting off or the threat of cutting off electricity did not reach the level of humiliation or debasement needed for there to be inhuman or degrading treatment"[62].

According to Antonio Cassese, apparently, the European Commission did not rule out the possibility of applying the prohibition of inhuman or degrading treatment to the lack of electricity or any other social and economic conditions. In other words, the decision in question did not reject entirely the possibility of lack of electricity to have harmful effects severe enough to amount to inhuman treatment[63]. The prohibition of inhuman or degrading treatment is very broad and cannot be restricted to physical or psychological mistreatment only. It can apply to any treatment or punishment with significant harm to the human dignity[64], including deprivation of electricity in extreme circumstances.

Conclusion

Although electricity has a crucial role in the implementation of several human rights - especially economic and social rights, there has not been a widespread recognition of this fact to date. Not even human rights agencies and bodies have comprehensive works on how the access to energy can impact the realization of fundamental rights.

Accordingly, substantial work still needs to be done in order to identify and detail the content of the right to electricity as well as its relationship with other human rights. Furthermore, more attention also should be given to how States are going to implement the universalization of access to energy. It is necessary to find efficient, renewable and clean means to supply the 1.5 billion people in the world with no access to electricity[65].

62 *Francine Van Volsem v. Belgium*, Application no. 1464/89, ECommHR, 9 May 1990, p.3.

63 CASSESE, Antonio. "Can the Notion of Inhuman and Degrading Treatment be Applied to Socio-Economic Conditions?", *European Journal of International Law*, Vol. 2, No. 2, 1991, 141-145, p.143.

64 *Ibid.*

65 United Nations Secretary-General. *Advisory Group on Energy and Climate Change, Energy for a Sustainable Future, Report and Recommendations*, New York, 28 April 2010, p.7.

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SUSTAINABILITY AND ENERGY MATRIX: AN ANALYSIS OF THE INTERNATIONAL LAW AND INTERNATIONAL INCENTIVE MECHANISMS

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Abstract: This paper aims to study environmental sustainability, under international law and doctrine, with emphasis on the transition to a cleaner energy matrix. Although this issue is internationally addressed, some countries continue to predatorily exploit their natural resources, aiming exclusively at economic growth. This paradigm negatively impacts the natural equilibrium of the Earth, generating risks that affect the habitat and the quality of human life. It is argued that the internationalization of cities and the location of sustainable development have combined to transform the cities in the international *loci* of sustainable development. Although it is positive that cities are willing to engage with sustainable development in order to mitigate the effects of climate change, sustainable development preliminarily requires a multi-level and transnational definition. The choice of the best sustainable method should not be guided by a model of autonomous decentralized cities, but should take into account the whole apparatus of national and international benefit-cost analysis. The relevant question is whether the normative paradigm of international environmental law is appropriate to implement the goals that are incorporated into the concept of sustainable development. Accordingly, the present paper aims, firstly, to understand the international legal framework of the subject and, secondly, to perform a detailed and critical analysis of the various players influencing the process, as well as the technical cooperation funds and the clean energy promotion mechanisms. Finally, with focus on Latin America, we will analyze the types of energy production that should be implemented as well as briefly outline the difficulties and possible means of implementation of these clean energy sources.

Keywords: Sustainability – Clean Energy Matrix – International Environmental Law – Latin America.

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Introduction

One of the most alarming issues today, in terms of international society, is the environmental crisis occurring in our planet. Thus, a new normative reality arises, aiming to restrain the harmful effects caused by this risk society, as well as new ideas and concepts concerning international environmental law.

Climate change and the most recent threats to the systems supporting natural life encourage international cooperation in the context of sustainable development, in order to limit the sovereignty of the State and to address these global concerns. As known, climate change mitigation is one of the biggest challenges sustainable development faces, and it is only through effective normative integration (national and international) that the impacts of this issue can be prevented and avoided.

The international environmental normative system has an important role to play in providing a legal framework that can promote an approach towards sustainable development, whose principles, although not entirely legally binding (yet), are fundamental to the interpretation, implementation and development of the climate change regime.

The matter of development and international environmental protection had its genesis with the Stockholm Conference, held in 1972, and has since been discussed in the drafting process of agreements and treaties at international conferences on climate, always trying to seek the most effective means of mitigation of climate change.

Nevertheless, there is an anthropogenic effect within the international climate system, in which the peripheral countries are pushing industrialized countries to take proportional measures in combating climate change, in order not only to implement sustainable development, but also finance such implementation in less developed countries or with late economic development. However, regardless of how it applies to the international legal system, what must be taken into consideration is the mutual interest of States in recognizing the seriousness of climate change and implementing the principle of sustainable development so that both (developed and developing countries) reduce their greenhouse gas (GHG) emissions.

Climate change is a global problem that requires international cooperation. Although nowadays there are discussions concerning the fact that industrialized countries are the largest contributors in GHG emissions (among other harmful effects to the environment), one should take into account that developing countries will continue to develop and, therefore, if they refuse to pursue sustainable development principles from this stage, they will soon also release pollutants into the atmosphere.

The focus given to the argument is as follows: in order to achieve full compliance with international environmental guidance and rules towards the effective combat to climate change, the development of peripheral countries must happen sustainably, and, to this end, the supply of technology, training and financial assistance to developing countries should be made, *a priori*, through investment funds from developed countries. This 'demand' for funding from peripheral countries by more industrialized ones, is the principle of common but differentiated responsibilities, that since the 1992 Climate Conference in Rio de Janeiro, was recognized by the international environmental doctrine as one of the central elements of the legal regime on climate change.

The present article aims to analyze the concept of sustainable development in the context of climate change and the search for clean energy as an effective means of reaching environmental sustainability in the global arena. Taking into account that it is widely recognized that the current power supply is unsustainable and the fact that sustainable energy supply is one of the main topics of the contemporary international political agenda, we believe that in order to achieve an effective response to these challenges, it is of fundamental importance the international cooperation of industrialized countries for the implementation and development of clean energy matrixes in the peripheral countries, notably in Latin America.

1. Overview of the International Environmental Law

International environmental law regulates aspects of the environment that depend on free action of humanity and its regulation exceeds the interest of a single State.

Historically, sustainable development originated from the efforts for the conservation of nature, which evolved into the international environmental law. Concern for the environment and the entire biosphere, consisted of interdependent ecosystems, was firstly introduced as a matter of scientific and political interest of the international community at the Stockholm Conference on the Human Environment, in 1972.[4]

In addition to emphasizing how human actions can irreversibly impair the balance of the biosphere, the Conference covered the need for protection of the human environment through joint efforts at local, national and international levels and, although no treaty was adopted, participating States agreed on two important documents: the Declaration of the United Nations Conference on the Human Environment, namely 'Stockholm Declaration', and an action plan with management suggestions for global environmental sustainability.[5]

In 1983, Gro Harlem Brundtland, former Prime Minister of Norway, was appointed by the Secretary General of the United Nations[6], President of the World Commission on Environment and Development, whose mandate was to examine the convergence between continued economic growth and the gradual environment deterioration. Taking into account the global ethics that should be considered in this matter, the Brundtland Commission introduced the concept of sustainable development for the international community, defining it as the "[development that] meets the needs of the present without compromising the ability of future generations to fulfill their own needs" 7.

While the Stockholm Declaration was the first of its kind and praised for introducing very ambitious environmental principles, the 1992 Rio Declaration[8] is the most often referred document in the international environmental context. Here are five legal instruments that were approved in its pursuit:

[4] *Cf.* Declaration of the United Nations Conference on the Human Environment, Stockholm/Sweden, June of 172, UN Doc. A /CONF.48 /14 / rev. 1 (16 June 1972).

[5] _____. UN Doc. A /CONF.48 /5 (16 June 1972). It is a non-binding document (with soft law character), which consists of 26 principles. It is the predecessor of the 1992 Rio Declaration.

[6] _____. UN. A / Res / 42/427.

[7] _____. UN. A / RES /37/7 (28 October 1983). The report "Our Common Future" establishes the main challenges for the world community: to achieve sustainable development by the year 2000 and to adopt multilateral solutions and a restructured economic system. The Commission called for greater international cooperation to eradicate poverty, to manage the global common spaces, and maintain peace and security throughout the world. In order to enlarge the issues addressed, it defined "environment" as the "habitat in which we all live," and defined "development" as "what we do in attempting to improve our live within that habit." Accordingly, the Commission acknowledged that the environment and sustainable development are inseparable. It also recognized the growing interdependence among nations in dealing with economic and environmental problems.

[8] The Declaration was adopted in the United Nations Conference on Environment and Development, which took place in the city of Rio de Janeiro, in 1992. Alongside the 176 States attending the event, more than 50 intergovernmental organizations and thousands of non-governmental organizations (NGOs) were present.

United Nations Framework Convention on Climate Change (UNFCCC),[9] the Convention on Biological Diversity[10], the Rio Declaration on Environment and Development (Agenda 21)[11], and the Principles of Forest Management[12].

Although all these documents have their own crucial importance, we must highlight Agenda 21, a more comprehensive action program. Despite its recommendatory nature, it has a guiding character that addresses the relationship between the environment and the economy. Its main scope was designed to merge the continued economic development objectives and environmental protection, whose essence is an action plan allowing States to achieve sustainable development through the following principles: the promotion of sustainable development through trade liberalization; financial support to developing countries in order to deal with international debt; and implementing macroeconomic policies favorable to the environment and development[13].

One should note that during the work of the Rio 92 Preparatory Committee as well as the Resolution no. 44/228 of the UN General Assembly, under strong pressure from developing countries, it was recognized that the responsibility to control, reduce and eliminate harm to the environment must rely on the countries that cause them. Hence, there is a link between environmental damages and the related capabilities and responsibilities. In addition to this axiology, it was established that the signatory States shall protect the climate system for the benefit of present and future generations, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities[14].

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9 United Nations Framework Convention on Climate Change, art. 4, 9 May 1992 - 31 ILM 849 [UNFCCC]. This treaty aims to control global warming and establish mechanisms of cooperation between the countries in a global scale in order to seek a consensus on how to deal with (and avoid) the negative impacts of the climate change.

10 Convention on Biological Diversity, 5 June 1992 - 31 ILM 818, 818 [Diversity Convention].

11 Rio Declaration on Environment and Development, UN Doc. A / CONF. 151/26 / Rev. 1 (12 August 1992) [Rio Declaration].

12 Non-legally Binding Authoritative Statement of Principles for a Global Consensus on the Management, Conservation and Sustainable Development of all Types of Forests, 13 June 1992 - 31 ILM 881.

13 Rio Declaration, supra note.

14 This can be found in the preamble of the UNFCCC. In the same line, Principle 7 of the Rio Declaration reads as follow: "States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit to sustainable development in view of the

In 1994, the United Nations Framework Convention on Climate Change entered into force. Since then, the State Parties meet annually to promote and monitor its implementation, giving rise to the well know Conference of the Parties – COP. The most important ones were the following:

- COP-3: The Kyoto Protocol was signed[15]. A milestone in the fight against greenhouse gas emissions, this agreement established relevant goals and definitions to operationalize the principle of common but differentiated responsibilities. Following the guidelines established therein, it imposes obligations for industrialized countries to reduce their total emissions of greenhouse gas by at least 5% below the levels of 1990, whose commitment period covers 2008-2012. The only obligation within the Protocol for developing countries is in relation to the need to expand international cooperation to create the Clean Development Mechanism (hereinafter CDM), which aims to enable joint activities to reduce emissions between developed and developing countries[16].

- COP-13: It created a platform where governments around the world agreed to increase efforts to combat climate change, adopting the Bali Road Map, which includes the Bali Action Plan (BAP)[17].

- COP-17: The Conference gave rise to the Durban Platform for Enhanced Action (Durban Platform), a legal instrument adopted within the UN Framework Convention and applicable to all its contracting parties. The platform is basically composed of two main objectives: immediately put in action (in this case it was from 2012) mitigations and agreements on

pressures their societies place on the global environment and of the technologies and financial resources they command."

15 The Protocol entered into force on the ninetieth day after the date on which not less than 55 Parties to the Convention, incorporating Parties included in Annex I which accounted in total for at least 55 per cent of the total carbon dioxide emissions for 1990 of the Parties included in Annex I, have deposited their instruments of ratification, acceptance, approval or accession. Accordingly, it entered into force in February 2005, with the Russian ratification.

16 Cf. Kyoto Protocol - United Nations Framework Convention on Climate Change. Available at: <http://www.fd.uc.pt/CI/CEE/pm/LegCE/Protocolo%20de%20Quioto%2011-12-1997.htm> Access: 18 July 2016. Relevant note: The Protocol distinguishes developed countries from developing countries, and countries with economies in transition.

17 Cf. Bali Action Plan in Report of the Conference of the Parties on its Thirteenth Session. Available at: <<http://unfccc.int/documentation/documents/advanced_search/items/6911.php?priref=600004671> Access: 29 July 2016.

climate change and negotiate a new international climate agreement - whose effect would be legally binding -, taking into account the principle of common but differentiated responsibilities and respective capabilities of the parties. These negotiations would occur up until 2015, and treaty will enter into force in 2020[18].

- COP-21: It adopted the 2015 Agreement, also known as the Paris Agreement. The two most important aspects of this Agreement refer to the principle of common but differentiated responsibilities. The first one relates on how to ensure the collective effort of all countries in an attempt to promote the stabilization or reduction of greenhouse gas emissions not exceeding the goal of 2°C. The second aspect deals with the contributions that each State will have to implement. Moreover, this implementation of the principle should be applied by all parties in full maintenance of what had been adopted in the decisions took within the Durban Platform. This challenge was launched in 2013, during the COP-19, when all State parties were invited to initiate or intensify domestic preparations for their contributions in order to determine the national level of greenhouse gas emissions and report them in advance before the Summit that would take place in Paris, during the COP-21. In general, the "common" part of the principle of common but differentiated responsibilities is being effectively operationalized by the concept of national level of greenhouse gas emissions. The operationalization of the differentiation is the key to allow the development of the new agreement[19].

2. An overview of the clean energy in the international policy agenda

The first major effort in order to enhance international cooperation on renewable energy sources took place in 1961, in Rome, at the United Nations

[18] DELEUIL, Thomas. **The Common But Differentiated Responsibilities Principle: Changes in Continuity after the Durban Cop**. Available at: <http://dx.doi.org/10.2139/ssrn.2056234> Access: 8 June 2016.

[19] Cf. **International Law Association, Legal Principles Relating to Climate Change**, ILA First Report, 2016.

Conference on New Sources of Energy. Focusing on discussions about solar, wind and geothermal energy, the biggest advance of this Conference was the exchange of practices and expertise between the attending States[20].

In the first major United Nations Conference on the Human Environment (held in Stockholm, in 1972) the energy issue did not gain much attention. The world was not worried about the power supply back then, because it had not gone through the great oil crisis and mainly because research on global warming was still in a very premature stage at that time.

Despite the modest relevance of energy back then, the Conference was extremely important, because it is considered a milestone in discussions about the environmental dimension of development. It also collaborated for the creation of an international body, the United Nations Environment Programme, which later came to create the Intergovernmental Panel on Climate Change (IPCC), the world's leading authority on global warming[21].

In 1981, Nairobi, Kenya, held the meeting of 125 States in order to develop measures for a joint action to promote the development and use of new and renewable energy sources, contributing to fulfill future global energy demands, especially those of developing countries. At that meeting, developing countries, largely affected by the oil crisis, called for greater North-South technical cooperation for the development and implementation of energy sources that would make those countries less dependent on oil price fluctuations. Thus, the developing countries created a new demand related to the need to create new international organizations to address this problem. There is, from that moment, the inclusion of renewable energy on the international agenda of States[22].

Accordingly, in 1983, the UN General Assembly created the World Commission on Environment and Development, headed by Gro Harlem Brundtland. This Commission issued the report "Our Common Future" (also known as the "Brundtland Report"), which was published in 1987. It intended to recommend long-term environmental strategies for achieving sustainable

[20] ROWLANDS, Ian H. **Renewable energy and international politics.** Handbook of Global Environmental Politics. Cheltenham, UK: Northampton, MA: Edward Elgar, 2005.

[21] GRASSO, Marco & ROBERTS, J. Timmons. **A Compromise to Break a Climate Impasse**. Nature Climate Change, Vol. 4, Junee 2014.

[22] ROWLANDS, Ian H. *Ob. Cit*.

development by the year 2000 and then begin to suggest conservation practices of the environment. It also proposed measures to achieve greater cooperation among developing countries and between countries at different stages of economic development[23].

The currently widespread concept of sustainable development was suggested for the for the first time in the report "Our Common Future", in which sustainable development was considered the development that meets present needs without compromising the ability of future generations to fulfill to their needs[24].

According to Veiga, the concept presented by the UN for sustainable development is a political and broad definition phrased to ensure economic and social progress and which institutionalizes the biggest challenge and the main goal of contemporary societies, namely the reconciliation between economic growth and nature conservation[25]. The impact of this concept was extensive as to inspire the realization of the UN Conference on Environment and Development (Rio 92), in Rio de Janeiro, as already outlined above.

3. Clean energy and climate change regime

With the advance of scientific studies, it was found that global climate changes are not derived only from natural phenomena, but also from human action, such as GHG emissions, deforestation and the utilization of fossil fuels. In the last decades of the twentieth century, there was a large increase in the consumption of fossil fuels, which is responsible for most emissions of CO2 in the atmosphere[26].

According to the European Environment Agency, climate change is a major environmental, social and economic threat. IPCC researchers say:

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23 HALVORSSEN, Anita M. **International Law and Sustainable Development - Tools for Addressing Climate Change**. Denver Journal of International Law and Policy, Vol. 39, N. 3, Junho de 2011.

24 The report "Our Common Future" was presented to the UN General Assembly by the Commission in December of 1987. Cf. UN. A / Res / 42/427.

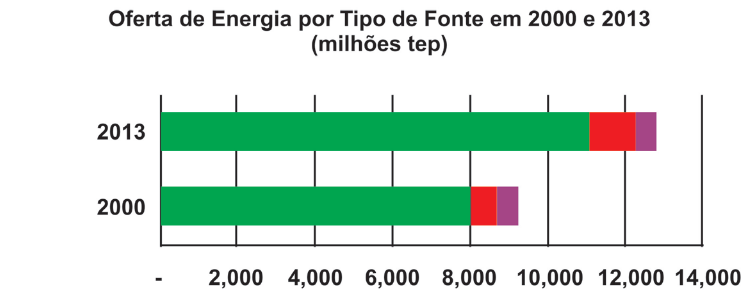
25 VEIGA, José Eli da. **Desenvolvimento Sustentável: o desafio do século XXI**. Rio de Janeiro: Garamond, 2010.

26 Cf. IPCC- Intergovernmental Panel on Climate Change. Available at: < http://www.ipcc.ch/>. Access: 14 June 2016.

> Over the past 150 years, the average global temperature has risen nearly 0,8ºC and about 1°C in Europe. Eleven of the last twelve years (1995-2006) are among the 12 warmest years in the instrumental record of global surface temperature (since 1850). If worldwide measures are not taken to limit emissions, the IPCC predicts that global average surface temperatures could rise from 1.8°C to 4°C by 2100. This means that the increase in temperature from pre-industrial times would exceed to 2°C. Beyond this limit, there may be irreversible and catastrophic changes[27].

Climate change directly impacts natural ecosystems, human security and water resources. In order to combat and mitigate the harmful effects of climate change, greenhouse gas emissions must be reduced significantly and, therefore, action policies and plans must be implemented by the States. Human activity is the main source of greenhouse gas, mainly from burning fossil fuels for electricity production, transport, industry and housing[28]. The graphics below illustrate the extensive use of fossil fuels and the related economic sectors that most consume them.

Chart nº 1: Energy offer according to the source type in 2000 and 2013.



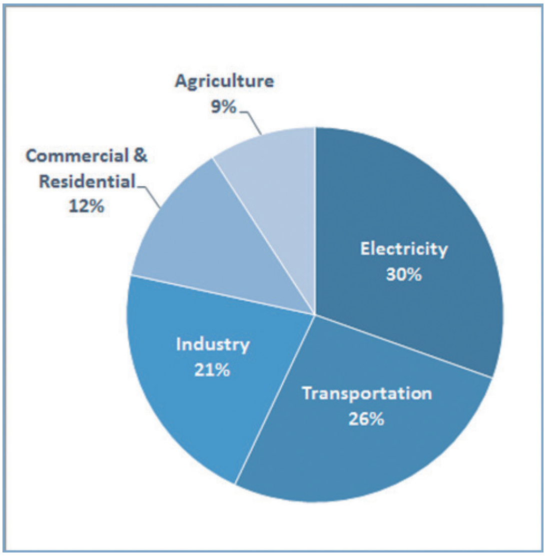
	2000	2013
Fósseis	8,046	11,086
Renováveis	663	1,200
Nuclar	584	563

Source: BP Energy Statistical Review, 2014.

27 _____. IPCC, 2015.

28 Cf. European Environment Agency. Available at: <http://www.eea.europa.eu/pt>. Access: 14 June 2016.

Chart nº 2: Total emissions of greenhouse gases by sector of the economy in 2014.



Source: IPCC.

Once the relationship between energy and climate change was understood, these two issues were jointly dealt in the subsequent years. Although the efforts to reduce levels of greenhouse gas have been significant, some changes are inevitable. That is why it is crucial to develop strategies for adaptation and mitigation of the harmful effects of climate change.

Given this limitation, summits and international conventions attributed the status of "common concern of mankind" to the atmosphere and, in response to studies by the IPCC and as a measure to face adversities in the local and international level, mechanisms to coordinate State actions were created. These mechanisms would become the international regimes[29].

Eduardo Viola sustains that the international regimes can be defined as a system of treaty rules agreed by governments of different States, with the objective to govern the actions of the various actors involved in the issue in question, and also reduces transaction costs between acceding national States. The political agenda of these regimes contains issues whose

[29] VIOLA, Eduardo. **O Regime Internacional de Mudança Climática e o Brasil**. Revista Brasileira de Ciências Sociais, vol. 17, nº 50, 2001.

causes, consequences and solutions imply relations of interdependence and cooperation among different countries, neighboring or not[30].

The threat of climate change increases the focus on international cooperation, sustainable development and sometimes imposes restrictions on the sovereignty of States, since it is only through the combination of international environmental legislation and effective domestic actions that it will be possible to avoid irreversible damage to the planet. Thus, cooperation is essential to achieve these goals, as climate change is essentially a transboundary problem and cannot be addressed only via autonomous decisions of individual States, without an established behavior pattern or an international action plan between all States with the objective to achieve effective results for the atmosphere and the safety of life on the planet[31].

The climate change regime is one of the examples in which cooperation between international actors is necessary in order to reduce the harmful effects of the overall process. According to Viola, the legal regime of climate change is one of the most complex and important international regimes because it deals with the relationship between economy and global environment. The main instruments of the regime are the 1992 United Nations Framework Convention on Climate Change and the Kyoto Protocol, signed in Kyoto, in December of 1997[32].

The own dynamics of the regime presents differences among its members. Hence, it differentiates the weight of members' responsibilities and importance regarding cooperation and adherence to agreements. According to Viola, the legal regime of climate change requires the presence of at least one actor that guides the process and is able to lead and sustain the regime. There are several conflicts of interest in the climate change regime because there are different groups with different emissions reduction targets according to their historical contributions. Also, although the climate change related problems reach all States, their effects have different degrees according to the region[33].

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30 _____. *Idem*.

31 KEOHANE, Robert; VICTOR, David. **The Regime Complex for Climate Change.** Cambridge University Press, Perspectives on Politics, vol. 9, 15 March 2011.

32 VIOLA, Eduardo. *Ob. Cit*.

33 VIOLA, Eduardo. *Ob. Cit*.

Global governance has pointed to the various parallel initiatives involving a range of different actors at different levels of governance, requiring a rearrangement of the regime itself, since this increasing participation of non-State actors in climate change governance has generated a number of challenges.

As affirmed by Keohane and Victor, there is no integrated system that limits the conditions of climate change. Instead, we have a complex of schemes, i.e., a fragile framework of specific regimes. This institutional structure persists in creating efforts to build a comprehensive and not very successful system, whose elements relies on cell-institution models in particular the aspects of the problem of climate change[34].

Despite this clear negative aspect, a complex of climate change regimes, following certain criteria, has advantages that other kinds of arrangements are unable to provide. These features reveal that climate change policies need to be adaptable and flexible, since the demands of international agreements vary according to the interests of the rulers and their implementing skills.

Furthermore, a high level coordination between national and international frameworks is necessary. However, such coordination faces difficulties because the regimes that govern international affairs - as in the case of environmental regimes - have no enforcement capacity towards the States. They do not even provide a system of reliable laws in which member States may compel the conclusion of agreements between them. On the other hand, these systems create a set of standards in which States can judge how other States are cooperating as agreed. Thus, they may increase the costs of a desertion[35].

According to Viola and Franchini, "[this] new development paradigm imposes strong challenges to governance, both domestically and internationally. Domestically it involves dialogue and coordination between State, market and civil society, and each of them must subordinate their own behavior to the requirements of the stabilization of the Earth system"[36]. The challenge would be to abandon the traditional logic of growth and consolidate the reduction process of greenhouse gas emissions and the use of renewable energy[37].

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34 KEOHANE, Robert; VICTOR, David. *Ob. Cit.*

35 _____. *Idem*.

36 VIOLA, Eduardo; FRANCHINI, Matías . Sistema Internacional de Hegemonia Conservadora e a Paralisia da Governança Climática Global. Ambiente & Sociedade, vol. 16, 2013, p.140.

37 *Idem*.

One can see an important behavior change, leading to a new phase for sustainable development. The milestone of this new phase is the adoption of the Sustainable Development Goals (SDGs) by 193 countries, which guide national and international cooperation activities in the next fifteen years, continuing and updating the Millennium Development Goals (MDGs).

The SDGs are fully integrated and indivisible, covering in a balanced approach the three dimensions of sustainable development: economic, social and environmental. Another great advantage is the effective participation of all actors, not just States. International organizations, non-governmental organizations, transnational corporations, civil society, academia, media, businesses and municipalities have an active and well-defined role in the implementation of SDGs. The world dialogue created from the global to the local is very important, showing that the goals should become public actions and policies of governments and local managers[38].

It is expected that the broad consensus on the SDGs will allow greater cooperation between the countries, which makes way for a more optimistic view concerning greater advances for humanity in the subsequent decades, towards sustainable development.

4. Technical cooperation funds and clean energy production mechanisms

Access to energy directly affects the security and socio-economic development of a nation. The strategic importance of issues related to energy directly impact the policies formulated by the States in their national and external actions.

We can see different realities worldwide regarding the energy matrix. Brazil, for example, has extensive use of renewable sources and energy potential, but still lacks investments for specific programs. The European Union, on the other hand, strives to move forward with a policy of incentives for renewable energy sources to ensure energy security, decoupling from the necessary energy imports. In both cases (Brazil and European Union), even in different ways, the efforts to ensure access to energy will, to some extent,

[38] Cf: <http://www.un.org/sustainabledevelopment/>

be affected by interaction in international and/or supranational level. These interactions may occur through international investments, international cooperation, international environmental obligations or the interaction of the private market with attracting investment factors and/or transfer of technologies.

Regarding the influence of the international sphere internally, we can see that the international commitments impact internal policies, promoting the adoption of new renewable technologies. The development of these new technologies will be a major tool to combat global warming, since renewable sources will be the main source of electricity in the year 2030, which corresponds to an increase of 80% of investments in renewable sources (non-hydro) compared to 2000[39].

Brazil has an important role in climate issues and more specifically with regard to renewable energy. More than 42% of the Brazilian energy matrix is composed of renewable energy[40], and undoubtedly, Brazil is one of the great players on the field, having an undeniable strategic role.

The importance and impact of international negotiations at the national level are incontestable. The COP-21, for example, was based on national commitments submitted by States and formalized through the Nationally Determined Contributions (INDCs).

Brazil presented its intended INDC to the United Nations Framework Convention on Climate Change. Among the challenges that Brazil faces, the main ones are poverty eradication, education, public health, employment, housing, infrastructure and energy access. Brazil emphasized the need for protection of vulnerable populations and the strengthening of its resilience, under which it had agreed to apply efforts to ensure the "transition to energy systems based on renewable sources and the decarburization of the economy […]". Brazil included in its INDC, the goal of reducing 43% the emissions of greenhouse gas by 2030 in relation to the 2005 levels, and achieving 45% of renewable energy in its matrix[41].

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39 IEA. **Energy and Climate Change: World Energy Outlook Special Report**. Paris: IEA, 2015.p.12.

40 REPÚBLICA FEDERATIVA DO BRASIL. Energia renovável representa mais de 42% da matriz energética brasileira. Available at: <http://www.brasil.gov.br/meio-ambiente/2015/11/energia-renovavel-representa-mais-de-42-da-matriz-energetica-brasileira>. Access: 16 June 2016.

41 REPÚBLICA FEDERATIVA DO BRASIL. *Pretendida Contribuição Nacionalmente Determinada para consecução do objetivo da convenção-quadro das nações unidas sobre mudança do clima.* Available at: <http://www.itamaraty.gov.br/images/ed_desenvsust/BRASIL-iNDC-portugues.pdf>. Access: 16 June 2016, p. 1-3.

In its INDC, Brazil seeks to expand the use of renewable sources, other than hydropower (Brazil estimates an increase of the use of hydropower from 28% to 33% by 2030), and seeks to expand the domestic use of non-fossil energy (with an increase in the application of wind, biomass and solar light in the production of energy). Brazil wants to reach 10% efficiency gains in the energy sector by 2030. The increase in the use of sustainable bioenergy has the goal to reach 10% in 2030. Also, Brazil has special goals to the agricultural, industry and transportation sectors[42].

In order to achieve its INDC goals, Brazilian implementation policies are conducted under the National Policy on Climate Change (Law 12,187/2009), the Law on the Protection of Native Forests (Law 12,651/2012), the Law on the National System for Conservation Units (Law 9,985/2000) and other related legislation, instruments and planning processes. For the development of new public policies, Brazil follows the National Plan for Adaptation to Climate Change (PNA) and the Multi-Year Plan for Development, Productivity and Social Inclusion (PPA). This demonstrates the practical implications of international commitments.

5. The access to energy problem

The understandings about climate change, as the obligation to reduce the increase in the world temperature[43], combined with the global challenges regarding sustainable development (as embodied in the Sustainable Development Goals, which imposes goals by 2030) mean that access to energy is not only an environmental issue, but it also refers to socio-economic and social inclusion related problems. The interaction between access to energy and socioeconomic development through renewable sources is undoubtedly the materialization of the concept of sustainable development.

[42] Op. Cit. p.3

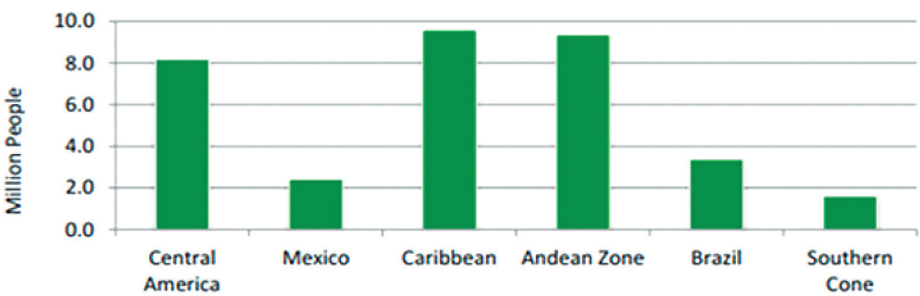
[43] The International Energy Agency proposes 5 measures in order to guarantee the commitments made in Paris: (i) energy efficiency in industry, construction and transport; (ii) progressive decrease in the use of coal power plants and the proscription of its construction; (iii) increase of investments in renewable energy technologies in the electricity sector, from 270 billion dollars in 2014 to 400 000 million in 2030; (iv) progressive decrease of subsidies for fossil fuels up until their complete abolishment in 2030; and (v) reduction of methane emissions in the production of oil and gas.

If we consider the large use of hydropower and biomass and the great advances in the field of new renewable technologies in Latin America, the energy matrix of this region is considered clean. Continuous integration of alternative energy sources in the local energy matrix creates economic, social and environmental opportunities. Even with such advances in the use of renewable sources, about 24 million people who live mainly in rural and remote areas still lack access to electricity in Latin America[44]. Regarding the rural population, 26% of this population has no access to energy[45] and, as they are not connected to the main power grid, they can be covered by micro-generation solutions.

The problems faced by Latin America in the energy sector are, *inter alia*: ensure the universal access to energy; fulfill the demand for electricity arising from the development of the region (need to double its installed capacity by 2030); integration of renewable energy sources to the necessary transformations of the electric grid; compliance with mitigation and climate adaptation policies as important means to reduce vulnerabilities and GHG emissions[46].

The following table discloses the current conditions of the access to electricity in Latin America and the Caribbean, according to a 2014 survey:

Chart nº 3: Population without access to electricity.



Source: IDB.[47]

[44] UNESCO. **Unesco Science Report: Towards 2030**. Paris: Unesco Publishing, 2105, p.199

45AIE. **Electricity Access Database.** Available at: http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/ Access: 17 July 2016.

[46] IDB. **Study on the Development of the Renewable Energy Market in Latin America and Caribbean.** World Watch Institute, 2014.

[47] *Idem.*

The search for clean and renewable sources of electricity and fuels (liquid and gas) has increased considerably throughout the world, especially when considering wind power, solar energy and the use of new biomass alternatives (such as increasing the use of rural waste and the development of algae production for biodiesel production). In addition, initiatives individually undertaken in homes or communities, applying distributed generation techniques, have gained strength in society and are important to the achievement of internationally assumed goals.

Local and/or close to its final beneficiary (final consumer) power generation - called micro distributed generation - is one of the alternatives of access to energy with no use of the power distribution grids. This alternative - proliferated on a world scale - allows remote areas to have access to power regardless of investments in the expansion of the core grid. The micro generation can be combined with various forms of renewable energy such as solar, wind, hydro and biomass.

In order to effectively consider the implementation of micro power generation solutions, it is necessary to overcome certain problems, such as high tax burdens, high-priced equipment, lack of specialized professionals to deal with the maintenance of the equipment and the environmental conditions. In light of these challenges, solutions to ensure clean energy are diverse, with technologies specially designed to deal with electricity generation, transport, heating and cooling. The use of more than one renewable source can bring more energy security to avoid the negative effects of possible climate variations, reducing intermittent services.

The use of renewable energies and decentralized solutions (micro-grid) is a sustainable alternative that avoids the costly expansion of the power grid, as mentioned above. These solutions will guarantee social inclusion, development with income generation and broad socio-economic objectives.

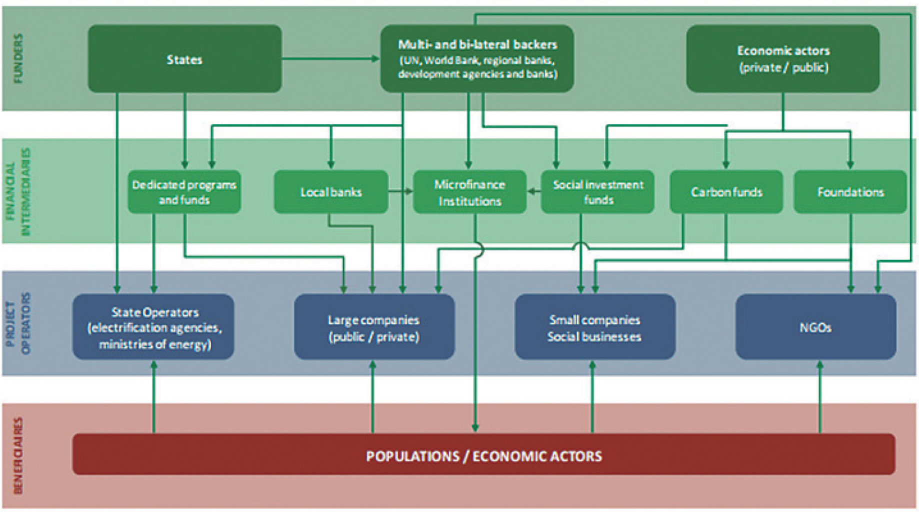
The projects involving infrastructure and energy are mostly long-term ones, demanding that policy makers adopt different forms of funding, seeking, in most cases, the reduction of energy costs with the combined use of different methods. The implementation options also vary in light of the local conditions and demands and may be, for example, decentralized generation in small farms, as can be found in Denmark and Germany, or large wind plants, as in the United States and China.

In order to comprehend all relevant elements concerning the access to energy, it is necessary to analyze the existing international mechanisms that allow any internal solution in the countries. The myriad of mechanisms is extensive, but without exhausting the topic, we will present some of the existing international instruments.

6. Boosting mechanisms for clean energy implementation (energy access)

Whenever it comes to investments, one should remember that they ought to be accompanied by regulatory reforms and a governance policy referring to the energy sector in question[48]. Bilateral or multilateral technical assistance and the activities of non-governmental organizations are essential, bringing with them benefits that go beyond the mere access to energy. There are a multitude of actors that can stimulate the development and implementation of new technologies, making use of different mechanisms, as can be seen below:

Chart nº 4: Actors involved in the access to energy.



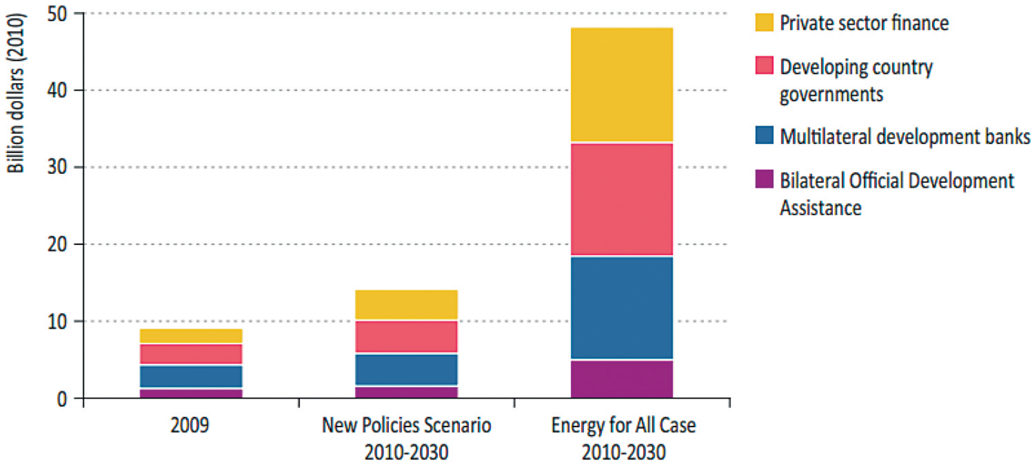
Source: ENEA.[49]

[48] OECD/International Energy Agency. **Energy for All: Financing access for all**. World Energy Outlook. 2011. Available at: <http://www.worldenergyoutlook.org/media/weowebsite/energydevelopment/weo2011_energy_for_all.pdf>. Access: 16 July 2016.

[49] ENEA. **Energy Access: Current Situation, Challenges and Outlook**. Paris: ENEA, 2014. Available at: <http://www.enea-consulting.com/wp-content/uploads/2015/05/ENEA-Consulting-Energy-access.pdf>. Access: 16 July 2016.

The funding instrument and the appropriate source for its development (domestic government, bilateral and multilateral funding, and private investment, among others) will depend on the technical and social features of the appropriate solution for each case. The funding may be from different sources, as shown in the following table:

Chart nº 5: Investment in energy access by source of funding.



Source: OECD/International Energy Agency.[50]

7. Incentive mechanisms for the development of clean energy

7.1. Incentive policies and private incentives

With respect to government actions in the internal sphere, the incentive policies has been extensively used, even those based on price or quantities. The International Energy Agency divided these mechanisms into categories: while the first category relies on price, the others are based on quantity factors - Feed-in System; Auction System; and Quota System[51].

If we comparatively analyze the incentives, it is possible to see that the feed-in tariff - the payment to the producer of each kilowatt-hour generated

[50] *OECD/International Energy Agency. Energy for All: Financing access for all. World Energy Outlook. 2011*

[51] International Energy Agency. **Renewable Energy into the mainstream**. The Netherlands, 2002.

using renewable sources - has been widely used in Germany[52] and Denmark. The United States employs PCT (Prodution Tax Credict) which, unlike the previous example, is a loan from the government to producers. In the United States' case, we still see strong incentive to R&D, coupled with tax incentives and renewable compulsory purchase programs at the state level.

One way of encouraging the implementation of renewable energy sources is through private investment. Tax incentives for the implementation of a certain project and special credit lines are some of the forms of government intervention in fostering the development of private projects in the energy sector, aiming to achieve the reduction of initial costs, expansion of the energy access, and development of a certain region and technology transfer.

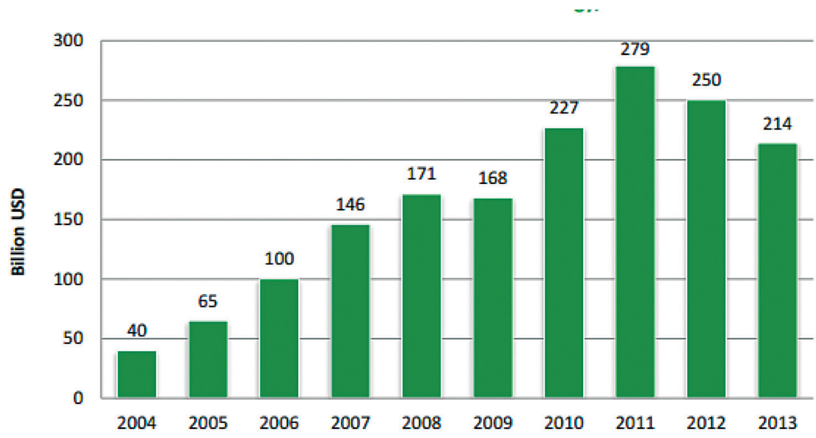
Furthermore, the renewable energy market is booming. Based in 2014 data, it is possible to see that the new alternative energy sources are responsible for almost half of the total new capacity of electricity production. A considerable increase in the level of investments due to the growth of energy sector in China, United States, Japan and Germany is estimated.

Global investment in renewable energy reached US$200 billion in 2013, which demonstrates the relevance of this sector. Furthermore, 6% of this expenditure was allocated to investments in renewable energy in Latin America and the Caribbean, especially in Brazil[53].

52 In 2000, Germany adopted the Law on Energy from Renewable Sources (*Erneuerbare-Energien-Gesetz - EEG*), which was a major breakthrough for the sector. This legal instrument gives priority to the production of renewable electricity in the German production and distribution system. Accordingly, local power plants should acquire the production and pay the producer a legal rate.

53 IDB. **Study on the Development of the Renewable Energy Market in Latin America and Caribbean**. *Ob. Cit.*, p. 7.

Chart nº 6: Global Investment in Renewable Energy 2004-2013.



Source: IDB.

Investment in renewable energy has a great impact on job creation. In 2013, 6.5 million jobs were created in the energy sector, most of them in China, Brazil, United States, India and Germany[54]. The increasing of investments necessarily involves the promotion of support and incentive policies.

In addition, banks have announced investment plans in the energy sector after the COP-21. For example, a partnership was created between the *Societé General* and French energy and technology companies, such as Total (oil company), EDF Energy and Orange. All of them established a new sector dedicated to climate change projects. Other banks such as the *Crédit Agricole*, BNP, Paribas, Bank of America and HSBC also announced the availability of funds to green projects[55].

1.2. Research & Development

According to the report "UNESCO Science Report: Towards 2030", investments in Research and Development - R&D increased 31% between

54 _____. *Idem*, p. 8.

55 NAKHOODA, Smita. **Climate finance: what was actually agreed in Paris?**. Available at: <https://www.odi.org/comment/10201-climate-finance-agreed-paris-cop21> Access: 18 July 2016.

2007 and 2013, reaching the figure of US$ 1,478 billion in 2013. This growing was faster than the growing of the worldwide GDP between 2007 and 2013[56].

The crises in international and national levels have affected the State ability to act, but the private sector has compensated through investing in R&D, a pattern that can be found in France and United Kingdom. The strategy of investing in R&D is based on its goal to achieve economic growth and value aggregation, dissemination of knowledge and competitiveness.

In Latin America and in the countries willing to implement the Sustainable Development Goals, investments in research on sustainable development are essential to effectively achieve these goals. Also, some countries have adopted mechanisms supporting the adoption of renewable energy.

The introduction of renewable energy was mostly developed through tax policies and incentives[57]. Brazil performed limitations to the budget designed to research in the energy sector: while in 2000 the rate was 2.1%, in 2012 it decreased to 0.3%. This reflects the series of investments in other energy sources, such as the major investments in oil and gas[58].

The boost to green and social technologies involves an incentive for R&D, such as the manufacture of wind turbines and the development of biostoves. Advances in R&D enable new technologies and reduce the cost, as seen in the case of solar panels.

The following is a table of some of the regulatory policies and tax incentives for renewable energy in Latin America:

[56] UNESCO. **Unesco Science Report: Towards 2030**. Paris: Unesco Publishing, 2105.p. 6.

[57] _____. *Idem*.

[58] _____. *Idem*.

Chart nº 7: Regulatory and incentive policies in Latin America.

Countries	Regulatory policies						Fiscal incentives and public financing				
	Feed-in tariff/ premium payment	Electric utility quota obligation/ Renewable portfolio standards	Net metering	Biofuels obligation/ mandate	Heat obligation/ mandate	Tendering	Capital subsidy, grant or rebate	Investment or tax production credits	Reduction in sales, energy, carbon, VAT or other taxes	Energy production payment	Public investment, loans or grants
Argentina	●		●	●		●	+	+	+	+	+
Brazil			●	●	●	●		+	+		+
Chile		●	●			●	+	+	+		+
Colombia			●	●				+	+		+
Costa Rica	●		●	●		●			+		
Dominican Rep.	●		●			●	+	+	+		+
Ecuador	●			●		●			+		+
El Salvador						●		+	+	+	+
Guatemala			●	●		●		+	+		
Honduras	●		●			●		+	+		
Mexico			●			●		+			+
Nicaragua	●								+		
Panama	●		●	●		●		+	+	+	
Paraguay				●					+		
Peru	●	●		●		●			+		+
Uruguay	●		●	●	●	●	+		+	+	+

Note: Data are unavailable for Bolivia, Cuba and Venezuela. VAT stands for value-added tax.

Source: Unesco.

An important initiative in Brazil is the legal obligation of Brazilian power companies, whether public or private, acting in generation and/or distribution, to invest part of their income, according to activity they perform, in programs of energy efficiency and to contribute to the National Fund for Scientific and Technological Development (*Fundo Nacional de Ciência e Desenvolvimento Tecnológico*). In 2014, R$ 342 million were spent in R&D projects, a much lower mark than the amount spent in 2011: R$ 712 million[59].

1.3. Regional mechanisms

One cannot forget the successful cases in Europe, either at a supranational level or in the internal, local context of countries where incentive policies for renewable energy have been used as examples for practices in different countries. The European initiatives are old, but, for example, the 2007 White

59 UNESCO. **Unesco Science Report: Towards 2030**. Paris: Unesco Publishing, 2105.

Paper published by the European Commission, exposes the need of a clean energy matrix and shows the paths to ensure that in 2010, 12% of the energy consumed in the continent was renewable[60].

In order to guarantee energy security and taking into account the supply risks and the commitments to reduce greenhouse gas emissions, European countries have encouraged the diversification of energy sources. At the national level, we can mention two well-know examples: the feed-in tariffs by the German government and the quota obligation implemented in the United Kingdom and France.

An analysis of the regional level reveals, in some cases, the search for similar solutions, given the similar local characteristics and challenges, whose similarity is due to the connection between historical, cultural, economic and social patterns. In general, with no undue generalization, Latin America, compared to other areas of the globe, has a considerable supply of alternative energy sources. One of the difficulties at the regional level is the different power structures, the lack of transmission infrastructure and the impossibility of compensations regarding fluctuations in the supply of renewable energy among countries.

Regional agreements are a source of local boost. In Mercosur, initiatives in the energy sector has a broad sense, also covering biofuels, as can be seen by the formation of the *Ad Hoc* Group on Biofuels. Some agreements adopted under the auspicious of Mercosur also show improvements in this topic[61].

In terms of international cooperation, we can mention Brazil's efforts to ensure South-South cooperation. Under the IBSA (India - Brazil - South Africa), for example, there are some agreements: the Memorandum of Understanding to Establish Trilateral Task Force on Biofuels (2008); Memorandum of Understanding on Cooperation in Wind Resources (2009); and Memorandum of Understanding on Solar Energy (2010)[62].

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[60] European Commission. **Energia para o Futuro: Fontes de Energias Renováveis** - Livro Branco para uma Estratégia e um Pano de Ação Comunitário. Brussels, COM 599, 1997.

[61] We can mention the following: *Acuerdo Marco sobre Complementación Energética Regional entre los Estados Partes del Mercosur y Estados Asociados* (2005) and the *Memorándum de Entendimiento entre el Gobierno de la República Argentina, el Gobierno de la República Federativa del Brasil, el Gobierno de la República del Paraguay, el Gobierno de la República Oriental del Uruguay y el Gobierno de la República Bolivariana de Venezuela para Establecer un Grupo de Trabajo Especial sobre Biocobustibles* (2006).

[62] REPÚBLICA FEDERATIVA DO BRASIL. **Divisão de Atos Internacionais**. Available at: <http://dai-mre.serpro.gov.br/>. Access: 16 July 2016.

7.4. International mechanisms

International mechanisms are the result of interactions between the distribution of resources and vulnerabilities that generate a complex interdependence. The present paper will discuss some of the funds that can be used to finance energy projects.

Although the World Bank was created to help countries devastated by World War II, today, it has a much more ambitious goal: to contribute to the process of economic development of its members, especially those classified as developing countries[63]. In recent years, the World Bank has given special emphasis to projects that address environmental protection and climate change.

The World Bank Group consists of five institutions, namely: the International Bank for Reconstruction and Development (IBRD), the International Development Association (IDA), the International Finance Corporation (IFC), the Multilateral Investment Guarantee (MIGA) and the International Center for Investment Dispute Settlement (ICSID) 64.

The International Bank for Reconstruction and Development - IBRD is a financial institution concentrated in providing financing in terms that private institutions would not offer. It also supports the sustainability of projects through consulting, different financial solutions, and technical cooperation both at national and sub-national levels.

The International Development Association - IDA provides loans and grants to the neediest countries on very favorable terms. It focuses on inequality and poverty reduction, promotion of economic growth and improvement of living conditions of the population. In the period of 2014-2017, its functions are turned to social inclusion projects, gender equality, countries affected by conflicts and climate change.

The International Finance Corporation - IFC is the branch of the World Bank Group that was created to provide for private companies in different ways: capital contributions in developing countries, long-term loans in the private sector, structured financing products and risk and trade finance management

[63] All Latin American countries are members of the World Bank Group, except Cuba.

[64] The expression "World Bank Group" refers to the five institutions and the World Bank refers only to IBRD and IDA.

as well as direct assistance to companies or governments. It also provides technical assistance on corporate governance; access to market information; advisement on managing environmental and social impacts of projects, as well as political and financial risks in the country where the project will be implemented.

The Multilateral Agency for Investment Guarantees - MIGA aims to stimulate investment in developing countries by giving guarantees against non-commercial risks. It also provides technical assistance in the field of promotion policies and attracts foreign investment to these countries.

The Inter-American Development Bank - IDB was established in 1959 to promote the development and integration of Latin America and the Caribbean. The two main principles guiding the Bank's operations are: the pursuit of social equity through poverty reduction and development with sustainability. The Bank offers financing, grants and technical assistance to projects that promote development, increases competitiveness at the global level, contributes to the modernization of the State, etc., working with national or sub-national governments and the private sector. Currently the IDB supports 387 projects, 70 of them are located in Brazil.

As the World Bank, the IDB is also a group of institutions - the IDB Group -, which is composed by the Bank itself, whose objectives were previously exposed; the Inter-American Investment Corporation (IIC), which aims to support small and medium-sized companies with long-term funding, to which they would not have access in ordinary commercial banks; the Fund for Special Operations (FSO), that manages exceptional grants or highly favorable loans to countries in severe crisis; the Multilateral Investment Fund (MIF), the IDB's autonomous fund. It was established in 1993 to assist the private sector, seeking to support business models that can be monitored by indicators and that will produce shareable knowledge. It also promotes micro-credit.

In addition to these institutions, there is the Andean Development Corporation/Latin American Development Bank - ADC, which is a multilateral financial institution with various financial services available: loans, structured funding, financial advice, guarantees, equity participation, technical cooperation and credit lines. The ADC has strongly supported infrastructure projects and those promoting regional integration. Its headquarters are in Venezuela.

Similarly to the ADC, but regarding the countries in the basins of the rivers Parana, Paraguay, Uruguay and Prata, there is the Financial Fund for the Development of the Plata Basin - FONPLATA, established in 1977 and headquartered in Santa Cruz de La Sierra, in Bolivia. It offers technical support, loans and guarantees for projects seeking investment in the region.

There are international funds that may be useful to fund the projects under discussion, such as the Global Environment Facility - GEF; the French Development Agency - AFD; the Japan Bank for International Cooperation - JBIC and even the International Fund for Agricultural Development - IFAD, a UN agency. All three subsidize, support, finance or invest in projects regarding economic development, social and global inequality, access to technology, knowledge and land, environmental protection or mitigation, among other objectives.

Among the mechanisms that promote investment and support on a global scale, we can mention the bodies of national governments whose goal is to help companies in their countries to invest in other parts of the world, providing good opportunities for investors. This is the case, for example, of OPIC - Overseas Private Investment Corporation, an US government funding institution. It mobilizes capital for American companies that want to safely invest in emerging markets.

As for the recently created mechanisms, there is the Paris Agreement, which provides for the establishment of an annual fund of US$100 billion, as part of the Green Climate Fund, financed by the richest nations to limit global warming, with the commitment to make considerable contributions to allow its effective operation[65].

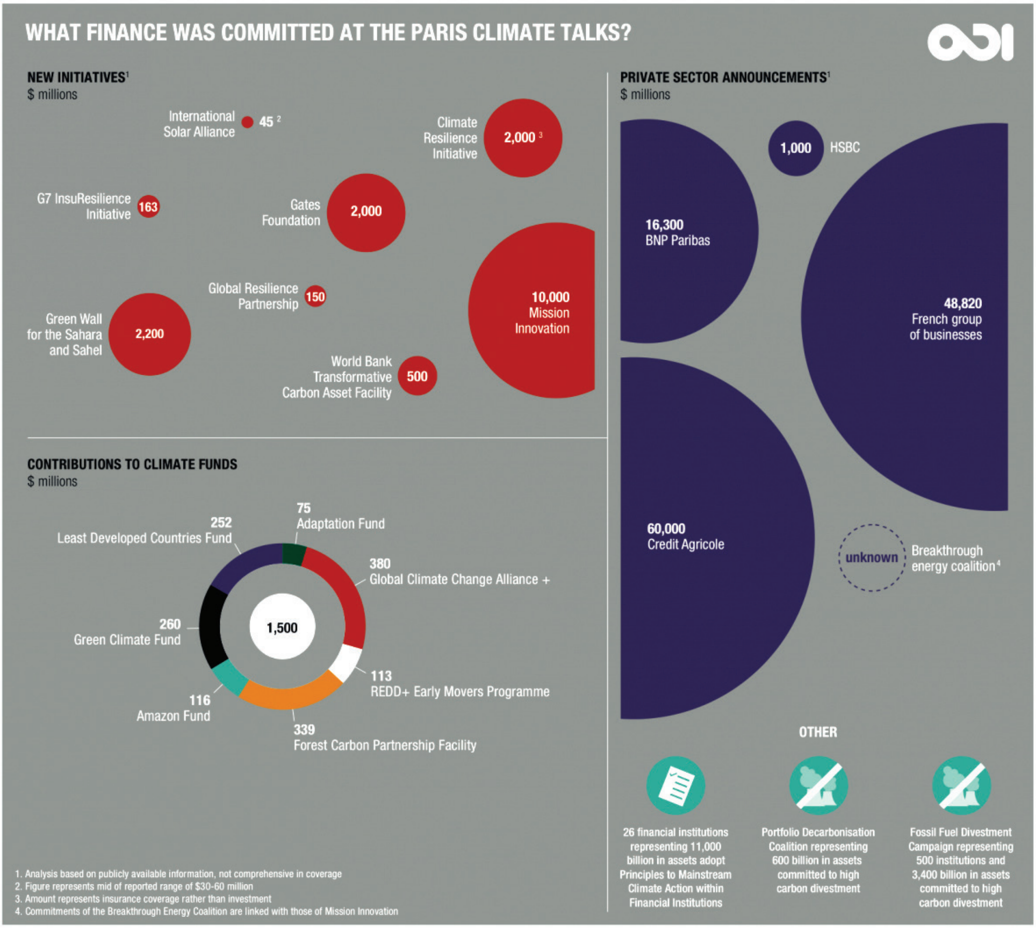
The multilateral development banks also have their own relevance. The Asian Development Bank announced that it will more than double its annual climate finance, which will reach US$ 6 billion in 2020. Also, the European Investment Bank announced a contribution of US$ 20 billion per year for the next five years, i.e., a funding of US$ 100 billion in total[66]. The Inter-American Development Bank acknowledged its goal to double the volume of its climate

65 An interactive map can be found in COP-21's website: <http://www.cop21.gouv.fr/en/list-of-recent-climate-funding-announcements/>.

66 NAKHOODA, Smita. **Climate finance: what was actually agreed in Paris?**. Available at: <https://www.odi.org/comment/10201-climate-finance-agreed-paris-cop21> Access: 17 July 2016.

finance in 2020 and the World Bank promised an increase of one third of its climate financing.

A group of 11 countries have declared that they will do contributions to the Least Developed Countries Fund, which will be managed by the Global Environment Facility. Below, one can see the commitments present in the Paris Agreement:



Source: COP-21

Moreover, many promises were made, including the establishment of the Adaptation Fund, the Least Developed Countries Fund and the Green Climate Fund.

Furthermore, twenty States[67] launched the Mission Innovation in order to support the innovation on clean energy and investments in research and development. This initiative has some partners, such as the Breakthrough Coalition of Energy, Bill Gates, Mark Zuckerberg, Richard Branson and Mukesh Ambani. This group of great players believes that renewable energy sources are part of a significant market with great business opportunities arising from the green revolution.

7.5. Proliferation of non-State actors and coalitions in the decision-making process

Sometimes, the inertia, inaction or institutional and/or economic constraints of States for the resolution of specific problems, give room for the civil society organizations to act in order to supplement the State absence in dealing of such problems. The challenge of ensuring access to reliable and sustainable energy demands a deep discussion concerning the action and management plans to deal with latent social problems as well as legislative review and public policies to guarantee the safety of all individuals.

Taking into account the principle of transparency, the COP-21 may have been the international conference with more active popular participation. The Conference revealed that society is no longer a passive actor, but actually one player with an effective role to play in accomplishing changes.

At the international level, access to energy programs were developed or supported by civil society organizations.

Conclusion

In the international sphere, studies dealing with access to energy and energy security are fundamental. Studies on environmental regimes, whatever the specific subject is, should be performed taking into account the whole international legal framework referring to this topic.

[67] They are: Australia; Brazil; Canada; Chile; China; Denmark; European Union; France; Germany; India; Indonesia; Italy; Japan; Mexico; Norway; Republic of Korea; Saudi Arabia; Sweden; United Arab Emirates; United Kingdom and United States.

With a general overview of the existing international instruments, it is possible to see the myriad of international agreements and commitments and the evolution of the international protection of the environment. The solution to the energy problem will undoubtedly be related to the development of international structures.

Additionally to international legal development, this issue will depend on: the expansion of international investments, international cooperation between countries and institutions; the expansion of international funds and the facilitation of access to them; the interaction with the private market; the attraction of investments and/or transference of technology; changes in national policies.

Technological development is one of the keys to the solution of the energy issue. Its implementation can receive financial support from international and national mechanisms. In addition, the creation of new technologies will be an important solution not only to global warming, but to the eradication of energy deprivation on certain social groups.

As discussed in the present survey, the regulatory mechanisms to encourage the development and implementation of renewable energy sources have been successfully used in some countries, always adapting themselves to fulfill the needs of the various concerned actors.

However, the suitable forms of incentives will be intensely debated in the international scope in the upcoming years. An illustrative example is the debate within the World Trade Organization - WTO on whether incentives to renewable energy are illegal. Given its impacts on the policies of countries and investments, this debate must be carefully evaluated.

Latin America has a prominent position on the renewable energy issue, but it still has to take measures to ensure the consistency of local legal and regulatory frameworks and its interaction at the international level. Accordingly, Latin America will be able to guarantee universal access to energy and the protection of its people and environment.

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THE ENERGY RELATED SOCIO-ENVIRONMENTAL CONFLICTS IN LATIN AMERICA: RENEWABLE ENERGY IN THE 2030 UN AGENDA

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Abstract: This paper aims to analyze the main energy related environmental conflicts in Latin America, as well as the model of conflict settlement, based on the great environmental impulse, with equality and freedom, promoted by the Sustainable Development Objectives of Agenda 2030, of the United Nations UN, and the Horizons 2030 document, from the Economic Commission for Latin America and the Caribbean, ECLAC. Thus, the research problem is the relationship among economic development, energy consumption and conflict, which discourages a new style of sustainable development in matters of energy, making it necessary to diversify energy sources for a progressive structural change into the generation of non-conventional renewable energy by the State, the market and society. Therefore, from a regional perspective, the result of this study, based on the Agenda and Horizons 2030 documents, seeks to institutionally guide the way in which a sustainable energy matrix that is diversified through renewable energy sources, accessible to all social actors, can be, in itself, an implicit environmental policy for the prevention of socio-environmental energy related conflicts that contributes to and strengthens the maximization of the common well-being and the rights of present and future generations in Latin American countries.

Keywords: Agenda 2030/UN – Horizons 2030/ECLAC – Socio-environmental Conflicts – Energy Matrix – Renewable Energy – Progressive Structural Change.

Introduction

Nowadays, the Latin America region, forged on an economic model of primary export, continues to experience a slight economic development,

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NOTE: The mentions to names of companies and/or economic actors, public and/or private in the present work do not presuppose a positive or negative opinion about their performance and arise from the references of the identified bibliography for the present research work.

in part associated with the decrease in the dynamics of the super-cycle of the international commodity prices of raw materials, specifically minerals, petroleum and energy. However, in spite of the improvement in economic indicators since the last decade and the unstable fluctuations in the application of international investments, these facts are being accompanied by the increase in the intensity of several socio-environmental conflicts as a consequence of the diverse socioeconomic impacts that are generated by the extractive activities of natural resources.

Socio-environmental conflicts do not come only from the impacts on the environment, but also from the relationship between the conditions of poverty and inequality in the access to the main public services in the places where the economic enterprises are located, specially the mining, energy and petroleum projects. Such conflicts usually involve the communities and social organizations close to the location of investment projects linked to the development of natural resources and infrastructure. In this sense, this highly combative context presents a risk for the viability of many projects, which can have potential negative impacts on the capitalization of new investments that promote greater socioeconomic development in the medium and long term.

However, from a perspective of the protection of the fundamental rights of the individual, lack of prevention and inadequate management of socio-environmental conflicts by social actors have direct consequences on the vulnerabilities of the rights of equality and freedoms of development, being both conductive filters to achieve the consolidation of the right to human development in a Socio-Environmental Constitutional State.

Therefore, the objective of this study is to analyze the socio-environmental conflicts arising from tensions between energy policies, environmental degradation and sustainable sources of renewable energy in Latin American countries, especially Brazil, Peru, Chile, Colombia and Mexico. In this sense, after having shown cases of various conflicts, taking note of the social actors involved and providing a brief description of the reality of the countries in question, a brief analysis will be made of five common elements that were evidenced through this work, in order to promote a deeper reflection to understand the possible mechanisms for prevention and management of socio-environmental conflicts in the region. Thus, the research's result seeks to institutionally guide the way in which an energy matrix sustainably diversified through non-conventional renewable energy sources, accessible to all social actors, can in itself be an implicit environmental policy for the prevention of socio-environmental conflicts, which contribute to and strengthen at the same time the maximization of the public welfare and of the rights of present and future generations, based on the great impetus for equality, development and sustainability in accordance with the Sustainable Development Objectives of the United Nations 2030 Agenda And the recommendations of the Horizons 2030 study of the Economic Commission for Latin America and the Caribbean ECLAC, presented in May 2016, at the Commission's session.

1. The energy issue in Latin American countries and its relationship with socio-environmental conflicts

The agenda of sustainable development processes in Latin America is an immediate priority for all countries wishing to reconcile greater social welfare and economic dynamism. The region is always compromised by negative externalities arising from social, economic and political contexts that restrict the implementation, structuring and execution of the public agenda of a new style of development which decentralizes the concentration of power and wealth.

> The world today faces the need to change its style of development, which has become unsustainable. The loss of dynamism and instability of the economic system, the inequalities and tensions caused by the concentration of wealth and income between and within countries, and the risk of an environmental crisis of great proportions are factors increasingly visible and present in the public debate. There is a quest for a new style of development and a new policy agenda, the relevance and urgency of which has been confirmed by recent developments in the international economy and, particularly, in the aforementioned region.[3]

Specifically, in view of the development models, economic growth and concentration of wealth in Latin America, the region currently maintains a permanent dependence on the international economy due to the negative volatility of the degrees of foreign investment, for not maintaining a policy

[3] ECLAC. **Horizontes 2030: La igualdad en el centro del desarrollo sostenible.** Santiago of Chile, UN, 2016.

of long-term economic growth, unlike other regions, for the constant permanence of the international prices of raw materials, for the restrictions on the diversification of its industries, for not incorporating a new style of development with sustainability in its public agenda, among other factors.

> Particularly in the last decade, the region reduced income differences with the developed world, but not technological or productivity gaps. It also promoted better distribution through labor market revitalization and more vigorous social policies, but failed to expand quality jobs to the necessary magnitude. Informality still characterizes a good part of the region's productive system. The structural change to close the productivity gap and create jobs that allow integration into the world of labor has been a notable absence since the 1980s.[4]
>
> These characteristics determine how recent events (the virtual stagnation of the world economy, increased financial volatility, flight to quality, slower growth in China and abrupt drops in commodity prices) affect the region as a whole, as well as its sub-regions. Since the period of 2010-2011, most countries have experienced a deceleration in the rate of economic growth, which has, in some cases, turned into a contraction. The aggregated demand component most affected by the slowdown is investment, which has negative implications on productivity and on competitiveness.[5]

Thus, even with the deceleration in economic development in Latin America, the demand for increased energy consumption has been boosted by the dynamism of investments, productivity and competitiveness vis-à-vis international trade. In this sense, the factor of the generation, use and consumption of energy for the regional economic development marks an intrinsic relation of institutional priority between energy security, economic development and well being of States.

However, given the need to boost economic development in parallel with a greater use of energy which, in most cases, falls upon fossil fuels, either by the extraction, use and consumption of oil, coal, gas and even by construction of hydroelectric plants, the social and environmental problems arise, caused by the negative externalities of the mass emissions of carbon dioxide (CO_2), which results in the vulnerability of the fundamental rights of present and future generations.

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[4] BÁRCENA, Alicia. PRADO, Antonio. **El imperativo de la igualdad. Por un desarrollo sostenible en América Latina y el Caribe.** Buenos Aires: Siglo Veintiuno. Editora Argentina, 2016.

[5] ECLAC. **Horizontes 2030: La igualdad en el centro del desarrollo sostenible.** Santiago of Chile, UN, 2016.

"Thus, economic development generates energy consumption and CO2 emissions, and this consumption has a positive impact on economic activity, due to the importance of the energy sector in these economies. On the other hand, given the predominance of fossil fuels as a source of energy in these countries, greater energy consumption necessarily increases CO2 emissions"[6], which, as we know, is economically, socially and environmentally unsustainable. In addition, the growth of the investment curve and the increased demand for energy is accompanied by an increase in the quantity and intensity of conflict situations around the natural resources and environmental impacts of extractive activities.

Institutional tensions between economic development, the generation, use and consumption of conventional energy sources, and the inefficiency in the management of natural resources currently lead to the generation of various socio-environmental conflicts in the countries of Latin America, with special emphasis on the States which have greater economic dependence on natural resources. Among various factors, such conflict has its origins in a confrontational culture[7] of social actors before the State, which does not give due mechanisms for the prevention and management of conflict settlement through dialogue and a culture of peace. In this sense, not only the dynamism of economic growth forged on investments is affected by this type of conflict, but also "some sectors such as education, culture and health are also directly affected by changes in the energy sector and certainly by climate change[8]".

> In the last decades, the debate on conflicts related to the exploitation of natural resources in general and, in particular, non-renewable ones, has been deepened. Although these conflicts are of a general nature and are inherent to the evolution and behavior of a society, they have been characterized as "socio-environmental" conflicts arising from situations of disagreement regarding the use, enjoyment, ownership and access to natural resources, as well as the effects on the environment and its

[6] HERES, David del Valle. **El cambio climático y la energía en América Latina. Estudios del cambio climático en América Latina.** Santiago of Chile: ECLAC, 2015.

[7] By confrontational culture we mean the group of behaviors, actions, attitudes, ideas or positions which the social actors generate before others, with the objective of disqualifying, anullating or illegitimating the confronted in order to impose its own decisions, without leaving any space for dialogue and establishment of agreements. Cf.: PERU. **Estado e conflicto social. Diálogo dos años después.** Oficina Nacional de Diálogo y Sostenibilidad. Lima: PCM, 2014.

[8] HERES, David del Valle. **El cambio climático y la energía en América Latina. Estudios del cambio climático en América Latina.** Santiago of Chile: ECLAC, 2015.

> consequent repercussions on health, quality of life and development possibilities of the directly affected communities. In other words, there has been an attempt to reduce the multidimensional nature of conflicts to their social and environmental dimensions, in a combined manner. It is therefore important to reconsider the scope of conflicts related to the exploitation of natural resources, without reducing them exclusively to some of the multiple dimensions that compose it.[9]

"Conflicts related to the exploitation of natural resources usually refer to productive undertakings of great economic importance and may even transcend their geographical boundaries to acquire an international or regional dimension."[10] "This is often followed by *ex post facto* rejection by affected communities, either in the decision-making process, or once the consequences begin to appear. In the context of 'micro' conflicts to 'macro' conflicts, this dynamic seems to replicate itself, with different nuances."[11]

In this scenario, situations of manifest tension, which we will call "socio-environmental conflicts" (SEC), are characterized by the confrontation between different actors. Mainly, SECs involve the local communities and social organizations and the productive actors engaged in exploration and/or intensive use of natural resources and/or infrastructure development. The SECs also involve the State, represented by some of its centralized or decentralized entities and/or at its various levels (national, sub-national or local). This type of conflict is mainly related to the challenges of citizen participation in decision-making processes, environmental impacts of productive projects, disputes over the use and ownership of resources, reports of human rights abuses and distribution of income generated by developed activities.

Particularly in Latin America, there is an increasing number of socio-environmental conflicts. The development of extractive activities, the construction of large infrastructure projects and the possible violation of the rights of indigenous peoples are associated with a large number of situations of conflict that seem to have a growth tendency in the coming years. Opposition

[9] ALTOMONTE, Hugo. SÁNCHEZ, Ricardo. **Hacia una nueva gobernanza de los recursos naturales en América Latina y el Caribe.** ECLAC's Books no. 139. Santiago of Chile.

[10] ALTOMONTE, Hugo. SÁNCHEZ, Ricardo. **Hacia una nueva gobernanza de los recursos naturales en América Latina y el Caribe.** ECLAC's Books no. 139. Santiago of Chile.

[11] ACUÑA, Guillermo. **La aplicación y cumplimiento de la legislación ambiental en la Región de América Latina y el Caribe.** Em Informe Ambiental Anual 2009 FARN (Fundación Ambiente y Recursos Naturales), Buenos Aires, 2009.

movements to infrastructure projects in the areas of mining, energy and oil involve a great diversity of actors, because of the risks of contamination of water and soil, disputes over access to land, deforestation, forest degradation, use of agrochemicals, among others.

With regard to energy issues and socio-environmental conflicts in Latin American countries, the greatest institutional tensions between social actors are currently arising from the traditional mega energy projects for fossil fuels and the construction of large hydroelectric dams with impacts on the environment, originating, in this way, several negative externalities, such as the elimination of forests, the reduction of river water flow, the economic shortage of local populations, socioeconomic impacts, among others. High energy demand has the purpose of generating electricity to serve not only residential, urban or rural sectors, but also the sectors of transport, services, agriculture, fishing and, above all, the larger industrial enterprises related to activities of mining and oil extraction.

In the following paragraphs, cases are presented which were selected to give visibility to the socio-environmental conflicts because of energy projects in the region. The criterion used to identify the SEC has been the existence of peaceful or violent demonstrations, media and social networks campaigns and/or litigation against a specific activity or project. Thus, highlighting the location, the social actors and their background, we will identify some more representative SECs[12] that are generating greater socioeconomic and political instabilities, especially in Brazil, Peru, Chile and Colombia.

[12] The original source of these cases is: ACUÑA, Guillermo e SCHATZ, Pablo: *"Conflictos socioambientales en América Latina y el Caribe: Identificación y elementos para su análisis"* – Work Document, ECLAC/UN, April 2014, **unpublished.**

a. Brazil

CONFLICT	LOCATION	IDENTIFIED ACTORS	COMMENTARY
Belo Monte Hydroeletric Dam	Xingú River, Pará state	Private Sector: Norte Energia S.A. (consortium leaded by Eletrobrás) National Development Bank of Brazil (BNDES) Social organizations: Xingú Vivo para Sempre Movement Interamerican Association in Defense of the Environment (AIDA) Indigenous community Juruna of the Boa Vista tribe Indigenous community Xikrin, inhabitants of the da Bacajá river's basin Public sector: Federal Government of Brazil Supreme Court	Project: The Belo Monte Hydroelectric Project involves the stagnation and diversion of the waters of the Xingu River and involves an investment of over 3 billion dollars. The Belo Monte dam will have an installed capacity of 11 GW, positioning itself as the third largest hydroelectric project in the world. Conflict: The project would flood 500 km2 of tropical forest and agricultural land; would displace more than 20 thousand people, including indigenous peoples and other riverside communities; cause loss of biodiversity and emissions of large volumes of greenhouse gases. In addition, local communities denounce the violation of the right of access to water, food, labor and transportation through the river. The risk of increased cases of malaria and other tropical diseases was reported. For over twenty years, indigenous peoples and affected riverside communities have protested against the project. There was great controversy over the alleged lack of citizen consultation, as well as the lack of free, prior and informed consent from the affected communities, in contravention of the Brazilian Constitution and the ILO Convention 169. As a result, civil society organizations filed a complaint with the Inter-American Commission on Human Rights (IACHR) requesting the determination of protective measures in favor of affected communities. The IACHR determined preliminary measures ordering Brazil to suspend the project and the violation the rights of affected communities. The Brazilian State has not complied with the order issued by the IACHR, since the Federal Supreme Court of Brazil authorized the continuation of the works. In July 2016, the mega construction of the Belo Monte Hydroelectric Plant was in its final phase of execution, then there will be public bidding processes for the adjudication of energy supply contracts, so that in the coming years they may prevail over their main socioeconomic and socio-environmental impacts on local and riverside communities close to the enterprise. Source: Elaboration based on the Interamerican Association for the Defense of the Environment (AIDA).

CONFLICT	LOCATION	IDENTIFIED ACTORS	COMMENTARY
Hydrologic Complex of the Madeira River	Rondônia State	Private sector: Santo Antônio Energia Brazilian's consortium of sustainable energy (CESB) Social organizations: Diverse Social organizations from Bolivia, Brazil e Peru Public sector: Initiative for the Integration of the South-American Regional Infrastructure (IIRSA) Inter-American Bank of Development (BID) Andean Corporation of Foment (CAF) Growth Acceleration Program (PAC) of the Federal Government of Brazil National Development Bank of Brazil (BNDES) Brazilian Institute for Environment and Natural Renewable Resources (IBAMA)	Project: The Madeira River is the most important tributary source of the Amazon River, and the surface of its watershed constitutes 20% of the total area of the Amazon Basin. The Rio Madeira Hydroelectric Project consists in the construction of two dams: the Jirau Hydroelectric Power Plant, with an installed capacity of 3.3 GW, and the Santo Antônio Hydroelectric Power Plant, 3.1 GW. Both dams were built in the state of Rondônia. The project would involve an investment of $ 25 billion. In addition, the construction of a waterway is planned. The project was conceived under the Initiative for the Integration of South American Regional Infrastructure (IISARI), within the Peru-Brazil-Bolivia axis. Conflict: The environmental impact assessment agency, Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA, in the Portuguese abbreviation), acknowledged that there would be high impacts on Brazilian ecosystems and possible trans boundary environmental impacts in Bolivia. The project could lead to the removal of up to 7,000 people, including indigenous peoples in voluntary isolation, such as the Katawixi and the Karipuninhaos. Social organizations have denounced lack of transparency; underestimation of social and environmental impacts in environmental impact studies; forced removal of persons; impacts on biodiversity; poor citizen consultation; possible trans boundary impacts; expansion of tropical diseases and affectation of human rights in general. Social organizations have initiated legal actions against agencies of the Brazilian government (including IBAMA) and against the responsible companies. The possibility of promoting legal action in international forum was not ruled out. Source: personal elaboration based on AIDA.

b. Peru

CONFLICT	LOCATION	IDENTIFIED ACTORS	COMMENTARY
Hydroeletric Project of Inambari	District of Camanti, Province of Quispicanchi (Cuzco), District of Inambari, Province of Tambopata and District of Huepetuhe, Province of Manu (Madre de Dios); District of Ayapata e San Gabán, Province of Carabaya (Puno).	Private sector: Generación Eléctrica Amazonas Sur S.A.C_ Social organizations: Manegement Committee of the National Bahuja Sonene Park Inhabitants of Lechemayo, Loromayo and Puerto Manoa Roda Camponesa of Carabaya Roda Camponesa of San Gabán	Project: construction of a hydroelectric dam on the river Inambari, at the confluence point of the departments of Cusco, Madre de Dios and Puno. The plant will have an installed capacity of 2 GW and will be the largest hydroelectric dam in Peru and the fifth largest in South America. Conflict: The population and civil society of Cusco, Puno and Madre de Dios oppose the Inambari hydroelectric project because they say it would affect the environment and the ecosystem of the region. They also denounce that their lands and the interoceanic road would be flooded, forcing the local communities to move from the zone, creating in this way diverse negative externalities. It is important to point out that Peru borders Brazil, being the first country interested in building such an enterprise, since its execution would require a potential of 20,000 MW in hydropower projects, benefiting in particular the Brazilian states of Acre, Rondônia, Mato Grosso and Mato Grosso do Sul. In addition to the Inambari energy project, there is also interest in the construction of hydroelectric plants such as Tambo 1, Tambo 2 and Paquitzapango. Currently, in July 2016, the project is suspended, at the evaluation phase, but interests of Brazilian companies have appeared in the sense to continue its execution. Nevertheless, the current Peruvian government, chaired by President Pedro Pablo Kuczynski, indicated that it will not promote the construction of such an energy enterprise because it directly violates the Amazonian ecosystem and the socio-environmental rights of present and future generations. Source: personal elaboration based on the People's Defender of Peru, Peruvian Society of Environmental Law, Smithsonian Magazine.
Exploitation of Hydrocarbons in the Putumayo River Basin	Basins of the rivers Napo e Putumayo, District de Putumayo, Province of Maynas (Loreto Region)	Private sector: Petrobras_ Social organizations: Indigenous Federation Kichwa of Alto Putumayo Inti Runa (FIKAPIR) Indigenous Organization Secoya of Peru – OISPE	Conflict: Indigenous organizations oppose the exploration of oil fields in lot 117, alleging lack of prior consultation and affectation of the Güeppí Reserved Zone and other areas subject to conservation projects. Local organizations seek to have the State declare an environmental emergency in part of the affected zone and to take the necessary measures to deal with this situation. Source: People's Defenders of Peru.

c. Chile

CONFLICT	LOCATION	IDENTIFIED ACTORS	COMMENTARY
Thermoelectric Central Castilla	Punta Cachos, Bahía Salada, Comuna de Copiapó, Atacama Region	Private sector: MPX Energía de Chile Ltd. Social organizations: Agricultural Community Totoral. Environmental Commission of the Regional Association of Atacama Cities.	Project: Electric coal-fired thermal power station, with the purpose of supplying energy to mining enterprises in northern Chile. Conflict: Social organizations denounce risk of atmospheric contamination and incompatibility with other local development activities, such as algae production, agricultural activities and tourism. In September 2012, the court rejected the environmental authorization. Source: personal elaboration based on means of communication.
Project Central Hydroelectric Hidroaysén	Aysén Region	Private sector: Hidroaysén (ENDESA e Colbún S.A.) Social organizations: Defense Council of the Chilean Patagônia Movement Chilean Patagônia Without Dams	Project: Consists of the construction and operation of five hydroelectric plants in the Baker and Pascua rivers, which would contribute 2,750 MW to the Central Interconnected System (CIS), with an annual average generation capacity of 18,430 GWh. Conflict: The project has an approved Environmental Qualification Resolution. Social organizations denounce the affectation of ecosystems, negative impacts on the landscape, and the affectation of tourist activities and local development. In May 2012, after social mobilizations at national level, Colbún SA announced the temporary halt of the project for as long as there was no national energy policy "with a broad consensus and granting the guidelines for the energy matrix that the country needs". By the end of January 2014, the Committee of Ministers for Sustainability had resolved numerous claims against the project and decided to auction two additional studies to define the future of the claims against the project. A final decision on the environmental viability of the project by the authority is pending. In July 2016, the viability of the Aysén Hydroelectric Project was again placed on the agenda of the Chilean government, so that the social license for its execution could be obtained. Nonetheless, organized civil society in the southern regions of Chile maintains its position contrary to this energy enterprise, which leads to various manifestations and conflicts between the State and society. Source: Personal elaboration based on media information.
Hydroelectric Dam Angostura	Confluence of the Bio Bio and Huequecura rivers, Commune of Santa Bárbara, Province of Bíobío, VIII Region	Private sector: Colbún S.A. ENDESA Social organizations: Mapuche Communities - Pehuenche de Los Notros, Lo Nieve e Los Nogales	Project: Dam center close to the confluence of the Bío Bío and Huequecura rivers with an installed capacity of 300 MW. Estimated value of investments of 500 million dollars. The dam would have an area of over 600 ha. Conflict: Mapuche-Pehuenche communities denounce that the center and its dam will be built in lands of its domain. In addition, they denounce affectation of the water resources, negative impacts on the flora and fauna; lack of indigenous consultation under ILO Convention 169; negative impacts on indigenous cultural heritage and violation of a prior agreement in which the company committed not to develop more hydroelectric plants in the region. After lawsuits of distinguished nature, the project is still in progress. Source: INDH.

d. Colombia

CONFLICT	LOCATION	IDENTIFIED ACTORS	COMMENTARY
El Quimbo Hydroelectric Dam	Cities of Gigante, Garzón, El Agrado, Pital, Paicol E Tesalia, Department of Huila	Private sector: EMGESA Social organizations: Association of the Affected by the Hydroeletric Project El Quimbo –Asoquimbo Public sector: Ministry of Environment, Housing and Territorial Development Government of the Department of Huila	Project: Hydroelectric dam on the Magdalena River, which would flood 8,250 hectares, currently dedicated to agricultural and livestock production. Conflict: The project would have triggered a change in the dynamics of land use and resettlement of inhabitants. Social organizations denounce impacts on biodiversity; change in the productive profile of the region; increase in the cost of living; lack of compensation for those who held precarious land titles and failure to comply with the company's social and environmental responsibility commitments. Since 2009, protests, blockades and public hearings against the project have taken place. The Colombian People's Defender expressed concern about the situation of artisanal fishermen, workers and truckers who extract sand from the Magdalena River, family mothers and people who buy agricultural products from the region to be sold in the market. Until July 2016, the current Colombian government, chaired by President Juan Manuel Santos, requested the reactivation of the el Quimbo Hydroelectric Plant, requesting judicial authorities to reverse their jurisdictional decisions. Nonetheless, the Colombian Constitutional Court determined the impracticability of the enterprise because it affected the socio-environmental rights of the localities near the dam in question. Source: personal elaboration based on the Defensoria del Pueblo de Colombia.

e. Mexico

CONFLICT	LOCATION	IDENTIFIED ACTOS	COMMENTARY
Project of Hydroelectric Dam La Parota	Papagayo river, locality of Cacahuatepec, state of Guerrero	Social organizations: Council of Ejidos and Communities Opposing la Parota (CECOP) Regional Coordenator of Community Authorities Public sector: Federal Electricity Commission (CFE)	Project: In 2003, the Federal Electricity Commission (CFE) proposed the construction of a hydroelectric dam on the Papagayo River. The project, of 900 MW of installed capacity, would flood 17 thousand hectares and would require the resettlement of 5 thousand inhabitants of the zone. Conflict: Local communities, meeting in the Council of Ejidos and Opposition Communities in Parota (CECOP), denounced CFE's lack of consultation of the citizens; indirect affectation of 75 thousand people; human rights abuses and criminalization of protest. Social organizations have carried out blockades, demonstrations and legal actions against the project. In 2009, the CNE announced the postponement of the project until 2018. Until July 2016, the Mexican government, led by President Enrique Peña Nieto, and Guerrero state Governor Hector Astudillo Flores, continue to seek a political solution to the viability of the La Parota hydroelectric project. Nonetheless, civil society continues to be in the position of non-viability of this energy enterprise, on the environmental protection of jurisdictional decisions. Sources: International Rivers and La Jornada Magazine - UNAM.

In view of the analysis of the various cases of environmental conflicts caused by the construction of Hydroelectric Power Plants and the exploitation of hydrocarbons in Latin American countries, one can highlight not only the high economic costs of the shutdown of such projects, but also the socio-political costs of rejection by the civil society in relation to the feasibility of these projects that affect environmental institutions and generate environmental misgovernance. Local societies believe that such projects not only violate their rights to enjoy an ecologically balanced environment in the face of extractive activities of natural resources, but also restrict the dynamism of the right to development with freedom and equality of opportunities at the expense of the right to human development.

> In this context of conflict, several projects of different natures have been interrupted by court orders. There are also productive undertakings that have been canceled unilaterally, alleging economic unfeasibility and/or lack of sufficient legal security to proceed. In this sense, an adequate preventive management of the SEC is a priority, in order to mitigate potential negative impacts on investments and on economic and social development in the medium and long terms.[13]

"The countries of the region have signed a series of international environmental agreements and in more than twenty years a normative nucleus (with different levels of success) has been developed for the management of natural resources and the protection of the environment"[14]; these international agreements, of domestic enforcement, also generate responsibility for the application and enforcement of the law, not only environmental, but in general. Thus, the use of tools to mitigate environmental and social impacts does not appear to be sufficient to avoid scenarios of growing conflict in the region. In recent years, many international initiatives to ensure citizen participation in environmental impact assessment processes, such as the Equator Principles, the International Finance Corporation Guidelines and the Organization for Economic Co-operation and Development (OECD) Guidelines, just to name a few, in addition to the existing legal mechanisms that, in general, generate suspicion in the populations affected by the projects due to their lack of effectiveness.

However, in matters of the permanent socio-environmental conflicts (SEC) in the region, such measures, in most countries, do not translate into better or more efficient environmental management of natural resources, as well as mechanisms for the prevention of SEC through dialogue, reconciliation and the management of interests. Thus, the signing of international commitments and their translation into domestic regulations does not seem to have implied in itself an improvement in the standards of environmental sustainability and, consequently, in the reduction of the scenario of social conflict.

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13 SAADE, Miryam Hazin. **Desarrollo minero y conflictos socioambientales: Los casos de Colombia, México y el Perú.** Serie Macroeconomía y Desarrollo N° 137 CEPAL. Santiago do Chile, UN, 2013.

14 ACUÑA, Guillermo. **Marcos regulatorios e institucionales ambientales de América Latina y el Caribe en el contexto del proceso de reformas macroeconómicas 1980-1990**. ECLAC's Environment and Human Settlements Division. Santiago of Chile, UN, 1999.

In the context of some conflicts, public consultations and technical assessment of environmental impacts occur after the projects have already become a *fait accompli* and/or are in an advanced stage of execution. This characteristic makes it difficult to manage projects, since it facilitates the adoption of intransigent positions based on mutual mistrust on the part of the affected communities, even motivating legal actions against the developed activity. Once the confidence of the affected communities in the productive sectors and in the authorities involved has been lost, the chances of obtaining the so-called "social license" to operate tend to decrease and costs tend to increase. This is linked to the importance of advancing the anticipation of social and environmental impacts, and the precautionary principle is of fundamental importance. That is why it is recommended as a mechanism of conflict prevention the use of environmental management tools designed to give virtuality to the principle of environmental prevention.

On the other hand, "it should be noted that the existence of conflict does not necessarily suppose a negative prognosis about the institutional and economic development of the region. Conflicts should not be understood and treated as mere destructive or dysfunctional phenomena, but as catalysts for change, development and social cohesion. This approach not only makes it possible to overcome them but also makes it possible for them to contribute to promoting a more sustainable development."[15]

In sum, the region has unparalleled biodiversity, so its preservation must be guided by an adequate management of natural resources, as well as by a culture of peace with environmental sustainability. In view of the various SECs, there is a need for a progressive structural change to harmonize a new style of development with freedom and equality. This is the central point for proper decision-making on the resolution of SECs in the region.

Before deepening the discussions that led to the adoption of the recent international agreements on sustainable development (first, The Future We Want, Rio + 20 document, and then the Agenda 2030, adopted in September 2015), recommending the formation of public policies on a new style of development with sustainability, in conjunction with the mechanisms for

[15] ALTOMONTE, Hugo. SÁNCHEZ, Ricardo. **Hacia una nueva gobernanza de los recursos naturales en América Latina y el Caribe.** ECLAC's Books no. 139. Santiago of Chile.

prevention, management and resolution of the various energy SECs, especially on the United Nations Agenda 2030 and Horizons 2030, it is important to analyze in detail what are the intrinsic elements of the socio-environmental problems in the region.

2. Elements for consideration in the analysis of socio-environmental conflict cases

From the identification of several cases of socio-environmental conflict related to energy projects in Latin America, certain elements[16] deserve to be considered for an in-depth analysis of the causes, characteristics and consequences of this problem. This chapter provides a brief review of those institutional aspects which deserve a detailed analysis of the current environmental protection policies of the countries where the SECs have been identified, thus enabling the construction of environmental prevention, management strategies and strategies to achieve a higher degree of sustainable development in the region. Let's see.

2.1. Challenges in matters of design, implementation and regulatory compliance

Regulatory dispersion and difficulty in accessing legal information systems are relevant elements to be taken into account in a deeper analysis of socio-environmental conflict. Following the Rio Conference in 1992, which resulted in the Rio Declaration on Environment and Development, the United Nations Framework Convention on Climate Change and the Convention on Biological Diversity, among other instruments, many countries in Latin America and the Caribbean have gradually incorporated into their domestic law a prolific normative of environmental content.

From the cases shown, contradictions between environmental legislation and the regulatory provisions on natural resources (water, mining, hydrocarbons and energy) are evident. We can also mention the norms of

[16] For an analysis of these elements (from the letter "a" to "e"), cf.: ACUÑA, Guillermo y SCHATZ, Pablo: *"Conflictos socioambientales en América Latina y el Caribe: Identificación y elementos para su análisis"* – Work Document, ECLAC/UN, April 2014, **unpublished.**

investment promotion and other implicitly environmental public policies, such as energy policies, subsidies for agricultural activities, biofuel production, among others. This contradiction between general and sectorial legal frameworks has the potential to contribute to the legal validation of conflicting interests and expectations in the context of productive activities related to the extraction of natural resources. The existence of conflicts of interest not expressly stated behind the rules may hinder the process of implementation and enforcement of normative compliance.

This situation may be even more complicated in the case of Latin American nations that have adopted the structures of federal States for their government, such as Argentina, Brazil, Mexico and Venezuela. These countries have a more complex institutional and normative framework, which involves the coexistence of a national or federal government with subnational and/or local governments, all with a high degree of autonomy. The national or federal government is constituted by legislative, executive and judicial powers, and has its own constitutional and legal norms. These institutions are replicated in each of the subnational jurisdictions, which have their own division of powers and regulatory milestones. Thus, in the context of federal States, a clear division of powers between the national and local jurisdictions on the use of natural resources and protection of the environment is crucial in order to minimize the conflicting incentives of the legal system.

In the federal States, in addition to the risk of regulatory overlap, there is a possibility of conflict in matters of policing powers and faculties of control by authorities at different levels. Jointly, all of this poses risks to the harmonious development of activities related to natural resources, which can generate a predisposition to scenarios of socio-environmental conflict. This is not to argue that centralized states are exempt from normative contradictions and/or overlapping of powers of control and sanction, since, at the same level of government, we can identify conflicting normative and policy objectives that can also contribute to the number and intensity of the conflicts.

Another aspect that deserves to be explored in greater depth is the variation of environmental protection and public health standards according to the different jurisdictions. Both regulatory bargaining and environmental dumping refer to those situations where a jurisdiction reduces environmental protection requirements in order to become more attractive to investments.

Principle 11 of the 1992 Rio Declaration establishes that norms applied in one country will not necessarily be the most appropriate in other jurisdictions[17]. According to the same principle, developing countries may be disadvantaged both socially and economically in the face of the "import" of standards from other countries[18]. However, the adoption of looser regulation by a particular jurisdiction may be perceived by affected communities in a conflict as a direct injury to their right to equality. It is not surprising that communities opposing a particular project claim that it could not operate in other jurisdictions with more stringent regulations.

Another determining factor is the scarcity of resources of the authorities responsible for the environmental application. Public bodies for the design and implementation of environmental policies were, in the early 2000s, among the least represented in the budget allocation in the countries of the region, compared to the allocation of resources to other sectors of public policy[19]. This lower representation did not change much in the following decade, which was affected, in turn, by several economic and financial crises. An insufficient environmental institutionalism means that officials responsible for prevention and enforcement tasks have less incentive and greater limitations in the development of their work, which is aggravated by the traditional asymmetry of capabilities and resources between the public and private sectors. Working to level this asymmetry would allow for legitimate interlocutors, which would facilitate instances of dialogue and conflict resolution.

In inter-jurisdictional contexts, the complexity associated with the oversight role and, especially, with the control tasks, is even greater, because it allows the confusion of normative sources and a more diffuse outline of the responsibilities and impacts of the decisions of authorities. In this regard, inter-jurisdictionality raises the challenges of governance over natural resources and can act as a catalyst for conflict. This is aggravated by the degree of fluency in communication between the different areas of government, especially among those bodies responsible for issuing licenses and authorizations for the use of

17 UN. **Rio Declaration on Environment and Development**. United Nations Conference on Environment and Development, Principle 11.

18 UN. **Rio Declaration on Environment and Development**. United Nations Conference on Environment and Development, Principle 11.

19 ECLAC. **Financiamiento para el Desarrollo Sostenible en América Latina y el Caribe: De Monterrey a Johannesburgo.** (8LC/R.2098). Santiago of Chile, UN, 2002.

natural resources and among environmental authorities that must supervise compliance with the conditions under which the projects were authorized.

That is why the integrated management of resources, through basin committees, for water resources, or through progress towards international agreements on cross-border pollution and citizen participation in decision-making in neighboring countries would have the potential to mitigate the risks of conflict.

Another aspect to consider in addressing the problem under analysis is the communities' perception that the damage has already occurred. In the context of some conflicts, public consultations and technical evaluation of environmental impacts occur once the projects are already a *fait accompli* and have already begun to be executed. This characteristic makes it difficult to manage projects, since it facilitates the adoption of intransigence positions, based on mutual mistrust on the part of the affected communities, arriving, even, to bring legal action against the developed activity.

Once the confidence of the communities affected by the productive actors and the authorities involved is lost, the chances of obtaining a social license to operate tend to decrease and costs tend to increase. This is linked to the importance of advancing the anticipation of socio-environmental impacts, so that the precautionary principle is of fundamental importance. This principle is the "golden rule" in environmental matters, for it recognizes that repairing the damaged environment is often impractical or excessively burdensome, and the impacts should be evaluated and mitigated in a preventive manner and before the damage is done. Once generated, the environmental and social impacts are complex, costly and, at times, impossible to recondition and repair.

In particular, a generalized context of conflict leads us to think about the importance of preventive instruments of a wide scope, such as the Environmental Territorial Ordering or ETO, the Environmental Impact Study (EIS) and the conformation of protected areas, among other tools. These are essential tools to reduce potential conflicts that would occur as a result of productive activities.

The ETO entails a process of planning the use of land and natural resources based on guiding principles in the ecological, political, social and economic contexts of a given spatial scope. The absence of territorial planning implies uncertainty about the land usage, the productive profile and the prospects for development of local communities. This uncertainty regarding land use expectations contributes to conflict scenarios, since different productive activities and development perspectives compete with each other and overlap in the same area of influence. The extensive use of ETO as a public policy for territorial planning would allow us to define the most appropriate way to use resources in a more sustainable and less conflictive way.

The EIS, for its part, has been widely incorporated into the legal systems of the region and seems to have a high degree of legitimacy. Although in many jurisdictions the EIS is a prerequisite for project and activity authorization, the sample of cases indicates that many extractive ventures are performed without adequately fulfilling this prerequisite. Often, the social demands that occur in the framework of an EIS are channeled to the requirement of a process of evaluation of impacts of character prior to the beginning of the productive enterprise in question. It seems that the affected communities express greater acceptance of those projects which impact on the environment have been evaluated in advance, since the lack of a prior assessment is widely perceived by the communities as a direct violation of their rights, without prejudice to the magnitude and intensity of the impacts caused. Recovering the credibility of those ventures, which, from the beginning, have not acted in accordance with the law, is expensive and perhaps even impossible. The value of the opportunity to conduct environmental and social impact studies in a participatory manner could result in the mitigation of costs in the process of obtaining permits and licenses to operate, including social license. In addition, it should be mentioned that there are tools for assessing impacts that have great potential to mitigate the risk of conflict situations and whose regulations are not sufficiently developed, such as strategic environmental assessment and assessment of cumulative environmental impacts.

In sum, from the institutional point of view, it is worth noting that several conflicts among the cases shown reflect the existence of investment projects in natural resources and infrastructure (for example, hydroelectric dams) within or near immediate areas, which had previously been subject to some conservation regime. This type of contradiction undoubtedly contributes to the configuration of conflict scenarios and certainly requires a serious evaluation by the authorities.

2.2. The rights of access to information, participation and justice

Socio-environmental conflict seems to be closely linked to the so-called "access rights". In almost all the SECs mentioned here, there is a direct or indirect affectation of the right of citizen participation in the decision-making process, the right of access to environmental information, and the real possibilities of access to justice in the scope of projects and activities related to the use of natural resources.

Principle 10 of the Rio Declaration on Environment and Development states that "the best way to address environmental issues is with the participation of all concerned citizens at their level." This principle is the cornerstone of the access rights, for it provides the legal basis for demanding access to information held by public authorities concerning the environment and the activities which pose a danger to communities. It is also the basis for the existence of institutional mechanisms to ensure the participation of citizens in decision-making regarding such activities.

The institutional mechanisms that make it possible to materialize access rights tend to be seen by many public and private authorities as an intrusion into the decision-making spaces traditionally reserved for them. However, participatory bodies tend to facilitate long-term development of projects and mitigation of conflict scenarios. Opportunities for participation give projects greater legitimacy in the eyes of potentially affected communities.

Participation and dialogue with citizens are also valid way of sharing information in both directions in relation to the expectations of communities and productive actors, creating spaces for the development of positive synergies between the parties and, possibly, for the negotiation of fair compensations. Considering that almost all identified conflicts are linked to existing challenges in citizen participation and access to information, Principle 10 is extremely important as the foundation of public policies aimed at minimizing socio-environmental conflicts with neighboring communities.

Now, what institutional mechanisms will be effective in enabling participatory instances? We believe that this will depend on factors specific to each society, which will attribute legitimacy to such instruments according to their history, cultural characteristics and recent conflicts. The communities grant greater legitimacy to citizen participation mechanisms when they have also participated in some way in its design process. The physical and symbolic distance that exists between the communities and the decision-making centers regarding public policies and applicable norms help increase the distrust that the communities have in the institutions. In this sense, deepening the processes of institutional decentralization and the application of pre-existing community mechanisms could facilitate greater legitimacy in institutions, more effective dialogues and the consequent mitigation of conflict risk.

The right of access to information is a fundamental aspect to prevent scenarios of social and environmental conflicts. It is important to emphasize that the available information about these conflicts is dispersed, of a subjective nature and difficult to verify. Barriers to access to public environmental information by conflict operators could contribute to the increase in the intensity of the conflicts in question. That is why the availability and transparency of simple, clear and detailed information in EIS processes plays a key role in generating more objective and reliable information.

"Ensuring the right of access to public environmental information is related to improving the quality of decisions, since greater participation can contribute to the generation of relevant and useful information.[20]" Through public hearings and instances of involvement between companies and communities, the real interests behind a conflict may arise, which may be different from those previously considered by the parties. For example, behind a complaint about the environmental impacts of a project there may be a fear of possible loss of other productive activities or uncertainty about the distribution of economic income. More and better instances of enterprise-community engagement and interaction would provide more room for robust, transparent, and effective negotiations.

It is common for affected communities to denounce barriers on information access on the State of natural resources, investment projects and technical environmental studies. These limitations, present in many conflicts, alienate communities, affecting credibility and trust in State institutions. Greater transparency in public affairs also allows for greater confidence in citizenship within institutions, contributing to the debate, participation and the formation of social opinion.

[20] NÁPOLI, Andrés. et al, **Acceso a la Información Pública. Una experiencia federal.** Fundación Ambiente y Recursos Naturales. Buenos Aires: FARN, 2007.

In turn, access to organized and readily available legal information is an important factor for the empowerment of citizens. It is striking that some sub-national States and jurisdictions in the Latin American region do not yet have a free regulatory information access system available on the Internet. Normative dispersion and lack of compilation of environmental laws and codes make it even more difficult and burdensome to access knowledge about rights that could have been violated in the context of a conflict. Facilitating access to coherent and accurate normative information allows the leveling of ground among social actors involved in a socio-environmental conflict, thus providing a framework for greater transparency of environmental information.

Regarding the right of access to justice, the availability of adequate and sufficient judicial resources to ensure respect for the individual and collective rights of the individuals and/or societies affected is a public policy imperative in the region. The American Convention on Human Rights (Pact of San José de Costa Rica) expressly provides for the right to judicial guarantees[21]. "Judicialisation of conflicts", that is, the use of judicial channels by the affected communities in order to obtain a suspension order for the project and/or extractive enterprise, is a phenomenon that is expanding in the legal action of social actors.

In fact, the greater empowerment of local communities and the difficulty of reaching agreements imply appeals to third parties in order to resolve the dispute and/or conflict. However, the judicialisation carries the risk of further deepening the antagonism between the actors, making the different positions irreconcilable. That is why judicial decisions do not necessarily provide a solution for the conflict which is sustainable over time, and may also affect the perception of the legitimacy of judicial authorities. For example, where the court decision is contrary to the claim of the affected community, the judicial authority tends to be discredited. Similarly, when a judicial decision orders a project to be stopped, the business sector criticizes the interference of the judiciary in the attributions of other State powers, raising alarm bells about the impacts on long-term economic development.

At this point, there are also normative elements that deserve to be analyzed. Judicial objections to projects or activities may be based on merits

[21] Article 8 of the American Convention on Human Rights, ACHR.

(e.g. project unfeasibility for it adversely affects the environment or public health) or may be based on a breach of an established procedure (e.g. failure to comply with a formal step in the EIS process). The absence of differences between judicial objections that attack the merits of a decision and those that object to a procedural flaw significantly affect the effectiveness of the judicial tool for resolving conflicts of this kind. It is important to emphasize the existence of systems that contemplate a clear difference between the "review of the merits" of a decision and the "judicial review of procedures" in Anglo-Saxon law.

Therefore, the sample of cases presented in Chapter II of this article highlights the legitimacy of the Inter-American Commission on Human Rights (IACHR) for the resolution of the SECs. The large number of complaints presented before this international organization within the SEC scope could be reflecting a number of limitations of domestic and/or internal jurisdictional bodies to address these issues, which would motivate the need to request environmental judicial protection from a supranational body, such as the Inter-American Human Rights System.

2.3. The indigenous issue and the conflicts over investment projects

The rights of indigenous people have been explicitly recognized in several international instruments and national constitutions of many countries in the region[22]. Notably, the United Nations Declaration on the Rights of Indigenous Peoples[23], International Labor Organization (ILO) Convention n. 169 on Indigenous and Tribal Peoples in Independent Countries of 1989 expressly recognize the rights of these peoples to be consulted in situations that can affect them.

Because of their vulnerability, investment projects related to natural resources affect indigenous communities in a particular way, giving rise to several SECs in their territories. According to the United Nations Permanent Forum on Indigenous Issues, Indigenous People suffer the costs

[22] For example, see: Constitutions of the Plurinational State of Bolivia, the Republic of Ecuador, the Republic of Peru, the Republic of Colombia, the Federative Republic of Brazil, Argentina, Mexico, among others.

[23] Resolution 295 (2007) of the General Assembly of UN.

disproportionately of intensive projects of extractivism of natural resources[24]. These impacts on the human and social rights of indigenous people are related to their resettlement and loss of traditional territories and to the environmental degradation of their traditional environment, which affects their development as well as physical and cultural survival; community and social dismemberment; negative long-term impacts on the rights to health, food and nutrition and; numerous situations of harassment and social violence, according to the positions of the above mentioned International Forum. In addition, the situation of isolated or voluntarily isolated people is especially vulnerable.

In fact, an alarming proportion of the SEC identified in a sample of cases involving indigenous communities. That is why issues related to the rights of indigenous peoples are of great relevance for the analysis of socio-environmental conflict in the region, an approach that is crucial to address the issue in question.

Firstly, the lack of definition regarding the ownership of ancestral lands has impacts on the exercise of indigenous peoples' autonomy in the decision-making process on the development of productive activities and management of natural resources. "It is necessary to implement territorial reorganization strategies that respect the collective human rights of indigenous people[25]."

On the other hand, the context of marginalization and inequality that affects indigenous peoples deepens the rupture between the institutions of the State and these communities and reduces the incentives to perceive their norms and institutions as legitimate. Such situation of rupture of the social contract contributes to the lack of consensus and increases conflict, while at the same time implies on the waste of opportunities for inclusive sustainable development.

In general, the most frequent factor in the SEC highlighted is the lack of prior and informed consultation of indigenous peoples in the decision-making processes related to the exploitation and / or extraction of natural

[24] UN. **Permanent Forum on Indigenous Issues. State of the World's Indigenous Peoples**. Department of Economic and Social Affairs, Division for Social Policy and Development, Secretariat of the Permanent Forum on Indigenous Issues. New York: UN, 2009.

[25] STAVENHAGEN, Rodolfo. **Relatório do Relator Especial sobre a situação dos direitos humanos e das liberdades fundamentais dos indígenas.** Mission to Ecuador, presented at the United Nations General Assembly, A/HRC/4/32/Add.2, 2006.

resources in their territories. The right to consultation has a strong precedent in international law: ILO Convention n. 169 establishes the obligation of governments to develop, with the participation of the people concerned, coordinated and systematic actions to protect their rights. This instrument provides for the obligation to consult through appropriate and representative procedures and institutions, as well as the right of such people to participate in the use, management and conservation of natural resources on lands that they have traditionally owned, and which the possession and ownership must be recognized. Only in exceptional cases, and with the prior, free and informed consent, may the resettlement of indigenous people takes place. In this case, the affected communities shall receive "lands whose quality and legal status are at least equal to the lands they occupied previously, and which enable them to meet their needs as well as ensure their future development.[26]"

On the other hand, the United Nations Declaration on the Rights of Indigenous Peoples recognizes the obligation of States to establish effective mechanisms for the prevention and reimbursement of any act that has as a purpose or effect the deprivation of their lands, territories or resources[27]. In addition, and in accordance with Convention n. 169, it provides that prior, free and informed consent as a prerequisite for decision-making that may affect the collective rights of these people[28].

> Under the EIA procedure, indigenous communities need to have information accessible from the earliest stages of the consultations, long enough to understand the findings of the studies and provide comments. In addition, consultation mechanisms should not only include measures to mitigate and / or compensate for the adverse effects of a project, but should also propose an equitable distribution of the resulting benefits. On the one hand, it is important that representatives of indigenous peoples negotiate in good faith, trying to reach consensus on the proposed measures and avoiding inflexible positions when the proposed measures are based on legitimate public interests[29].

[26] International Labor Organization (ILO) Convention n. 169 on Indigenous and Tribal Peoples in Independent Countries of 1989, article 16.4.

[27] UN. **United Nations Declaration on the Rights of Indigenous Peoples**. A/RES/61/295, article 8.2(c).

[28] UN. **United Nations Declaration on the Rights of Indigenous Peoples**. A/RES/61/295, articles 10 and 19.

[29] ANAYA, James, **Report of the Special Rapporteur on the situation of human rights and fundamental freedoms of indigenous people,** presented at the United Nations General Assembly, A/64/338, 2009.

On the other hand, business representatives must understand the value attached to the spoken word, the importance of maintaining a transparent and frank dialogue, the continuity of their own interlocutors and respect for the institutionality of the communities concerned.

Some of the countries in the region that have already signed Convention n. 169 have adopted legislative measures to accommodate their legal systems to it; however, the number of SECs that affect indigenous people continues to grow over the years. It is possible to think that behind these conflicts there are challenges associated with the understanding between different world perspective, ways of relating to nature as well as schemes of social and institutional organization. However, some limitations in the legal framework could be favoring the high incidence of SEC involving indigenous people. For instance, the conception of indigenous people as collective subjects of law has not yet been consolidated and their expectations over their ancestral lands are not adequately recognized on a clear and predictable legal framework. In addition, there is space for improvement in the assessment of impacts on the cultural heritage of peoples; respect and protection of communities in voluntary isolation and; the use of consultation and consent channels as well as the design of public defense schemes for their rights.

Finally, it should be mentioned that the challenges in managing investment projects and their impacts on indigenous communities can affect even activities conceived within the framework of sustainable development strategies, such as public and private conservation projects, protected areas, payment environmental services, among others. This kind of endeavors usually involves a change in land use and the modification of property rights and land use, which is viewed with concern by indigenous people. Thus, taking into account this context, it is considered that a more decisive progress in the legal recognition of the collective rights of indigenous people will have an impact on the mitigation of SECs in the territories of these communities.

2.4. Mining, energy and extractivism endeavors

As repeatedly noted, Latin America presents a scenario of growing conflict, not only in relation to the environment of mining activity, but also in relation to energy projects for the construction of hydroelectric plants that generate various costs of environmental transactions.

Because of the historical exploitation in Latin America, mining activities generate significant negative environmental externalities for the affected communities. In recent years, mineral conflicts have been associated with the rejection of social organizations regarding the location of certain reserves, especially when it comes to implementing opencast mines, that uses toxic chemical inputs, mainly during their exploration and productivity processes.

Communities are particularly aware of the risks associated with such circumstances, so the rejection of communities is categorical; Many communities organize themselves with the goal of halting mining projects and eradicating mining altogether. In this way, mining conflicts are caused by their relation to the risks of pollution, the scarcity of water resources and the accumulation of permanent environmental liabilities. However, the elements of this class of SEC do not run out there; there are also numerous reports of human rights abuses, displacement of communities, frustrated expectations regarding the distribution of mineral income and, changes in traditional productive activities, among others socioeconomic impacts.

In this sense, in the scope of the conflict over these endeavors, the SEC also stands out for the implementation and / or execution of energy projects, specifically for the impacts that the construction of hydroelectric plants requires. In general, regarding the concern of the local communities living in settlements close to energy projects, the impact on water availability stands out as well as impacts on the use of roads, chemical contamination and dust raised by transport and, solid residues deposited in water tributaries, among other socio-environmental concerns.

2.5. International treaties, foreign investment and conflict

In the preparation of the sample of cases, it was possible to observe that many social organizations that oppose to the investment projects in natural resources and infrastructure associate the socio-environmental impacts of these ventures with Foreign Direct Investment (FDI), Free Trade Agreements (FTAs) and the participation of multilateral financing institutions (the so-called "multilateral banks"), such as the Inter-American Development Bank (IDB), the World Bank and the Andean Development Corporation (CAF), now called the Latin American Development Bank. These SEC actors consider FTAs and other instruments facilitating foreign investment as the very materialization of the process of trade liberalization that is associated with successive crises and economic adjustment processes. They also argue that FTAs have direct and indirect repercussions on the issue of SEC, and may influence the dictation and application of national and international standards and norms.

Although it is not impossible to think that the need to attract capital could favor a greater flexibility of the environmental and / or social rules by the States, in order to avoid the imposition of obstacles to investments, there are enough elements to change the negative perception of the communities. In other words, the organized opposition against the negotiation of FTAs is not absent in the context of socio-environmental conflicts in the region. In this sense, the importance of deepening research and analysis to determine the extent to which Free Trade and Foreign Investment Agreements - often signed between developed and developing countries - could contribute to the scenario of socio-environmental conflicts. For example, we might ask whether the State could show a greater reluctance to modify an emission standard in the face of the fear of causing a withdrawal of investment or, conversely, raising environmental standards to facilitate investment, among other things.

Grassroots organizations associate multilateral organizations with the process of economic liberalization of the 1990s and with adjustment policies following successive economic crises. There are even voices that question the logic of having multilateral agencies that finance fossil fuel extraction activities, mining facilities, logging, and large hydroelectric dams, when they, on the other hand, argue that they play an active role in the adoption of mitigation strategies and adaptation to climate change and other environmental issues[30]. However, the standards for projects in which multilateral funding agencies intervene tend to be stricter than State standards, since these agencies require the participation of the civil society in their projects and their procedures tend to be more and more transparent and informed. However, social organizations and affected communities do not seem to perceive these standards in their execution, in light of the results of ESCs.

[30] Permanent Forum on Indigenous Issues, op.cit., p. 118.

2.6. For a progressive structural change

The increase of ESCs in mining, energy and oil projects is gaining more attention from Latin American countries, which have sought to form mechanisms for prevention, conduction and environmental management based on dialogue, conflict resolution and efficiency in governance of natural resources based on a progressive structural change on development with sustainability. The elements for the analysis of the cases of socio-environmental conflicts, specifically the challenges related to design, implementation and compliance of national and international rules as well as the rights to access to information, participation and environmental justice, must be adequately addressed at the preponderance of a culture of peace.

> In environmental issues, we are facing a change of era, with the development of a new consensus on the quality of economic growth, which is reflected in the SDGs. Intertemporal exchanges are less acceptable as an expression of the dynamics of growth and pollution; there is more room for the search for complementarities between growth, equality and energy efficiency, and green growth is emphasized, without leaving to a hypothetical future - where wealth would be greater and technology more efficient - the compensation for environmental damage[31].

As for the relationship between energy related SECs and progressive structural change, the public agenda should be focused on the harmonization of energy efficiency, on new sources of renewable energy with lower socioeconomic impacts and on the effectiveness of socio-environmental rights of present and future generations. It is on these three central points that this structural change could initiate a new style of development with sustainability.

Thus,

> progressive structural change implies that the economy is moving along a path of low carbon growth, in which production and emissions are gradually unbundled. This requires the development of technological capabilities and innovations with a focus on sustainability. Mitigation and adaptation to climate change is not spontaneous; they require an integrated package of investments, the great environmental impulse (...) For example, a simultaneous shift toward cleaner energy sources, the expansion of efficient urban transport systems, the control of pollution along the productive

[31] ECLAC. **Horizontes 2030: La igualdad en el centro del desarrollo sostenible.** Santiago of Chile, UN, 2016.

> chains, the articulation between the new sources of energy and production, the articulation of the demand of labor with the supply of capacities, skills, training and education, imply policies directed to coordinate efforts in several different areas. It is necessary to combine the efforts in order to redefine innovation pathways and the energy matrix with educational processes that promote the use of public goods and modify the style of development.[32]
>
> In relation to progressive structural change, the exploitation of natural resources poses challenges in two different spheres: one is the productive matrix around such exploitation and the efforts to introduce higher density capacities, technological innovation, productive links and synergies with other sectors. It should also be possible for investments in infrastructure for the exploration and transportation of natural resources to generate the broadest benefits possible for other productive sectors and for society as a whole. The other area corresponds to state appropriation and adequate use of fiscal revenues derived from income from natural resources to promote human capacities (through investment in education and training) and other productive sectors with high added value (through industrial policies). These two spheres of progressive structural change may have a positive impact on equality, as educational achievements and productive capacity expand, favoring social inclusion through the employment of higher productivity, promoting wider access to services and diverse connections by developing better infrastructures and adding to the tax coffers to achieve better and broader coverage of social protection systems. The characteristics assumed by the governance of natural resources will depend, in great measure and in different ways, on the fate of the productive diversification agenda[33].

Therefore, in view of the studies on energy related SECs in Latin America and the recommendations for a progressive structural change for development, we will focus on the possibility of this structural change on the current environmental energy policy of fossil fuels and / or traditional use, dynamism and promotion of alternative, renewable, clean and / or green energy resources, i.e., non-traditional energy sources as a measure to mitigate the ravages of the relationship between environment, energy and conflict, in accordance with international agreements on sustainability of development, such as the UN Agenda 2030 and ECLAC's proposal for Latin America and the Caribbean, the Horizons 2030.

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[32] ECLAC. **Horizontes 2030: La igualdad en el centro del desarrollo sostenible.** Santiago of Chile, UN, 2016.

[33] BÁRCENA, Alicia. PRADO, Antonio. **El imperativo de la igualdad. Por un desarrollo sostenible en América Latina y el Caribe.** Buenos Aires: Siglo Veintiuno Editores Argentina, 2016.

3. The 2030/UN Agenda and the Horizons 2030/ECLAC for the great environmental impulse for renewable energy sources in the region

Today, in view of the various energy related SECs, Latin American countries are giving more attention on environmental protection policies in their public agendas, as well as on the diversification of the energy matrix with the promotion of electricity generation projects based on alternative and / or renewable sources that can meet the full energy demand for cities, farms, industries, transportation, services, among others. Faced with these facts, there is a need for States to structure a new style of sustainable development agreed upon among all social actors seeking a greater environmental protection impulse, guaranteeing individuals greater equality and freedom for their development, as well as diversification of the energy matrix by renewable sources.

> The application and enforcement of the law in general, and in particular the environmental laws, has become a central issue in the Latin American and Caribbean region, since public policy objectives are, for the most part, expressed and reflected in rules. In our region, the historical development cycles of environmental regulation, which began in the mid-twentieth century, but with greater specificity during the 1970s, reflecting the 1972 Stockholm effect, have had a significant impact on the construction of the environmental regulatory framework[34].
>
> At the same time, a consensus is emerging in the international system regarding a different path, with an emphasis on combating inequality and protecting the environment. The 2030 Agenda for Sustainable Development and the Sustainable Development Goals, adopted in September 2015 by the United Nations, reflect this consensus, and constitute a political and conceptual advance with regard to the agenda previously set in the Millennium Development Goals. They represent progress politically, because they are the outcome of a broad-ranging debate conducted in a context of democratic multilateralism actively involving governments and social stakeholders, and they vindicate the principle of common but differentiated responsibilities between countries, in environmental as well as social and economic matters. Conceptually, the progress lies in the wider range of themes covered in the new Agenda. Equality and environmental sustainability are the main pillars of

[34] ACUÑA, Guillermo. **La aplicación y cumplimiento de la legislación ambiental en la región de América Latina y el Caribe.** Relatório Ambiental Anual 2009. Buenos Aires: Fundación Ambiente y Recursos Naturales, 2009.

> the Sustainable Development Goals, but they also embrace other initiatives, such as the right to productive and good-quality employment, citizen participation and transparency[35].

Thus, in view of the relationship between the UN Agenda 2030 for Sustainable Development and the SDGs, the mechanisms for prevention, management and mitigation of the SECs, the efficiency of natural resources governance, the diversification of the energy matrix based on new sources of renewable energy, according to the equation between State, market and society, all actors have the common responsibility to define a new style of development with equality and freedom, which guarantees the socio-environmental rights of both present and future generations.

Specifically on the promotion of renewable, clean and / or green energy generation, it is necessary for States and social actors to seek alternatives to compensate for the socio-environmental impacts of hydroelectric power projects and to reduce the consumption of traditional fossil fuels, which only reinforce the old development model without any progressive structural change. Faced with this scenario, natural resources such as sunlight, wind, water, waves and also urban solid waste and some agro-industrial waste, among others, are also sources of opportunities that could offset the impacts of environmental pollution through the sustainable use of renewable energy resources.

Accordingly, among the technological alternatives for the generation of electricity through non-conventional renewable sources, we have wind energy (windmill platforms), solar light (photovoltaic thermal panels), biomass, tidal energy, geothermal, among others. Therefore, although each energy source responds differently according to the generation, state and production in which the energy matrix will take place, it is considered that the promotion of renewable, clean, green and / or alternative energy sources will ensure the mitigation of socio-environmental impacts. Thus, the energy matrix based on solar light, wind, biomass, tide, biodiesel, make up the ideal pattern of clean energy sources that will contribute to greater protection of the environment, as well as promote a greater social welfare with sustainability, reflected in greater security, job creation, production of consumer goods, among others.

[35] ECLAC. **Horizontes 2030: La igualdad en el centro del desarrollo sostenible.** Santiago of Chile, UN, 2016.

Hence, ensuring access to sustainable renewable energy for the society will be one of the main tasks to be carried out by the states, based on a long-term public agenda.

In this context of diversification of the energy matrix, United Nations General Assembly's Resolution 70/1, entitled "Transforming our world: The 2030 Agenda for Sustainable Development", reinforces the idea of goals to be achieved by States in order to adapt themselves to a progressive structural change with sustainable development models.

Dealing with social and renewable energy issues, we have the Goal no. 7 of the United Nations Agenda 2030 for Sustainable Development, which states the following:

> 7.1. By 2030, ensure universal access to affordable, reliable and modern energy services; 7.2. By 2030, increase substantially the share of renewable energy in the global energy mix; 7.3. By 2030, double the global rate of improvement in energy efficiency; 7.a. By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology; 7.b. By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small developing Island States, and land-locked developing countries, in accordance with their respective programmes of support[36].

However, in the context of dissemination of sustainable renewable energy and governance of natural energy resources, SDG 7 of Agenda 2030, which is linked to SDG 12 of the Agenda in question, reinforces the position that "sustainable consumption and production consist in the promotion of the efficient use of resources and energy efficiency, sustainable infrastructures and to facilitate access to basic services, green and decent jobs, and a better quality of life for all. Its application helps to achieve overall development plans, reduce future economic, environmental and social costs, increase economic competitiveness and reduce poverty[37]."

[36] ECLAC. **Agenda 2030 y los Objetivos de Desarrollo Sostenible. Una oportunidad para América Latina y el Caribe.** Each objective corresponds to the General Assembly Resolution 70/1 entitled "Transforming our world: the 2030 Agenda for Sustainable Development". Santiago of Chile, UN, 2016.

[37] ECLAC. **Agenda 2030 y los Objetivos de Desarrollo Sostenible. Una oportunidad para América Latina y el Caribe.** Each objective corresponds to the General Assembly Resolution 70/1 entitled "Transforming our world: the 2030 Agenda for Sustainable Development". Santiago of Chile, UN, 2016.

In correlation with the SDGs 7 and 12 and the mechanisms for the prevention, management and resolution of SECs, it is also important to highlight the SDG 16, which aims to "promote of peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels", recommending to all States to "(16.7) ensure responsive, inclusive, participatory and representative decision-making at all levels", as described in detail in the elements for consideration of the socio-environmental conflict analysis of chapter 2 of this study.

> For the implementation of the UN Agenda 2030, it is necessary to build new, more solidary and equitable alliances internationally and within each country. This process is more complex and demanding in institutional and policy-making terms than the Millennium Development Goals due to the characteristics of interdependence of the new objectives and the universality and indivisibility of the new agenda[38].

Accordingly,

> Putting the 2030 Agenda for Sustainable Development into effect will require action on three fronts: international governance for the production of global public goods; regional cooperation and input to the global discussions; and national policies, in particular macroeconomic, social, industrial and environmental policies[39].

However,

> This involves coordination between the various areas of public intervention, as well as the participation of all actors, including business and civil society. At the same time, it involves dealing with the political economy of interests that historically have made this kind of change difficult. In order to achieve the objectives of the 2030 Agenda for Sustainable Development, a socioeconomic and political reality marked by tensions and contradictions must be overcome[40].

Along with the SDGs of Agenda 2030, it is also regionally important to highlight the institutional document of the Economic Commission for Latin America (ECLAC) - *Horizons 2030: Equality at the Center of Sustainable Development*

[38] ECLAC. **Horizontes 2030: La igualdad en el centro del desarrollo sostenible.** Santiago of Chile, UN, 2016.
[39] ECLAC. **Horizontes 2030: La igualdad en el centro del desarrollo sostenible.** Santiago of Chile, UN, 2016.
[40] ECLAC. **Horizontes 2030: La igualdad en el centro del desarrollo sostenible.** Santiago of Chile, UN, 2016.

- a document that we have been quoting and making reference to and that highlights the transcendence of the harmonious reconciliation of economic development and sustainability based on a progressive structural change stimulated by a great environmental impulse that promotes development with equality.

However,

> in order to achieve the goals of an agenda with the year 2030 as deadline, with focus on equality, it is necessary to change the style of development and implementation of economic, industrial, social and environmental policies, which must be aligned with progressive structural change. In this new paradigm, institutions and public policies are articulated around a major environmental impulse aiming to transform the productive structure, which complements the incorporation of technical progress, sustainability and equality[41].

This is the basis for an increase in quality and productivity, which would expand and make more and better sustainable social policies.

In line with the document Horizons 2030, ECLAC points out that

> building capacities and developing institutions and policies around a great environmental impulse offers a learning horizon with great potential for economic transformation[42]. These opportunities also applies to the social sector, demanding the full incorporation of the society into capacity building, which implies the universal extension of the right to access public goods and services, such as education and health, and social protection in contexts in which technical progress constantly redefines employment opportunities. [43]

In addition,

> a key to progressive structural change is to accelerate capital accumulation, because today's investment explains the productive structure of tomorrow and is the main instrument of productive transformation, expansion of technological capabilities, and redefinition of development style. [44]

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41 Available at: http://www.cinu.mx/noticias/la/se-busca-concientizar-a-la-pob/.

42 Thus, the great environmental impulse is a concentrated effort of coordinated investments to redefine production and consumption patterns based on learning and innovation.

43 ECLAC. **Horizontes 2030: La igualdad en el centro del desarrollo sostenible.** Santiago of Chile, UN, 2016.

44 ECLAC. **Horizontes 2030: La igualdad en el centro del desarrollo sostenible.** Santiago of Chile, UN, 2016.

The energy sector will play a key role in redefining the style of development. The region has advantages in the generation of renewable energy, in particular hydroelectric, solar and land-based wind energy. While the prices of some of these energy sources are already lower than those of conventional sources, there is still the challenge of reducing their intermittency so as to make them reliable as base energy supplies. More decisive support for the incorporation of renewable energy, by cutting fossil fuel subsidies, taxing carbon emissions and adjusting regulations for purchase, generation and transmission, would facilitate a faster switch-over to cleaner energy sources. Renewable energy also has the potential to generate backward linkages, as has happened with solar and geothermal energy. [45]

New opportunities for production diversification are emerging from the application of information technologies to production and the increased density of the industrial fabric, as current technologies and the energy mix are redefined. Examples include the management of smart cities, the expansion of mass transit, the processing of biodiversity, the development of biomaterials and the bio economy, eco-labeling, and renewable energy sources, as well as the production of renewable energy, with consequent development of their value chains[46].

In sum,

The importance of developing proper governance of natural resources and the key role it has played in building an agenda for equality and development has been emphasized. This stands out in the region in view of the proportion of countries that specialize themselves in these resources. Appropriate governance can become a policy tool for the structural change itself. [47]

In order to materialize these proposals, and without ignoring the strength of majorities or consensus, it is necessary to establish social pacts, of a medium and long-term strategic horizon, involving a wide range of actors and requiring very legitimized State policies. The specific content of the social pacts should be tailored to the characteristics of each country, such as institutional development, productive matrix, monitoring, political culture and model, social conditions and available capacities, among others. Term commitments and mutual commitments made through a pact can contribute to political and social actors having convergent expectations and greater ownership of the proposals, which helps stablish stronger and more legitimate policies and institutions. Pacts can articulate an intertemporal relationship with a broad participatory process, which may be essential in dilemmas with a high level of uncertainty.[48]

45 ECLAC. **Horizontes 2030: La igualdad en el centro del desarrollo sostenible.** Santiago of Chile, UN, 2016.

46 ECLAC. **Horizontes 2030: La igualdad en el centro del desarrollo sostenible.** Santiago of Chile, UN, 2016.

47 BÁRCENA, Alicia. PRADO, Antonio. **El imperativo de la igualdad. Por un desarrollo sostenible en América Latina y el Caribe.** Buenos Aires: Siglo Veintiuno Editores Argentina, 2016.

48 BÁRCENA, Alicia. PRADO, Antonio. **El imperativo de la igualdad. Por un desarrollo sostenible en América Latina y el Caribe.** Buenos Aires: Siglo Veintiuno Editores Argentina, 2016.

Therefore, so that Latin American countries can achieve greater environmental impulse, mitigating the SECs and, consequently, strengthening their environmental institutions, there is the need for a balanced, cooperative and integrated action of the State, society and the market in the progressive implementation of Sustainable Development Goals of UN Agenda 2030, as well as the commitment to respect the guidelines for strengthening the institutionalization of the document Horizons 2030. These guidelines were drafted taking into account the nuances of the development with equality and freedom, which guarantee the socio-environmental rights of present and future generations.

Conclusion

It is argued that inequality is the main asymmetry in order to achieve a new style of sustainable development, since it is necessary to diversify the implicit environmental public policies for a progressive environmental structural change by a new arrangement between State, market and society. Otherwise, there will be conflicts between the various social actors.

Socio-environmental conflict is an expression of inequality. At the same time, it constitutes a threat and an obstacle to development. It is necessary to find a balance that allows both the development of the economy and the inclusion of impoverished and once marginalized peoples and societies in the economic system, minimizing the negative impacts on the environment and societies. Undoubtedly, this is one of the most important challenges that our region faces today, and it comes down to the pursuit of sustainability in a framework of equal opportunities.

A scenario of conflict as found today in Latin America requires a preventive management response by the States of the region. Normative and institutional aspects have much to offer to address this particular problem, whose solution is connected to the expansion of participation spaces and access to information. In the process of elaborating case samples, we identified some elements that seem to be closely linked to the configuration of conflicts related to natural resources. The quantitative and qualitative measurement of the presence of these elements could influence the level of magnitude and intensity of the conflicts. Consequently, analysis of the factors mentioned in this document is recommended, since their prior identification would be helpful to anticipate, manage and prevent SEC.

In this perspective, the development of prevention mechanisms and environmental management instruments would contribute in a fundamental way to prevent socio-environmental energy conflicts in the region. In addition, a stronger, more transparent and efficiency-based institutional framework is an inexcusable requirement if the goal is to reduce conflict. Weak governance indicators translate into higher levels of environmental degradation, poverty and conflict, and, consequently, greater inequality. Thus, there are planning strategies that can reduce exposure to conflicts in the medium and short term.

Specifically, socio-environmental conflicts related to energy arise from the State's continued commitment to obtaining and generating energy from fossil fuels, and even from financing hydroelectric projects that also have a major impact on the degradation of the environment in the region. Thus, States have to seek new alternatives to renewable energy sources based on clean, green and sustainable sources of innovation and technology, because the promotion of such energy has a transcendental role in times of modernity, development, equality and freedom with sustainability.

In summary, the energy SECs give rise to political, social, economic and environmental challenges at different scales. These challenges demonstrate the importance of moving towards harmonious growth in a context of equal opportunities, which lies at the heart of sustainable development. Thus, the State's priority through their Ministries of Environment and Energy and even the Public Defenders Offices is should be to structure mechanisms for prevention, management and resolution of socio-environmental conflicts between the government and social actors that are undermined by the public-private dynamism of environmental unsustainability. Hence, it is suggested that all States should consider the creation of an Office for Prevention and Dialogue Resolution of SECs.

Definitely, from a perspective of the international environmental protection instruments - among other instruments - all States should articulate the short, medium and long term dimensions of the dynamics, application and implementation of the SDGs of the 2030 Agenda, in conjunction with sound environmental fiscal policies creating incentive models for harmonization between State, society and the market. In this line of promotion of SDGs, the participation of the organized civil society is fundamental to achieve a better governance of natural resources and, even more, of energy resources that generate not only a greater dynamism for the economic development of the countries, but which also strengthen the applicability of fundamental human rights for the sake of social welfare and human development based on the use of renewable energy sources.

An additional space for dialogue and consensus building was open with the recent creation of the Forum of Latin American and Caribbean Countries on Sustainable Development[49], which will enable the monitoring and enforcement of the integrated implementation of all of the 2030 Agenda. In this context, especially taking into account the interrelationship between the SDGs on environment, energy and law enforcement institutions, the results of the implementation of SDG 7 could be jointly reviewed in their dynamic relationship with the SDSs 12 and 16, connecting the performance of programming and execution of the generation of non-conventional renewable energy sources, reflected in the data on poverty, access to energy and reductions of CO2 emissions. Finally, to know the current status of the environmental performance of renewable energy sources it's extremely important to implement a new public agenda based on a new style of development with sustainability, promoted by the SDGs of the United Nations 2030 Agenda and the document Horizons 2030 of the ECLAC.

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[49] Resolution no. 700/XXVI of the ECLAC's Session, May 2016, Mexico City.

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IMPACT OF ENERGY MATRIX IN SUSTAINABLE DEVELOPMENTIN LATIN AMERICA AND THE CARIBBEAN

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Abstract: This document details the Latin America and Caribbean energy sector's information with a focus on what this region is doing and must do strive towards the achievement of sustainable development. An analysis of the energy economic context of the region has been performed, which includes data on population, access to electricity, the effect of fuel prices in the energy matrix and the economy, supply and consumption of energy and electricity generation data. Subsequently, we will reach the development of renewable energy in the region, which specifies data on geothermal energy, hydropower, biomass, wind energy and solar energy. An analysis of the region and the objectives of the 2030 Agenda for Sustainable Development approved in 2015 has also been made. These objectives are related to the United Nations' pillars of Sustainable Energy for All initiative. In addition, an analysis of the Paris Agreement and the Declaration of Tarija of the Meeting of Ministers of the Latin American Energy Organization (OLADE) has been included. It is determined that these agreements present an opportunity for Latin America and the Caribbean, because they include priority issues for the region in social, economic, environmental and energy areas. Finally, it includes actions and support provided by OLADE to the Member Countries to fulfill the objectives for 2030, such as coordination and advice, with the ultimate goal of achieving integration, protection, conservation, rational use, marketing and protection of energy resources in the region.

Keywords: Sustainable Development – Renewable Energy Sources – Sustainable Development Goals – Sustainable Energy Model.

Introduction

Energy in all its forms is fundamental to any human activity. The modern world can't function without power when it comes to most daily activities, such as transportation, communication, health, the food industry, recreation, as well as at the industrial and commercial level. For this reason energy is strictly related to economic growth of countries.

[1] Director of Studies and Projects of Latin American Energy Organization.

[2] Electricity Coordinator of Latin American Energy Organization.

However, following the economic growth in countries, the demand for energy becomes higher.

Today, the use and exploitation of energy resources on the planet have become one of the main priorities and challenges of the countries. Oil prices, the dependence on fossil fuels, energy security and environmental impacts are attracting increasing attention and concern by governments and society.

According to the Bulletin Annual Statistics and Organization of Petroleum Exporting Countries - OPEC - 2016 "The total world crude oil reserves are estimated at 1,493 million barrels in 2015, with a slight increase of 0.1 percent over the previous year. The largest increases came from Angola, Venezuela and Iran, while in Norway, the United Kingdom and Colombia demotions were observed. OPEC increased its proven oil 0.1 percent to 1.211 billion barrels in 2015, keeping its share of 81.2 percent of total world reserves of crude oil[3]". The same report also indicates that in 2015, "Natural gas reserves decreased by 0.3 percent, which means about 202.0 trillion cubic meters. This reduction was partly due to increased gas production, natural and reduced spending on exploration and development, primarily as a result of low gas prices the total production of natural gas sold in the world increased 1.9 percent in 2015 to reach 3.6 billion cubic meters, increases occurred mainly in North America and the Middle East[4]". *T*oday hydrocarbons contribute more than half of the primary energy consumed worldwide, with 31% of global primary energy consumption comes from oil, so the most used source.

On the other hand, regarding emissions from energy production, according to the Intergovernmental Panel on Climate Change, "CO2 emissions worldwide from the combustion of fossil fuels and industrial activity contributed to about 78% of total emissions of greenhouse gases (GHG) for the period 1970-2010. However the foregoing, the LAC energy matrix has a high percentage of renewable energy sources for electricity generation (25% share of renewable energy), compared to 9% in the rest of the world[5]".

It is important to note that oil is still the main source of energy worldwide today, covering about one third of the necessary, and the transport sector is

[3] Free translation.
[4] Free translation.
[5] OLADE-SIEE (data of 2014).

the main consumer of this energy resource, so that the demand has increased substantially. In turn, the world production of electric energy in the world is still based on fossil fuel sources.

Also, they have increased participation and the use of natural gas and coal due to the discovery of reserves with an abundance of resources. Natural gas has become a major source of energy in developed countries, its use is oriented for heating and electricity generation. Meanwhile, coal represents 27% of total primary energy consumption has increased considerably due to their use in emerging countries such as Asian countries, led by China.

The increase in energy consumption in developing countries is and will continue to be much higher than the increase in energy consumption in developed countries. According to World Bank data, the regions with the largest oil consumption are Asia and North America, led by China. The largest gas consumers are the United States and Russia followed by Iran, China, Japan, Canada, Saudi Arabia and the United Kingdom.

According to the International Energy Agency (IEA), in its prospects for energy to 2040, oil consumption will fall only by 5% compared with 2013. Meanwhile, natural gas will rise in demand to 24% of the estimated total energy equivalent to about 18,000 million tons of oil, which means an increase of 3% since 2013. Although the share of renewable energy (hydro, biomass and other renewable energy) will increase 15% in the years mentioned, the indicators show that in the coming years do not expect major changes in the global energy matrix, as oil and fossil fuels will remain the main source of energy in the short, medium and long term.

According to the IEA, to be able to meet demand in 2040, the overall investment in the energy sector would be of about US $ 68 trillion, 37% of which would be in supply investments oil and gas, 29 % in electricity and 32% for improved efficiency in end-use energy. More than 60% will be allocated for investments in renewable energy, led by China, The European Union, The United States and India.

Countries move to a transitional energy sector based on renewable energy, energy efficiency and sustainable development. They have generated global rules that promote sustainable energy, as is the case of the United Nations General Assembly Resolution 65/151 stating “the need to improve access to energy resources and services for sustainable development that are reliable cost, economically reasonable viable, socially acceptable and environmentally sound[6]".

Also at COP 21, held in Paris in December 2015, the agreements are intended to lower the temperature, which requires to drastically limit emissions of greenhouse gases through energy efficiency measures, investments in energy sources and renewable reforestation, among other things.

Another advance that is important to note is the adoption of Agenda 2030 "Sustainable Development Goals of the United Nations Organization General Assembly, a plan of action for people, the planet and prosperity, including the issue of energy among 17 goals as one of the engines that drives other agreed goals."

In addition, countries are adopting state policies supporting this transition. A clear example of these policies are: clean energy plan promoted by the US and the carbon trading scheme announced by China and enter into force in 2017.

In addition, many countries are promoting legislation and regulations for the promotion of renewable energy and energy efficiency. All these actions have achieved that in 2014 renewable energy sources were secured as the second largest source of electricity worldwide.

1. Economic and energy context of Latin America and the Caribbean – LAC

The Inter-American Development Bank - IDB indicates that Latin America and the Caribbean only represent 8.5% of the of the world population, however, this means that by 2014 the region had 600 million people. 68% of this population (402 million people) were located in South America, 27% (162 million) in Central America and Mexico and 5% of them (26 million) were located in the Caribbean. Despite the fact that 96% of the population of the region have had access to electricity in 2014, the remaining 4%, that is, 26 million Latin Americans, do not have access to energy; in South America that means 12 million people, in Central America and Mexico, 6,000,000, and in the Caribbean, 8,000,000. In this sense, the region should look for solutions that allow these people access to clean and quality energy.

6 Available at: <http://www.un.org/spanish/documents/instruments/docs_sp.asp>.

In recent years, the price of energy products (oil, natural gas and coal) declined, with the price drop of crude oil mostly affecting this variable. This had an impact on the region's economic and energy performance. The GDP per capita in the region stagnated in recent years, which has caused a slowdown in economic activity, affecting consumption and investment in the productive sectors of countries.

According to the BID[7], to reach 2030's electricity demand the region needs to double its installed capacity to 600 GW for which required an investment of about 430 billion dollars. The renewable energy potential in Latin America and the Caribbean is sufficient to cover the electrical needs projected for 2050 22 times.

According to the Global Carbon Atlas[8] data, the energy matrix of the region has a high percentage of renewable sources, and the power generation matrix is one of the cleanest in the world: Every inhabitant emits 2.1 kg of CO2 per year, compared to the world average of about 4.9 kg of CO2 per year, according to 2011 data. In the area, also, on average, for each product unit is delivered 0.3 kg of CO2, and the global average is of 0.4 kg CO2 according to the 2014 data.

2. The energy sector in Latin America and the Caribbean

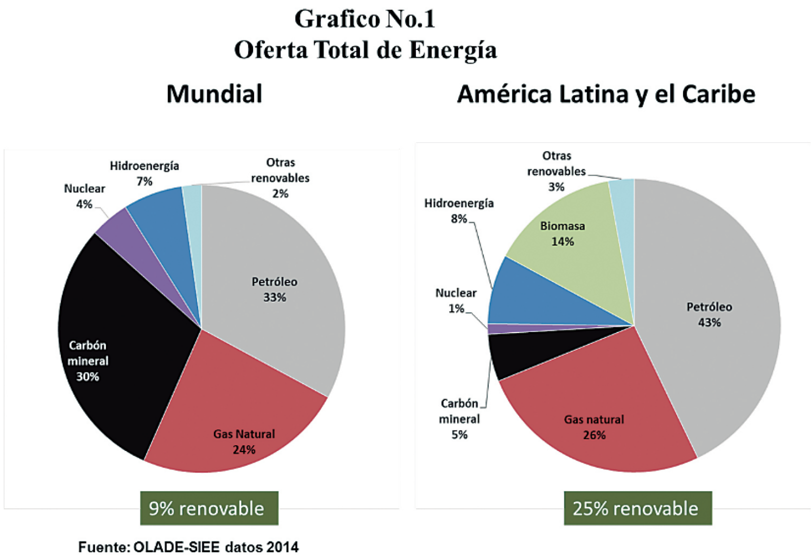
2.1. Total Energy Offer

According to OLADE, in 2014, oil composes 33% of total accounts worldwide of energy supply, natural gas 24%, coal 30%, nuclear and renewable energy 7%, including 9% from hydropower. For the countries of Latin America and Caribbean, oil represents 43% of its energy supply, natural gas 26%, 14% biomass, coal 5%, nuclear only 1% and renewable energy account for 25%. It is important to note that Latin America and the Caribbean exceed 11% of the overall average data for the use of renewable energy in the total energy supply (Chart Nº 1).

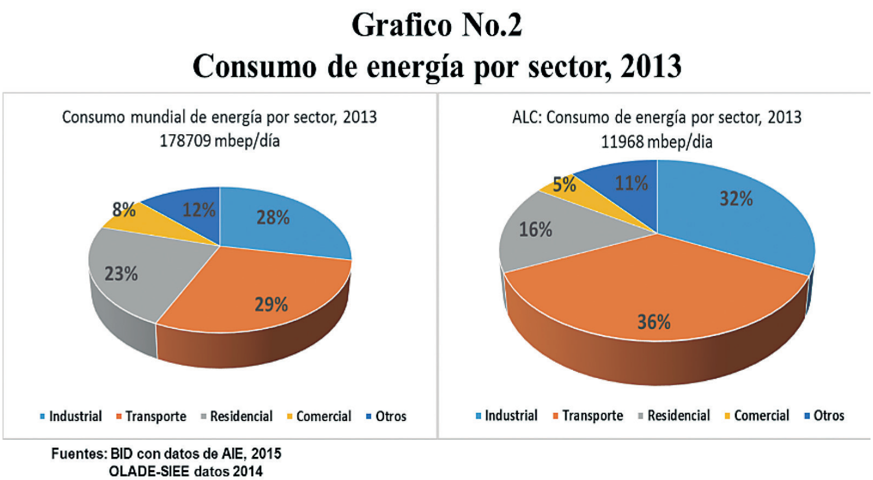
7 BID, Repensemos nuestro futuro energético, 2013

8 Available at: http://www.globalcarbonatlas.org.

Chart nº 1: Total energy offer.



2.2. Energy consumption



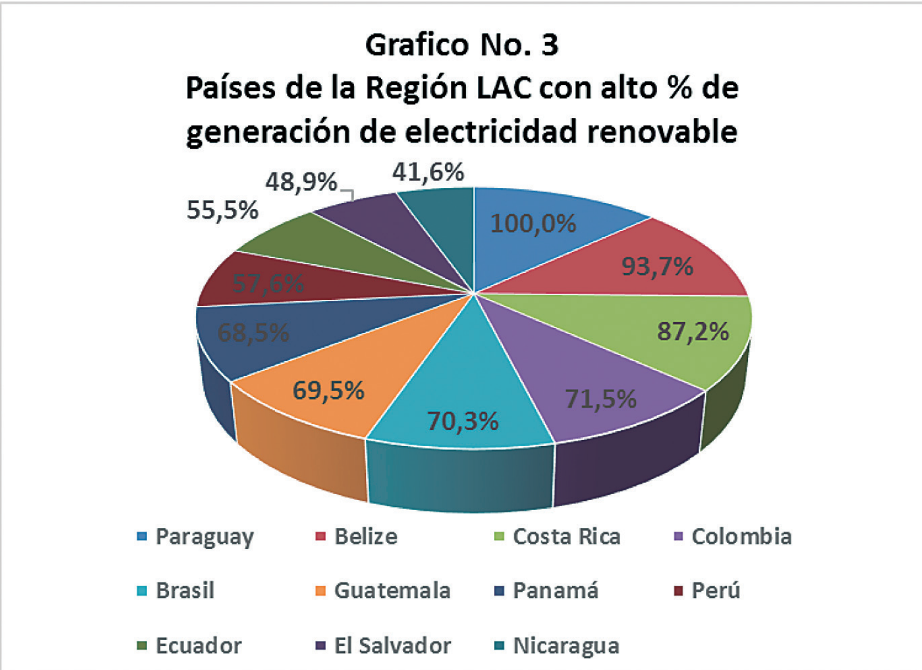
The total amount of energy produced in the world, the sector with the largest consumption is transport with 29%, followed by industry with 28%, residential 23%, trade with 12% and others 8%. In Latin America and the

Caribbean, the largest consumer is transport with 36%, followed by industry with 32%, residential 16%, trade with 11% and other 5% (Chart no.2).

The per capita consumption of electricity has grown rapidly around the world in recent decades. From 1974 to 2013 the number grew from 0.7 to 2.5 bep per person a year. In the LAC region the growth trend of electricity consumption is parallel to the global consumption, rising from 0.3 to 1.5 bep per person a year.

2.3. Electricity Generation

Chart nº 3: Countries of LAC with high % of renewable electricity generation.



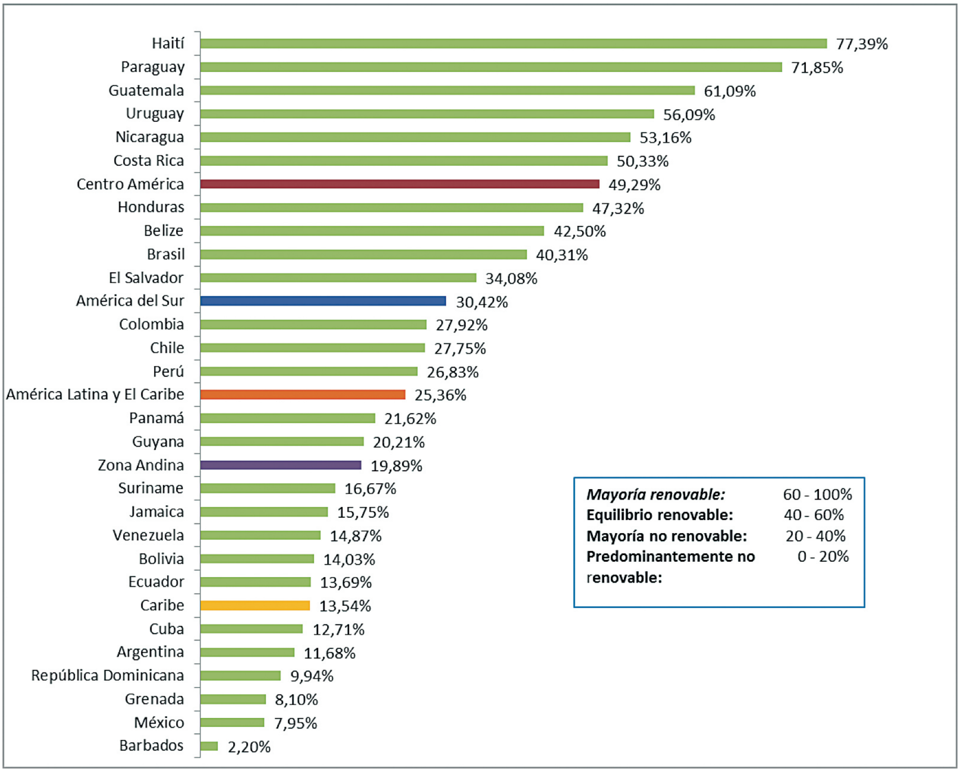
In terms of electricity, the same statistics reported by OLADE 2014 show that among countries in the region with more renewable energy sources, are Paraguay, Uruguay, Belize, Costa Rica, Colombia and Brazil, which have a share of renewable energy over 70% in its array of power generation. Then there's Guatemala, Panama, Venezuela, Peru and Ecuador, which have a renewable share above 50% in its array of power generation. However, it is important to highlight the efforts being made by most countries in the region to increase the use of renewable resources available.

The countries of the Caribbean sub-region have high electricity production percentages from fossil fuels, such as Guyana, Grenada, Haiti and Trinidad Tobago with 100%, on the other hand, some countries such as the Dominican Republic and Jamaica, have 9% 4% respectively.

2.4. Renewability Index

According to OLADE in 2014, the LAC region has a renewability rate of 25.36%. By analyzing the sub-regions in Central America, it is clear that this ratio is close to 50%, 20% in the Andean region and in the Caribbean, only 14% (Figure No. 4). Despite having electricity generation stem100% from fossil fuels, Haiti has the highest renewability rate due to the high use of biomass, mainly wood for cooking.

Chart nº4: LAC Renewability Index.

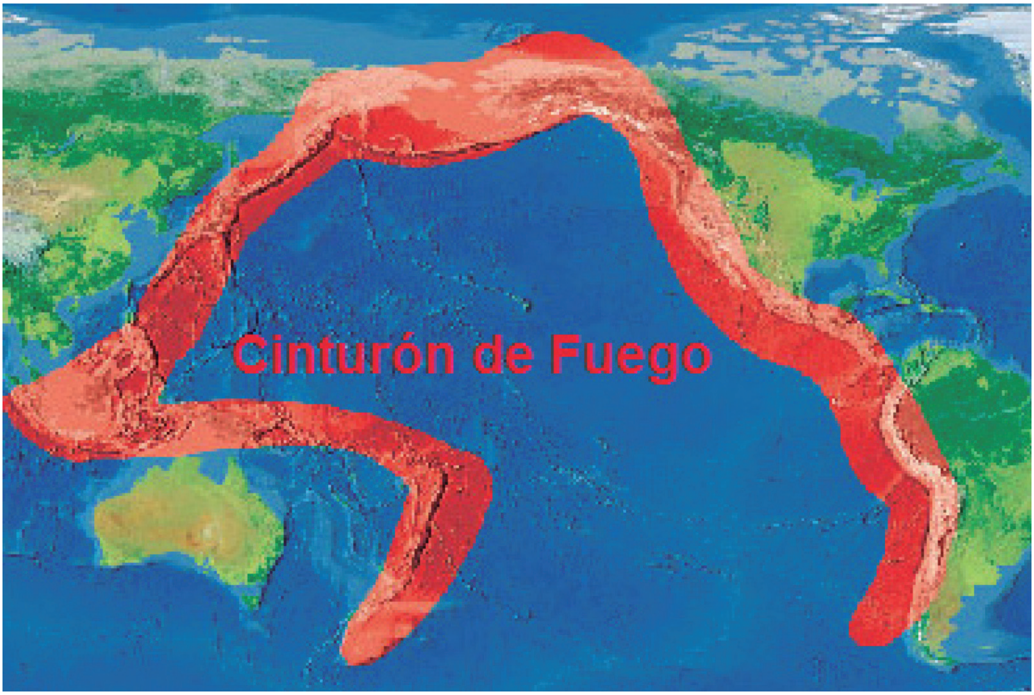


Source: SIEE-OLADE, 2014.

3. Renewable Energy development in Latin America

3.1. Geothermal Energy

Latin America has a huge geothermal potential which accounts for about 15% of global geothermal capacity. Mexico is at the top of the list, one of the countries with the most geothermal capacity. Each approach to the development of the entire region differs markedly. Costa Rica and El Salvador want to increase capacity mainly through the public sector; Nicaragua and Guatemala want the development of the private sector, and are willing to develop and follow models of public-private partnerships.[9]



Source: Geoenciclopedia.

However, Latin America and especially the countries in the so-called Ring of Fire, have a significant geothermal potential that can be exploited in the future. During the years around 2010 Mexico had a total installed capacity of 1,081 MW and Central America, with an installed capacity of 623 MW.

[9] CAF -Banco de Desarrollo de América Latina-, Congreso Geotérmico de Centroamérica y el Caribe (GEOLAC 2015) Nicaragua 2015.

According to a study of IRENA in 2015 in Latin America and the Caribbean, *almost all countries have renewable energy targets and most have enacted laws or regulations for development. In the electricity sector, the established policy for the promotion of renewable energy is mainly based on auctions and tax incentives*[10]. In terms of legislation related to geothermal energy, Costa Rica and Nicaragua have this kind of legislation since 1976 and 1977 respectively. Currently *most countries in the region are adopting legal structures, national policies and strategies to increase the generation of geothermal energy*[11]. This is because national governments are increasingly aware of the importance of geothermal resources, not only to mitigate the effects of climate change, but also to enhance the social and economic models that improve the well-being of the people of their countries. This indicates that the development of this renewable energy source will occupy a prominent place in the development plans of future expansion of the electricity production of countries and it is expected that more countries take advantage of this important energy source.

As an example, Chile, in 2010, seeking to develop its geothermal potential, passed the law of geothermal energy, which regulates the exploitation of these resource activities, generating hundreds of applications. According to the Ministry of Energy of the country, in 2015 there have been 75 exploration concessions and 6 concessions.

3.2. Hydroelectricity

Latin America and the Caribbean have a hydroelectric exploitable potential of 705 GW located in 23 countries of the region. 23% of which are used in power plants with an installed capacity of 161 GW, remaining as the region with the highest use of this natural resource in the world. Countries like Argentina, Chile, Costa Rica, Dominican Republic, El Salvador, Guatemala and Mexico, use at least 20% of their resources, while Paraguay and Uruguay use more than 70%. On the other hand, Belize, Bolivia, Ecuador, Nicaragua, Peru and Suriname use less than 10%[12].

10 International Renewable Energy Agency –IRENA-, Energías Renovables en América Latina 2015, Una Visión de las Políticas, Junio 2015.

11 Affirmation of the Engineer Juan José García, Coordinator of the Geothermal Training Regional Training Program National Energy Board in El Salvador.

12 Latin America Energy Organization, Informe de Estadísticas Energéticas 2014, Primera Edición 2014.

3.3. Biomass

According to CEPAL[13], traditional biomass has a contribution to primary energy of 13% in Latin America and the Caribbean, Europe and North America it accounts for 5% and 2% of primary energy from the forest industry. In Latin America and the Caribbean biomass has not been a primary source of exploitation for electricity generation, but it has a traditional use (cooking). Nevertheless, biomass currently accounts for 14% of the total energy supply in the region.

Several countries use biomass residues for electricity generation, one is Brazil, especially in the use of bagasse from sugar cane, with an installed capacity of 9,180 MW, followed by black liquor, fuel for the industrial process and paper pulp, which represents 1,530 MW. The rest of the installed power with biomass as a renewable energy source is covered with wood waste, biogas, grass, palm oil, coal and rice husk.

Biomass is also relevant in countries with high production of sugarcane, such as the countries of Central America and the Caribbean. In countries such as Argentina and Colombia, there is growing interest in cogeneration systems. In Colombia, the main sources of biomass are bagasse, rice husks and fruits of oil palm.

3.4. Wind energy

Wind power installed in the world has grown exponentially. In 2015, according to the Global Wind Energy Council (GWEC) 14 , there currently is an installed capacity of 432,419 MW, while in 2000 there were only 2,700 MW. The main electricity-producing countries with wind power are China, United States, Germany, India and Spain. In Latin America and the Caribbean, policies for the introduction of more renewable energy in the energy mix have led to increased use of wind energy. In South America, the installed capacity increased from 435 MW in 2008 to 4,137.6 MW in 2013 and expansion in Central America has been similar, from 226 MW to 2,355 MW during the same period. In Mexico in 2009 there was a wind installed capacity of 250 MW and in 2015 it

[13] Economic Commission for Latin America –CEPAL. "América Latina y El Caribe: Potencial Biomasa como Fuente Energía y Retos para su aprovechamiento Sostenible", 2016.

[14] GWEC, Global Status of Wind Power, 2015.

increased to 1600 MW. Currently, in the region, Brazil is the country with the largest installed capacity of wind power, followed by Mexico and Argentina.

For its part the region of Central America has an installed power capacity of over 400 MW of wind, only in Costa Rica which represents 15% of total electricity production.

According to the president of *Wind Energy Uruguayan Association (AUDEE),* "Electricity generation from wind exceeds 2,000 gigawatt-hours (GWh) and provides more than 20% for the production of this raw material in the country, according to official figures in June this year. The progress has surprised the whole world, because in 2013 the wind contribution was only of 1.2%. The purpose of this economy is to end 2017 with 38% of energy being wind generated. Following this aim, Uruguay would almost reach Denmark, which gets 42% of its electricity from wind, and would be above Portugal and Spain, whose wind energy is at 22.5% and 19% respectively of electricity production."[15]

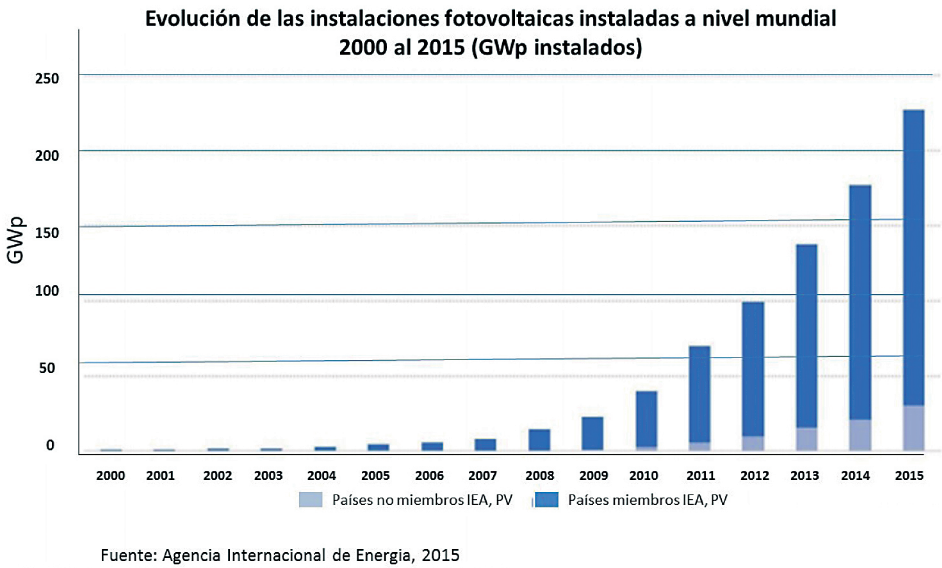
3.5. Solar Energy

According to the International Energy Agency[16], the production of electricity with photovoltaic solar energy worldwide grew 50 GW in 2015 over the previous years. This indicates that the total installed capacity is about 227 GW. In the region where there was a higher growth of solar PV was in Asia, which accounted about 59% and ranked first for the third consecutive year. The most significant progress was made in China, followed by Japan and then the European Union and the US. India stands out as the country with great potential for growth in photovoltaic cells for electricity generation (Chart No.5).

15 Interview with Fernando Schaich, El País, Spain. August 14, 2016. http://economia.elpais.com/economia/2016/08/12/actualidad/1470996789_969168.html

16 IEA, Energy Atlas.

Chart nº 5: Worldwide evolution of photovoltaic installations 2000 to 2015 (installed GWp).



Source: International Energy Agency, 2015.

Although the use of solar energy in the LAC region has been largely isolated premises, in 2014, the photovoltaic solar installations grew to reach 625 MW of installed capacity, compared to 133 MW in 2013. Chile leads the region in the use of photovoltaic energy for electricity generation, followed by Mexico and then Brazil.

4. Latin America and the Caribbean and the Objectives for Sustainable Development

4.1. The Sustainable Development Goals

The 17 Sustainable Development Goals (SDGs) from the Agenda 2030 for Sustainable Development - adopted by world leaders in September 2015 under the UN Summit - officially came into force on 1 January 2016. With these new application universal objectives, over the next 15 years, countries will step up efforts to end poverty in all its forms, reduce inequality and combat climate change[17].

[17] Available at: http://www.un.org/sustainabledevelopment/es/la-agenda-de-desarrollo-sostenible/

The SDGs

> urge all countries to take steps to promote prosperity while protecting the planet. Also, recognize that efforts to end poverty must go hand in hand with strategies that promote economic growth and address a number of social needs, such as education, health, social protection and opportunities employment while combating climate change and promoting environmental protection[18].

Source: www.un.org/sustainabledevelopment/es/objetivos-de-desarrollo-sostenible

It is important to expose that these new SDGs included the goal 7 "affordable and clean energy." This objective aims, by the year 2030, to ensure universal access to affordable, reliable and modern energy, substantially increasing the share of renewable energy in the global energy matrix, to double the global rate of improvement in energy efficiency, strengthen cooperation international levels to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced technology and cleaner fossil fuels, and to promote investment in energy infrastructure and clean energy technology and expand infrastructure and improve technology

[18] Ibid. 13.

to provide modern and sustainable energy for all in developing countries, particularly the least developed countries and small island states, according to their respective support programs.

Goal 7, is closely linked to the three pillars that promote Sustainable Energy for all by the United Nations (SE4All, for its acronym in English), the three pillars are:

- **Universal access to energy:** ensure universal access to modern energy services that have great social and economic benefits to society. Latin America and the Caribbean are close to achieving universal access to electricity, but going from 95% to 100% access requires even greater investment and a new set of solutions[19].

- **Renewable energy:** Search the region take advantage of the potential offered by sustainable energy sources (geothermal, wind or solar), to integrate these sources into the existing energy infrastructure in the region. Latin America and the Caribbean have one of the highest renewable energy consumption rates of any region of the world, this in part due to the use of their potential water resources. The renewable energy potential in Latin America and the Caribbean is large enough to meet the electricity needs in 2050 designed 22 times[20].

- **Energy Efficiency:** Doubling the global rate of improvement in energy efficiency - more of our existing resources - is an achievable goal that will improve living conditions, create sustainable patterns of consumption and promote practices that will secure our energy future long deadline. In the global context, Latin America and the Caribbean is a region with great potential for improving energy efficiency. This means that citizens and industries can reduce their costs and be more sustainable[21].

[19] Inter-American Development Bank: http://www.iadb.org/es/temas/energia/se4allamericas/acceso-a-la-energia,14853.html

[20] Ibid. 15.

[21] Ibid. 15.

4.2. The Paris Agreement

On December 12, 2015, in Paris, France, was announced the adoption of the Paris Agreement, at the closing of the eleventh meeting of the Conference of the Parties -COP21- which manages the long-term objectives set in the fight against climate change and its consequences. This agreement embodies a major challenge for the international community and requires timely and verifiable commitments increasingly stringent for those countries that have adopted compliance.

The following points are defined as the highlights of the Paris Agreement:

- Keep global average temperature well below 2 degrees Celsius above pre-industrial levels, although countries are committed to make every effort to not exceed 1.5 degrees and avoid catastrophic impacts.

- Regarding reducing emissions, 187 of the 195 countries that participated in the COP21 submitted their national commitments to combat climate change, which will take effect in 2020.

- The countries will review their commitments every five years to ensure goal achievement.

- As a long term goal, countries seek to limit emissions immediately, knowing that it will cost them more for developing countries. It seeks a balance between the gases emitted and those that can be absorbed from 2050.

- The agreement states that developed countries should help mitigation and adaptation funding in developing states. They should set aside a minimum of $ 100,000 million per year from 2020 to support mitigation and adaptation to climate change in developing countries and review it before 2025. Countries should put funding are the US, Japan, United Kingdom France, Germany and Switzerland.

4.3. Tarija Declaration of the Ministerial Meeting of the Latin American Energy Organization

As part of the XLV Meeting of Ministers of OLADE held in October 2015 in Tarija Bolivia, the "Declaración de Tarija" (Declaration of Tarija) was adopted, containing twelve points, among which the following agreement among the member countries of this organization stands out:

- Agenda Implementation for Sustainable Development 2030: with the themes of access to energy, energy efficiency, social inclusion, gender equality, environmental protection, reducing the impact of climate change and use of various energy sources.

By working for the fulfillment of Goal 7 of the Sustainable Development Goals, countries in the region are contributing to the development of other goals. Through energy to support the energy program of poverty reduction and improved quality of life of Latin Americans. Support for residential cooling projects, commercial and schools improve nutrition and improve the health and well-being of the inhabitants with the preservation of vaccines and drugs.

The access programs in turn, support children to attend classes in schools and allow them to do their schoolwork when there is no natural light. Through these programs the establishment of women's groups supported to promote integration and equality between men and women. In most projects promoted by OLADE, women are leading productive projects and their work as community members is encouraged, allowing for economic growth at personal level for families, but especially for communities. These projects, in turn, stimulate the sustainable use and development of energy resources of the communities through the promotion of renewable energy, avoid emissions and promote respect and care for the environment.

By promoting renewable energy, countries develop towards functional cities. In the electricity sector, available technologies for intelligent networks facilitate the integration of renewable sources, this is the place where the wind and solar energy advance by leaps and bounds. This, too, can promote more sustainable production and rational energy consumption and production in the beneficiary communities.

5. OLADE and the Sustainable Development Goals

To describe the contribution made by OLADE to their countries to achieve the Sustainable Development Goals working, among others, in four areas:

- Access to Energy
- Energy Efficiency
- Renewable energy
- Climate Change

The region has been visionary on the issue of access to energy. In the 70s, about 130 million people had no access to electricity. Currently, the LAC region with about 600 million inhabitants reached electricity coverage near 96%. 63% of OLADE's members have more than 95% coverage and 85% of its members have more than 90% coverage. Only three members have 80-90% coverage and one country has 28% coverage. If analyzed by sub-regions, South America reached 97% electricity coverage in Central America, 96% in Mexico and 70% in the sub region of the Caribbean. This means that about 26 million people in the region have access to electricity.

Although 75% of poor people in the region are still without access to energy, and they are ones who consume less power, but use a high percentage of their income to the pay for energy, the BID indicates in its reports. The region is the only one that could achieve the SE4All 2030 goal of universal access[22]. However, achieving this objective has a high financial cost; it was estimated that it is necessary around US$ 10 billion in the period, which gives us an estimation of US$ 700 million per year.

OLADE has been part of the improvement of these indicators through technical assistance, supporting its member countries in the definition of energy policies and regulatory frameworks in the energy sector, which has resulted in improved living conditions of its inhabitants. An example of this work is the methodology implemented in three countries; (Guatemala, Bolivia and Guyana), where the application of the principles of corporate social responsibility is bringing electricity to communities that do not have this energy resource[23].

[22] Available at: http://blogs.iadb.org/cambioclimatico/2015/05/01/

[23] See the case of Guatemala: https://youtu.be/qCruYzwojAI

On the issue of energy efficiency in the intensity region decreased slowly. The OLADE member countries have made great efforts in this area, defined policies, legislation, regulations and standards, together with this much investment effort that countries do not have is necessary, supporting multilateral funds is essential to achieve objective. It is estimated that by 2035 the industrial sector will require an investment of US $ 185 billion are needed $ 5 billion, $ 70 billion for the construction sector and $ 195 for the transport sector[24].

OLADE supports this goal through the Program for Latin America and the Caribbean Energy Efficiency -PALCEE- which aims to institutionalize energy efficiency by strengthening the responsible actors, responsible for guiding and directing programs, laws and set energy efficiency standards each of the member countries.

As mentioned earlier in this document, renewables are in the region as a major source of energy. Renewable energy supply is around 30%, this offer varies greatly depending on the country. Much of the electricity production in the region is hydroelectric and the use of non-conventional renewable sources is barely 5%, however, the generation with wind, solar and geothermal energy is constantly growing.

The region has a great potential of conventional and non-conventional renewable sources. Examples of the importance about the issue of hydropower are Brazil and Venezuela, with a high hydroelectric generation, barely touched 32% of its full potential.

The efforts made by countries to have a more renewable energy matrix made so that the use of renewable sources for electricity generation was approximately three times higher in the region than in the rest of the world. Seconds studies of OLADE[25], 2011 to 2030 will require more than $ 900 billion for the LAC region to include more renewable energy in the energy matrix value, and this will depend on each country.

The fact that the region is so renewable has allowed the integration of electrical systems in some countries and sub-regions. The clearest example is the electrical integration of Central America, which came at a cost of about

[24] BID, Energía: Abasteciendo el Crecimiento de las Américas, 2015.

[25] OLADE, Priorización de Proyectos UNASUR, 2015.

US $ 494 billion. OLADE estimated at $ 31 billion to achieve an electrical integration of South America.

Currently OLADE is making great efforts for its member countries to maintain low emissions fuel use, supporting policies and mitigation programs and adaptation to climate change. OLADE considers it important to promote renewable energy, energy efficiency and use of clean technologies and processes that are appropriate mechanisms to reduce net emissions of greenhouse gases. OLADE supports the commitment to the strategies and objectives in the field of energy and environment, and promotes specific studies that help to achieve measures to reduce emissions.

According to the forecasts of different organizations, including OLADE's studies, and taking into account the region's efforts in achieving sustainable development goals, it is important to note that due to the economic growth of LAC, the use of primary energy in the region will continue to increase progressively over the coming decades. In 2030 it is expected that the region will be in excess supply and fossil fuel reserves so its use is difficult to achieve medium term. The main barrier to greater diversification of energy sources is that many countries subsidize energy prices.

The goal proposed by SE4All initiative to achieve a renewability rate of 26% worldwide in 2030 is an easy target to reach in the region, as it currently has a high rate of renewability (25%). However, the replacement of wood and biomass by LPG and natural gas could create a decline in the index.

According to CEPAL, in the LAC region the structure of GHG emissions sources is different from the world, since the emissions from changing land use and forestry account for almost half of the total area, while the energy sector participates with a much smaller degree. In addition, the region is wrapped with a small proportion of the total global emission, with only 5%. Nevertheless, it has a total average emissions per capita above the world average. Therefore, there is little pressure from the international environmental community on this issue.

In the energy sector, wind power is a renewable source with increased development prospects for 2030, natural gas is expected to be strong competition for renewable energy. Solar energy, despite having great potential in the region, and the fact that many countries are integrating slowly at the end there is a decisive change in the energy matrix for the medium term. Overall global technologies for the use of renewable energy must be imported, which implies high costs for implementation of projects in the region.

The adoption of the Agenda for Sustainable Development, signed by 193 countries, is an opportunity for the countries of Latin America and the Caribbean, because it includes the priorities for the region in social areas, economic, environmental and energy. In the area of sustainable energy is an opportunity for our countries to transform the economy, improve the quality of life of Latin Americans through the guarantee of universal access to modern energy services, improve performance and increase the use of sources renewable energy and efficiency production and energy end-use and ultimately contribute to the mitigation of climate change.

Conclusion

The fast economic growth experienced by the region in recent years led to economic and social improvements in the countries, the consequence of which has been the impact on the environment. This indicates that the region should be supported in sustainable energy development, which allows access to energy and social inclusion for the most disadvantaged people in society and should be done taking advantage of the great potential of renewable energy available to the region.

Countries in the region have made progress in defining policies, legal frameworks and regulations specific to the promotion of renewable energy, energy efficiency and climate change. These include incentives and mechanisms to promote the development of sustainable energy to support the social inclusion policy. The transfer of technology and use of human resources and local materials in each country is also encouraged.

Among the most prominent examples in Latin America and the Caribbean are: Mexico, after its energy reform and climate change agenda it developed an energy diversification program, to take advantage of its renewable energy resources. Uruguay, with the strength to make the decision to stop using fossil fuels and held a strong program including wind energy. Costa Rica announced the goal of becoming a neutral carbon economy by 2020 and Chile which passed a Renewable Energy Law for 2020, 20% of the energy matrix is renewable.

The energy integration that is taking place in the different sub-regions, with Central America as the most prominent, strengthen sub-regional and regional order energy markets, creating favorable conditions for the use of renewable energy conditions at a time when the climate change is affecting the energy structure and reducing sources of power generation.

The adoption of the Agenda for Sustainable Development, signed by 193 countries, is an opportunity for the countries of Latin America and the Caribbean, because it includes the priorities for the region in social areas issues, economic, environmental and energy related. In the area of sustainable energy is an opportunity for our countries to reach transform the economy, improve the quality of life of Latin Americans through the guarantee of universal access to modern energy services, to improve performance and increase the use of renewable energy sources and production efficiency and energy end-use and ultimately to help with mitigation measures to climate change.

Through agency cooperation, OLADE can help countries achieve their goals by 2030, supporting coordination and counsel with the ultimate goal of achieving integration, protection, conservation, rational use, marketing and advocacy energy resources of the region. In turn, the organization works in looking for a relationship, most cost equitably between developed countries and those in the region that are in development to achieve the protection of energy resources and technical cooperation for sustainable and integral development of each one of its member countries and the region in its entirety.

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THE UNDER EXPLORED POTENTIAL OF THE INTEGRATION OF ELECTRICITY SUPPLY IN LATIN AMERICA: A BRIEF REFLECTION

Virginia Parente[1]

Abstract: Why do countries that share thousands of miles of borders, such as those in Latin America, still have so little energy integration compared to countries in other regions? Overall, Latin America relies on many renewable and non-renewable energy sources, but it does not seem to be able to overcome institutional issues inherent in its modus operandi in order to unleash this potential for exchange. Neglecting this opportunity does not seem like a smart strategy. Confusing energy security with energy independence also does not help. The task of this brief article is to analyze these issues in the light of the experience of other countries and continents. After referring some international experiences and analyzing the issues of greater integration, this article suggests the strengthening of contractual relations between investors in projects in the electric energy infrastructure involving multiple countries, removing any questions or disputes from the national state spheres in order to treat them in instances of mediation and arbitration located in countries more neutral and distant from the sites of the conflict.

Keywords: Energy integration - Latin America - Electric integration - Energy infrastructure - Transnational investments - Electro-intensives - Universal access to energy.

Introduction

One relevant question is why do countries as close as those in Latin America that share thousands of miles of borders still have so little energy integration and cooperation compared to their North American neighbors. Even European countries, whose language and culture are much more distant from each other, and with a past of explicit enmities, have managed to overcome their differences and move towards a more integrated, dynamic, intelligent and competitive energy market, which provides for more competiveness and security to their diverse economies. In Latin America, the cultural origins and the languages spoken are, for the most part, of the same origin or very close, which should be a facilitator for a better integration in other spheres.

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As an aggravating factor, the energy challenges of the Latin American countries are still greater than those of more developed countries. There, the universal access to the services is a goal already achieved; the rate of population increase is stable and, in some cases, even negative; and the energy efficiency is a goal severely pursued, so there is no additional pressure to increase the electricity supply.

Differently, in Latin America, the supply of electricity still does not or poorly serves about 5% of the population as a whole. Hence, one out of 20 people in the Latin American continent does not have access to or has very precarious access to this vital public service. Although this statistic is different for each of the countries in the region, it is known that life expectancy is up to 25 years lower for those who are not served by electricity. In some regions with no access to electricity, women have an average life expectance of 45 years and men are expected to live up to 48 years. Women are expected to live less than men, due to the enormous daily physical work that comes from, among other things, no running water and strenuous task of seeking water daily. This is because the distribution of water depends on the availability of electric energy to transport it from lower to higher points, where the water tanks of villages or neighborhoods are located. The low access to running water leads to poor hygiene and to birth complications. The lack of access to electricity energy leads to the inhalation of particles and substances used for lighting, lamps and cooking with stoves, etc. The lack of adequate conservation of food results in its rapid deterioration. Thus, families are forced to go to markets every day. All these factors compromise the quality of life.

In addition, given the lower per capita income of the Latin American population when compared to developed countries, any action towards increasing the per capita income in Latin American countries is accompanied by a strong demand for electricity. From the point of view of the families, a higher income can translate into acquiring their first or second refrigerators (often larger and more energy demanding than the previous ones), or acquiring air conditioners to handle hot or cold temperatures in the region, among others facilities.

From the point of view of the various industrial segments established in the Continent, it is worth remembering that many are exporters of commodities or manufactured and semi-manufactured products, and several of these products are electro-intensive. Accordingly, for these industries, the share of electricity in the final cost of products and security of energy supply are essential in maintaining their ability to compete in the global market. Even the industries engaged with petroleum and petrochemicals, mining, ceramics, glass, agricultural commodities, meats and sausages, among many others, demand stable electric power at a competitive price. Tertiary activities with great potential throughout the region, such as the tourism segment, require electricity to attract world-class tourists who demand air conditioning and Internet access.

1. Energy safety or energy independence: lessons from Canada and the US

The answers to the initial question relating to the weak or precarious energy (and electricity) integration between Latin countries are not unique and here we intend to explore only some of them. Let's begin with the false understanding that *energy security* and *energy independence* are perfect synonyms, as many people think. *Energy security* basically means being able to rely on a supply of energy with quality and stability, i.e., with no prospect of rationing or interruptions, even for brief moments. On the other hand, *energy independence* means resolving the issue of energy supply independently, i.e., domestically, within national borders. It is known that even countries with abundant primary energy sources do not deal with these terms as synonyms, although they populate the political discourses of all regions of the planet, especially in times of electoral disputes.

Canada and the United States have long shared this understanding. Both countries have diversification potential from primary sources for electric power generation and haven't decided to meet their supply needs domestically and independently. The fact is that there is a great and intense exchange of energy between the borders of Canada and the USA. What is the advantage? The first is minimizing the distance and costs associated with delivery. It is easy to understand that it would be much more costly to have two transmission systems crossing across these countries, one being exclusively American, connecting the east and west of the United States, and another, practically "parallel", but more to the north, that interconnected exclusively the east and west of Canada. Thus, these countries solved their electricity needs within their borders, in an isolated and independent way.

However, Canada and the United States rely heavily on electricity through "vertical" transmission lines, from north to south, between their borders. On one hand, there is a system integrating the eastern coasts of Canada and the United States and, on the other, a system integrating the western coasts of Canada and the northwestern United States. The second advantage of this and other integrated systems is to reduce energy loss associated with the longer transmission lines. The third is to minimize the risks of shortages, since these tend to decrease when a system is fed by multiple sources, since, for example, if it rains in one place, it may not rain in another, and the hydroelectric or thermoelectric energy generated in one region can be transmitted to another and vice versa. Also, if the problem is due to a failure in a transmission line that has failed to connect the generating source to a power center, that demand can be met through another line that interconnects that requesting center to another generating power center. Not to mention the reduction of socio-environmental impacts, since shorter transmission lines travel shorter distances, which requires smaller areas for the maintenance and safety of these lines, among many other aspects.

2. Risks of cross-border projects and *modus operandi*

The borders between Latin American countries offer a huge and still underexploited potential. Together, these countries form a rich and diverse region when it comes to energy sources. Wind generation, for example, has shown significant growth rates in the region and could be shared more intensely across borders. The use of non-intermittent energies such as hydroelectricity with reservoirs or thermal generation with natural gas or biomass in a combined cycle can further boost the participation of wind power in the energy mix of the region, because they are showing the least expensive way to "establish" wind and solar photovoltaic energy. In addition, there is a large potential for the secondary energy trade and for the manufacture and export of equipment connected to the energy supply chain (GANNOUM, 2016).

The understanding that natural gas has a relevant role in the transition to a low carbon economy is also relevant. Even though it is a fossil fuel, natural gas distances itself from its fossil counterparts by having an impact of 21 to 25 times lower in terms of release of greenhouse gases when generating the same unit of energy when compared with the same unit of energy generated with oil or coal (MARQUES & PEREIRA, 2016). Thus, the potential for exchanging natural gas and / or thermal electricity between frontiers should not be ignored. In addition, natural gas can replace other more polluting sources with significant socio-environmental advantages.

The hydroelectricity of small, medium and large scale can also be adopted, even very sparingly in the Amazon Region. To this end, projects cannot focus on a single sub-biome of that Region and should follow a systematic regional conservation plan (WWF, 2013). Differently from what one may see at first glance, the Amazon Region is not a homogeneous biome. It houses almost two dozen distinct sub-biomes, which have specific and unique fauna and flora. Thus, the preservation of these sub-biomes should be the goal to be pursued. This does not mean, however, not touching them, but above all not overloading them with concentrated dams in the same sub-region. Such ambition should be disavowed by the granting authority, even if this means contradicting the economic logic of concentrating several nearby hydroelectric dams, due to construction and / or maintenance logistics.

Despite the big international reaction regarding hydroelectric exploration in the Amazon Region, it is increasingly clear that the greatest pressure on the Region comes mainly from deforestation in order to widen the agricultural frontier and illegal logging. The impacts of reservoir areas are, in general, much smaller than the other two factors: expansion of the agricultural frontier and illegal logging (GOLDEMBERG, 2015). In this context, the strategy should be to seek the development of a long-term shared vision of conservation, evaluating the impacts of a hydroelectric power program on this vision, considering not only the local impact, but also the systemic connectivity (WWF, 2013).

There are definitely a few initiatives to explore the potential for energy exchange between the borders of Latin American countries. Some of these initiatives are significant, such as the Itaipu project, while others are much smaller. There are also projects that are going at a very slow and unstable pace. It can be said that they are all high uncertainty investments, even the ventures already in operation. One of the reasons for that lies in our *modus operandi*.

On one hand, it cannot be denied that investments in energy infrastructure imply monumental risks in any country. Such investments are, in general, large volumes of resources concentrated in a single and demanding project, which in itself increases the risk. These are also capital-intensive investments, which are comparatively more expensive commodities in less developed countries because they represent more risk. They are irreversible or "sunk" investments as well, since once the energy infrastructure projects - whether a thermoelectric plant, a hydroelectric plant, a wind farm, a transmission line, or a gas pipeline - are built or even started, it's impossible to "load" this infrastructure, "carry" it and move it to another place or country, if the profitability conditions become adverse in the site where the project is located.

Conclusion

Finally, it is worth noting that the lifespan of investments in the infrastructure directed to the supply of power runs through many parliamentary mandates. Agreements often concluded during the term of a governor - whether it's a democratically elected president, dictator, chancellor, state or provincial governor, prefect or a public agent - are not necessarily honored when the new governor takes office whether in the pendular movement of democracies or by dictatorial ruptures.

This is associated with the fact that the countries of Latin America have, in general, a "cartorial culture". We have the (bad) habit of solving investment issues between countries, even when they involve only private capital, as issues inherent in national States. It would be easier and more appropriate to resolve such issues between companies and investors, even if one of the investors or part of the capital came from the governments of other countries involved in the energy infrastructure project.

In the proposition made here, it is suggested that contractual issues in Latin America should always contain clauses that provide for arbitration and mediation. Thus, arbitration forums located in neutral countries could be chosen, even from other continents, with the prerogative for arbitration forums with a tradition of good operation. Thus, issues that eventually arise during the development of investments and the useful life of cross-border electricity infrastructure projects, in order to take advantage of existing potentials, could be treated with the appropriate dimension without gaining unnecessary traits of inter-State disputes, or without being harmed by short-term political-populist interests, which would in no way contribute to mobilizing domestic and / or foreign capitals for the continued, stable, and long-term investment that Latin American countries so badly need.

Accordingly, we will certainly be contributing to increase competitiveness, in the global market, of companies located in Latin America. More importantly, we will be working to reduce with a greater speed and with less cost the portion of the people that often only see from a distance a power transmission line that does not reach them.

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II

DOMESTIC PANORAMAS

In Latin America, energy integration initiatives are still scarce and insignificant; In general, countries seek to universalize access to energy in their domestic environment on an individual basis. For this, some countries face quite peculiar challenges, such as the use of firewood for heating households in Chile, for example.

However, a common problem is the supply of energy to isolated or difficult access areas. Poverty in these areas is an aggravating factor, since, in general, they do not present economic attractiveness for private investment, and the installation and maintenance of energy-generating devices involves costs. Some alternative solutions are, therefore, presented by the countries in the domestic sphere. The creation of a specific financing fund for these cases is, for example, an interesting proposal of the Energy Reform implemented in Mexico since 2013.

Supplying these isolated or inaccessible areas, universalizing energy supply in Latin American countries, is a challenge that has been treated in a variable way by the countries of the region, but which necessarily involves the promotion of the use of alternative sources of energy based, preferably, on the resources available in each country.

This means that, although some of the problems are common, solutions are individualized and depend on the conditions of each state. In Colombia, for example, the construction of large hydroelectric plants is unfeasible. Such antagonism implies the need for solutions based on micro networks. In Brazil, on the other hand, in addition to the abundance of water sources, there is a great potential for the use of biomass, wind and solar energies. In Peru, the consolidation of a Socio-environmental Rule of Law has been sought through the implementation of public energy policies based on renewable sources.

These challenges motivate the comparative study of the energy matrix of some of the Latin American countries, highlighting their weaknesses and potentialities - which makes it possible to demonstrate successful experiences, both in the regulatory and institutional spheres, of each individual State.

CHILE

CHALLENGES FOR THE UNIVERSAL ACCESS TO CLEAN ENERGY IN CHILE

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Abstract: In line with the United Nations Sustainable Development Goals, the recently published Chilean energy policy for 2050 establishes as a goal on access to energy: "to ensure universal and equitable access to modern, reliable and accessible energy services for the entire population." The purpose of this article is to determine the implications of the stated goal, which goes beyond the mere access to energy and involves working to improve the quality of the energy supply, with a significant emphasis on heating and its impact on people's well-being. Accordingly, a number of precedents have been revised to establish a diagnosis of the current status quo in order to determine the main challenges that must be faced to allow the implementation the energy policy's objective. The following challenges were identified: access to low-emission and modern by-products manufactured from forest resources, improvements in the thermal insulation of houses in order to reduce the heating demand, access to efficient technologies for heating, electrification projects with renewable energies in remote areas.

Keywords: Energy Accessibility – Heating – Firewood – Sustainability – Pollution – Renewable Energy.

Introduction

Energy is an essential element for human development. It is an engine for all kinds of activities at different scales: from people's daily life necessities to the productive needs of a country's economy. Accordingly, access to quality energy, in a sufficient amount for a prosperous social and economic development and that minimizes negative impacts on society and the environment, must be a fundamental component of energy policies.

In fact, the 2050 Energy policy, Chile's first long-term policy, establishes the goal of "Ensuring universal and equitable access to modern, reliable and

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accessible energy services for the entire population."[2] These statements follow international commitments on access and energy poverty, such as the global launch of the United Nations Sustainable Development Goals, whose objective 7 establishes a duty to "guarantee access to affordable, secure, sustainable and modern energy for all"[3], and proposes "to ensure universal access to modern, reliable and affordable energy services by 2030".

Achieving the long-term energy policy goals will require actions that go beyond the issue of energy accessibility, i.e.. the fulfillment of basic energy needs, and must also ensure the sustainability of the energy supply and consumption, equity in energy prices and artifacts and the availability of quality energy technologies and resources, allowing the use of energy resources to promote the integral development of the people and positively impacting the quality of life.

In order to understand the political implications and the main challenges that it brings with it, a characterization of the energy matrix and the main peculiarities of the energy consumption is carried out in the present paper. Later, it presents a diagnosis of the access to energy, with the attributes indicated in the goal proposed in the Chilean Energy 2050 policy.

1. Chilean energy matrix, general background

Local energy resources do not have a significant presence in the Chile's matrix, since 68% of its primary energy comes from fossil fuels that are mostly imported. Biomass is the main local energy source, with a bigger share in the national energy matrix; 30% of the total energy supply is derived from biomass, being used for both electricity generation and final consumption in industry and the residential sector. Other local energy sources are hydroelectric energy, with a significant participation in electricity generation, and non-conventional renewable energies, which have begun to be implemented in recent years in the supply of electric energy, such as solar and wind energy.[4]

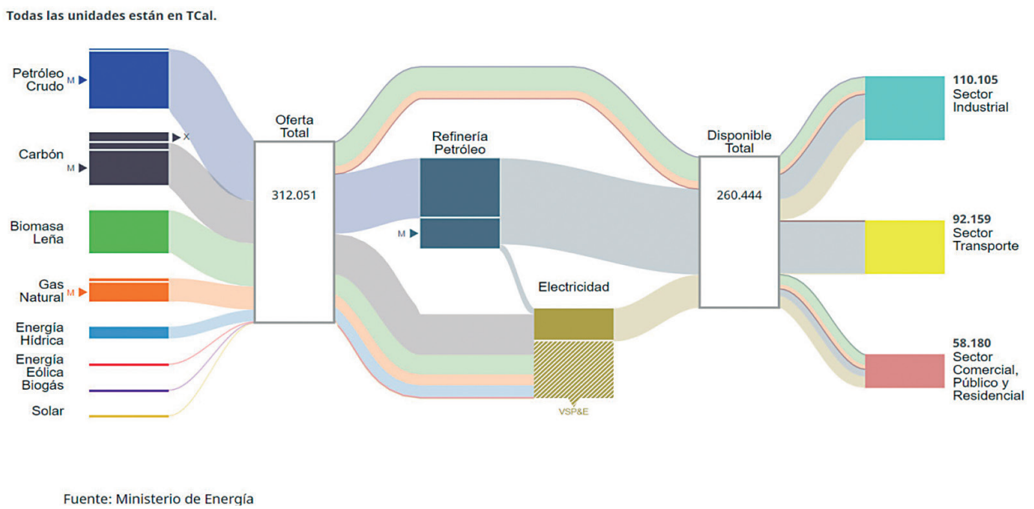
2 MINISTRY OF ENERGY. **Energía 2050, Política Energética de Chile**: Chile, 2015, 152. Available at: <www. energia2050.cl>. Access on: 30 Aug. 2016.

3 UNITED NATIONS. **Objetivos de Desenvolvimento Sustentável.** Available at: < http://www.un.org/sustainabledevelopment/es/>. Access on: 30 Aug. 2016.

4 Source: MINISTRY OF ENERGY. **Balance Nacional de Energía 2014:** Available at: < energiaabierta.cne.cl>. Access on: 30 Aug. 2016

The main sectors that determine the energy consumption are the industrial sector, consuming 42% of the energy available through oil derivatives, electricity and biomass products (forest residues); in second place we have the transport sector, which consumes 35% of the energy available mainly from petroleum products; and thirdly, the commercial, public and residential sectors, which consume 22% of available energy mainly through firewood, followed by electricity. Figure 1 summarizes the information on Chile's energy balance[5].

Chart nº 1: Chile's National Energy Balance.



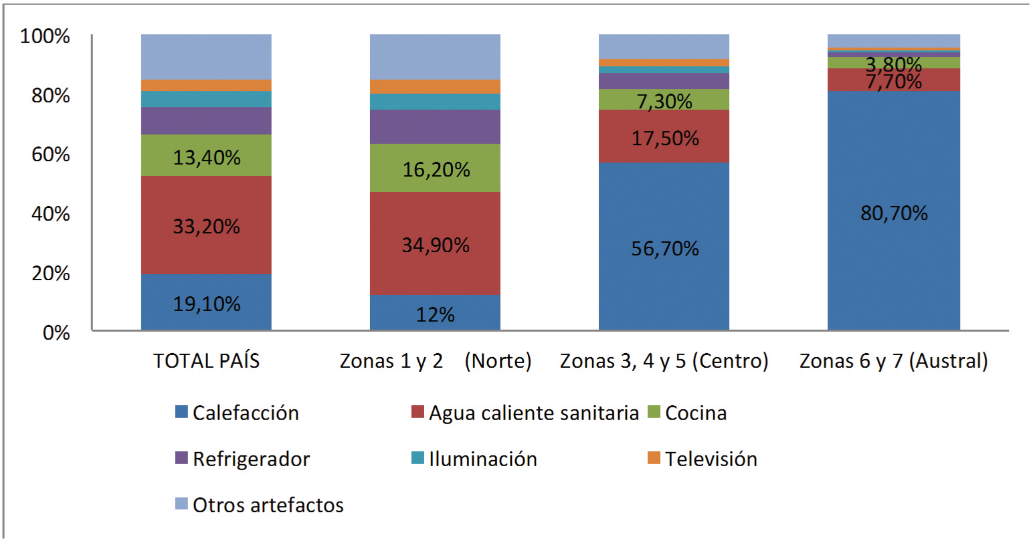
Source: Ministry of Energy. Available at: <energiaabierta.cne.cl>

In order to define the main characteristics of the access to energy in Chile, in accordance with national policies and international targets, a deeper analysis of the population's energy consumption at the residential sector will be carried out. Given the climatic diversity of the country, whose northern region is characterized by warm and dry climates, the central zone by mixed climates and the southern zone by cold climates, the end uses of energy vary widely among the different zones of the country.

5 Source: MINISTRY OF ENERGY. **Balance Nacional de Energía 2014:** Available at: < energiaabierta.cne.cl>. Access on: 30 Aug. 2016.

As one moves towards the south of the country, the importance of heating energy consumption increases in relation to the total consumption of households, reaching 80% of the energy consumption in the colder zones, as shown in Figure 2, which presents the results of surveys carried out in a 2010 study, which analyzes the final uses of energy in the residential sector[6]. In the same study, the energy used in each case is characterized, establishing that the main fuel used for heating is firewood, used as the main source of heating in more than 90% of households in the southern zone. On the other hand, the domestic hot water needs are met with gas water heaters, mainly, using liquefied gas. In the kitchen, also, the main fuel is liquefied gas, but in rural areas the use of the wood stove has greater significance, being the fuel used to cook in 50% of the households in the year of 2002[7].

Chart nº 2: Distribution of residential energy consumption by thermal zones.



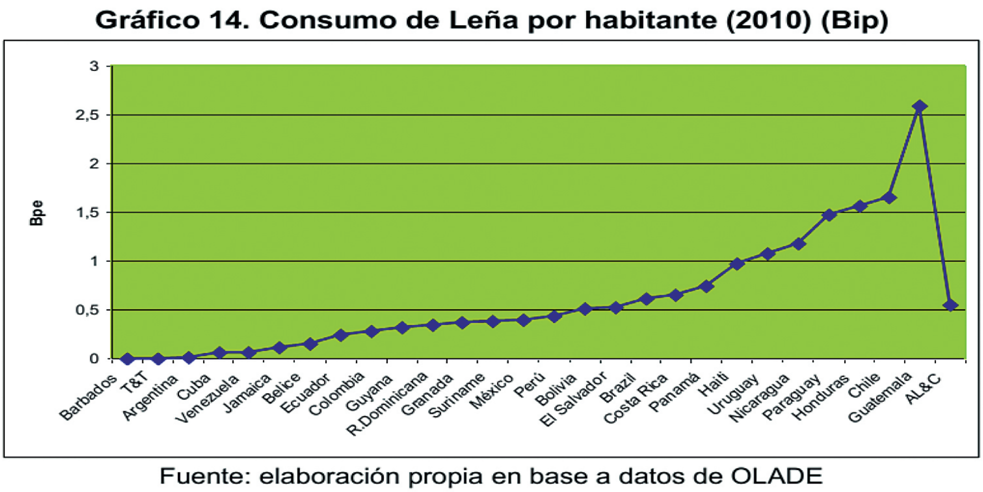
Source: Graphic elaboration based on data from the Technological Development Corporation.

[6] CORPORACIÓN DE DESARROLLO TECNOLÓGICO, PROGRAMA PAÍS DE EFICIENCIA ENERGÉTICA. **Estudio de usos finales y curva de oferta de la conservación de la energía en el sector residencial:** Chile, 2010, 443.

[7] Source: INSTITUTO NACIONAL DE ESTADÍSTICAS, **Censo de población y vivienda**: Chile, 2002.

In fact, Chile is one of the countries with the highest firewood consumption in relation to other countries in the region, as shown in Figure 4, being the second country with the highest consumption of wood per inhabitant, an indicator that considers the use of wood for cooking and heating. As noted above, while in other countries of the region firewood consumption is mainly associated with cooking, the consumption of firewood in Chile is mostly associated with heating.

Chart nº 3: Firewood consumption per inhabitant.



Source: Corporación Andina de Fomento, 2013.

As for the electricity consumption, the power comes mainly from centrally interconnected power grids through the Interconnected Systems (Central Interconnected System and the Great Northern Interconnected System), and the energy is generated mostly in coal-fired power plants (45%), biomass plants (21%), hydroelectric plants (12%) and thermoelectric plants with natural gas (11%). Both coal and natural gas are mainly imported: 85% of all the coal and 80% of all the natural gas used in Chile are imported. Although today the supply of solar energy presents a marginal contribution, its participation in the generation of electric energy has grown significantly in the last years, existing a considerable potential for solar energy in the country given its high levels of radiation.

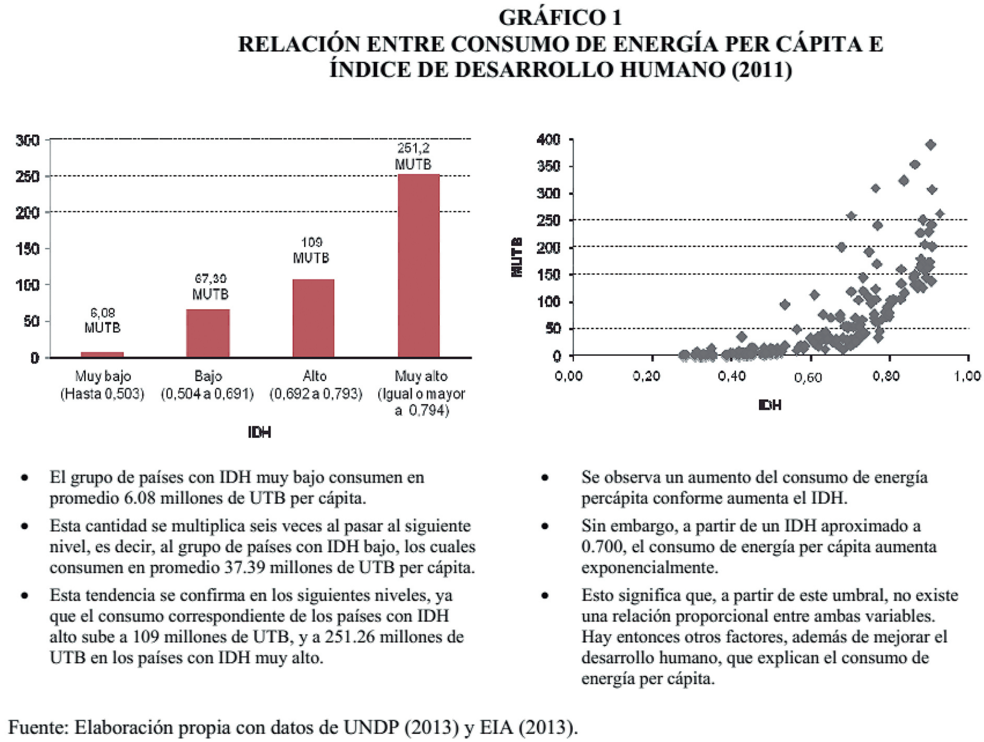
These antecedents provide guidelines for the analysis of energy consumption by the population of the country, giving insights on energy services and the needs they currently satisfy, and allowing to understand some key elements for the establishment of an energy access diagnosis: (i) regarding the consumption of electricity, the current consumption is satisfied with connections to a centralized power grid, whose energy is mainly produced in coal power plants, using mostly imported coal; (ii) regarding fuel consumption, firewood has a great importance in the central and southern parts of the country, representing a high participation in the distribution of energy consumption within households, due to the need for heating, which is mainly fulfilled with the burning of firewood in individual fireplaces inside the houses.

2. Universal and equitable access to modern, reliable and affordable energy

Access to energy, and in particular to clean, reliable and affordable energy, plays a key role in improving the quality of life of people and, consequently, in the human development of a country. In fact, there is a relationship between per capita energy consumption and the Human Development Index (HDI), according to ECLAC's study on energy poverty in Latin America[8] (see Figure 4). The same work establishes methodological elements for the analysis of access to energy as a factor in the study of energy poverty, highlighting the need to consider climate as a determinant factor in energy consumption patterns, in the differentiation of absolute energy needs and in the economic goods.

[8] OCHOA, Rigoberto. Pobreza energética en América Latina. **CEPAL Serie Documento de Proyecto**, No. 576, 2014, 36 p.

Chart nº 4: The relationship between per capita energy consumption and the 2011 Human Development Index.



Source: Ochoa, 2014.

Access to energy is introduced into political agendas coupled with the need to "increase the energy supply to incorporate larger portions of the population into modern living standards, to cover basic unmet needs with access to energy services and equipment, to finance poor sectors through prices and subsidies that ensure energy supply and to implement measures for the rational use of energy and the dissemination of clean energy sources for all social strata in order to achieve sustainable social inclusion."[9]

The main effects in people's quality of life of the lack of access to energy or of the access to energy that does not match sustainability patterns (equitable, clean, modern, reliable, affordable) are:

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[9] ECLAC. **Contribución de los servicios energéticos a los Objetivos de Desarrollo del Milenio y a la mitigación de la pobreza en América Latina y el Caribe**. Chile, 2009, 82 p.

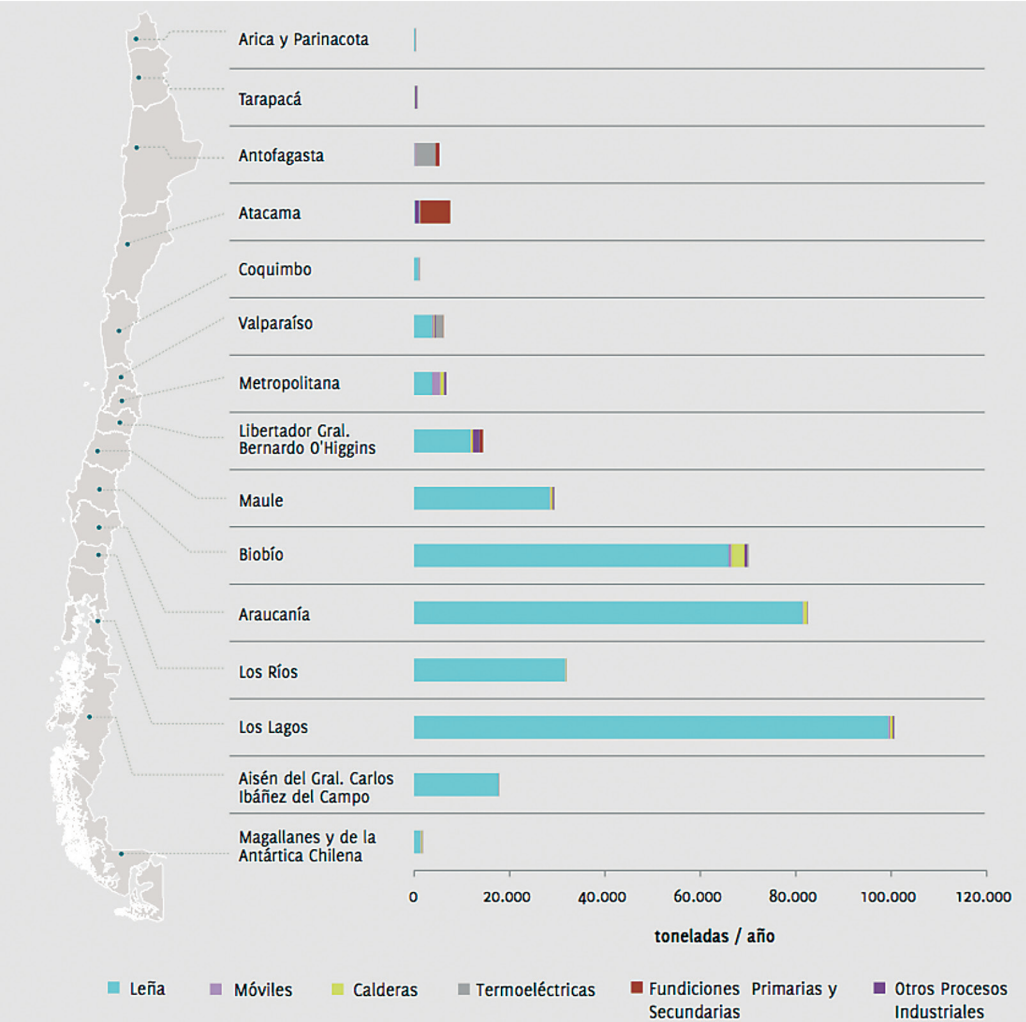
- Health problems related to the lack of thermal comfort due to heating deficits and to the presence of atmospheric pollutants associated with the improper burning of fuels (low efficiency of the instruments used for heating, fuels with high pollutant emissions, ventilation problems and bad habits);
- Debt associated with high costs of energy services;
- Social and geographical isolation;
- Low productivity of small-scale economic activities that are important sources of family income.

In Chile's case, these effects can be detected in different segments of the population and geographical areas, with health problems having the greatest impact on the population. The lack of thermal comfort, due to poor housing conditions and the costs of the fuel for heating, can be seen in the temperatures measured inside the houses of the country, with more than 60% of the population in the central and southern areas of Chile having temperatures below 15° C inside[10]. The magnitude of the health problems associated with pollution problems is set out in the "First Report on the State of the Environment", which indicated that: 4,070 people die each year from cardiopulmonary diseases related to high air pollution; 127,000 visits to emergency rooms were due to episodes of acute bronchitis in the population; and the burning of wood for heating is the main cause (with a contribution of 90%) of pollution by particulate materials[11].

[10] MINISTRY OF ENERGY. **Energía 2050, Política Energética de Chile**: Chile, 2015, 152 p. Available at: <www.energia2050.cl>. Access on: 26 Aug. 2016;

[11] MINISTRY OF THE ENVIRONMENT. **Primer Reporte del Estado del Medio Ambiente:** Chile, 2011, 152 p.

Chart nº 5: Sources of particulate material emissions by region of Chile.



Source: Ministry of Environment.[11]

3. Access to electricity in Chile

Chile has high rates of electrification coverage and its rural electrification programs have had positive impacts, since 96.5% of the population has access to electricity. Despite this, challenges are being faced today in order to achieve improvements with a direct focus on overcoming poverty and improving the quality of life of rural communities.

Firstly, the population that currently does not have access to energy services is characterized by belonging to communities geographically isolated by several conditions: (i) located in mountainous areas with difficult access; (ii) located in islands; (iii) communities with scattered houses. In all these cases, it is necessary to search for alternative solutions to connect these people to the power grid, in order to cover their basic needs. The Ministry of Energy estimated that in 2006, 29,000 homes could not be electrified by extending the grid because of their extreme isolation and dispersal.[12]

To date, rural electrification projects have allowed the expansion of electric coverage in more than 220,000 homes in 20 years, mainly through projects to extend the electricity grid. However, there are still some projects based on self-generation with diesel at the rural level, which have higher costs and special needs for operation and maintenance and do not consider technical integration with social development[13]. Statistics show that projects of rural electrification through diesel generation have an average useful life of three years, after which they must be replaced. Through several documents, it is possible to recognize the idea that the participation of the community in the maintenance and operation of the systems would allow a greater sustainability over time to this type of projects through the appropriation of the technologies[14].

In 2013, through a poll, 79 isolated locations with the potential to develop rural electrification solutions through micro-networks were identified, in accordance with the following criteria: (i) number of houses to be electrified; (ii) human development index; (iii) migration patterns; and (iv) prior existence of an electrification project. Most of these projects are located in the northern part of the country.

[12] Source: Presentation at the Ministry of Energy, IV Seminario Latinoamericano y del Caribe de Electricidad, 2014.

[13] UBILLA, Karen et all. Smart Microgrids as a Solution for Rural Electrification: Ensuring Long-Term Sustainability Through Cadastre and Business Models. **IEEE Transactions on sustainable Energy,** Vol 5, Issue 4, p 1310 – 1318, 23 June 2014.

[14] JIMÉNEZ, Guillermo et al. It Takes a Village. **IEEE Power and Energy Magazine**, Vol 12, Issue 4, p 60 – 69, 12 June 2014.

4. Access to energy for heating in Chile

As noted above, the main source of energy for residential heating in Chile is firewood. However, in contrast to the usual analyzes, wood consumption in Chile is not intrinsically associated with poverty, since its consumption is present in several socioeconomic strata of the population (with greater presence in the middle and lower socioeconomic strata, in which the consumption of wood can be found in 50% of the households in the country, but its participation in higher socioeconomic levels continues to be more than 20% nationwide[15]), and is present in urban and rural areas (with a greater presence in rural areas: while 80% of rural households use wood, 30% urban households use this material nationwide).

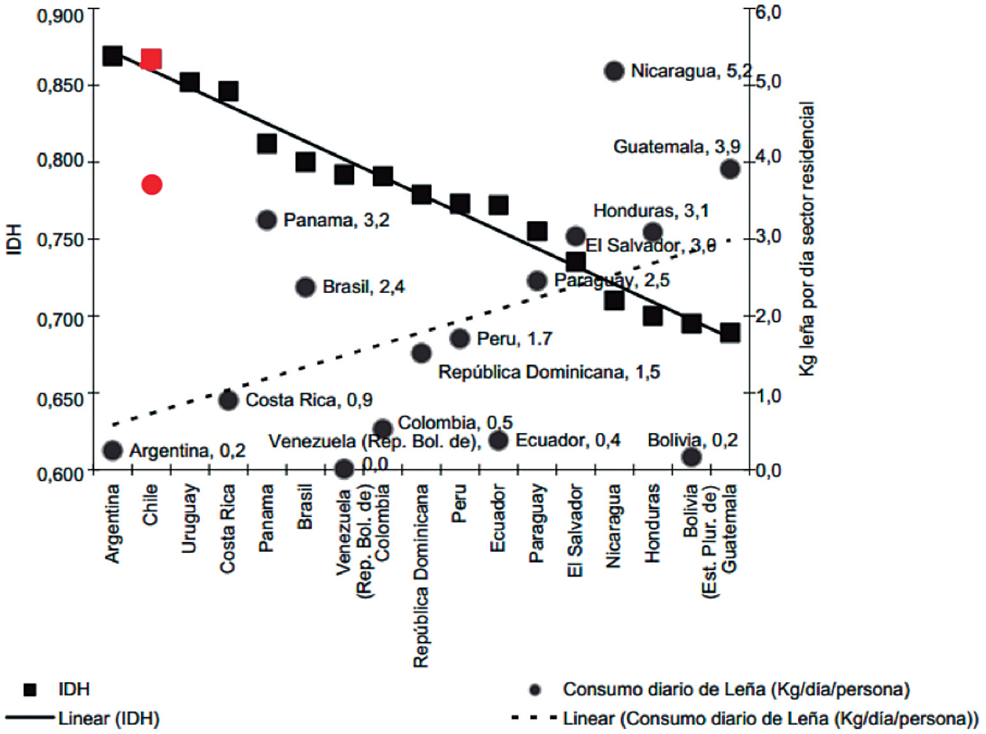
On the other hand, unlike other countries where there is a coexistence of low or intermediate levels in the Human Development Index and high degrees of rural poverty and firewood consumption per capita, Chile has a high rate of human development and a high consumption of firewood, as indicated in the figure[16].

At the international level, the use of firewood is associated with poverty due to the conditions of harvesting by women and children, a situation that weakens the population's well being. However, this scenario does not correspond to what happens in Chile, where wood is extracted by small wood producers who rely on its trade as a source of income. Nonetheless, firewood sales prices have narrow profit margins for these producers.

[15] Source: MINISTRY OF SOCIAL DEVELOPMENT. **Encuesta de Caracterización Socioeconómica Nacional**: Chile, 2013.

[16] ECLAC. **Contribución de los servicios energéticos a los Objetivos de Desarrollo del Milenio y a la mitigación de la pobreza en América Latina y el Caribe.** Chile, 2009, 82 p.

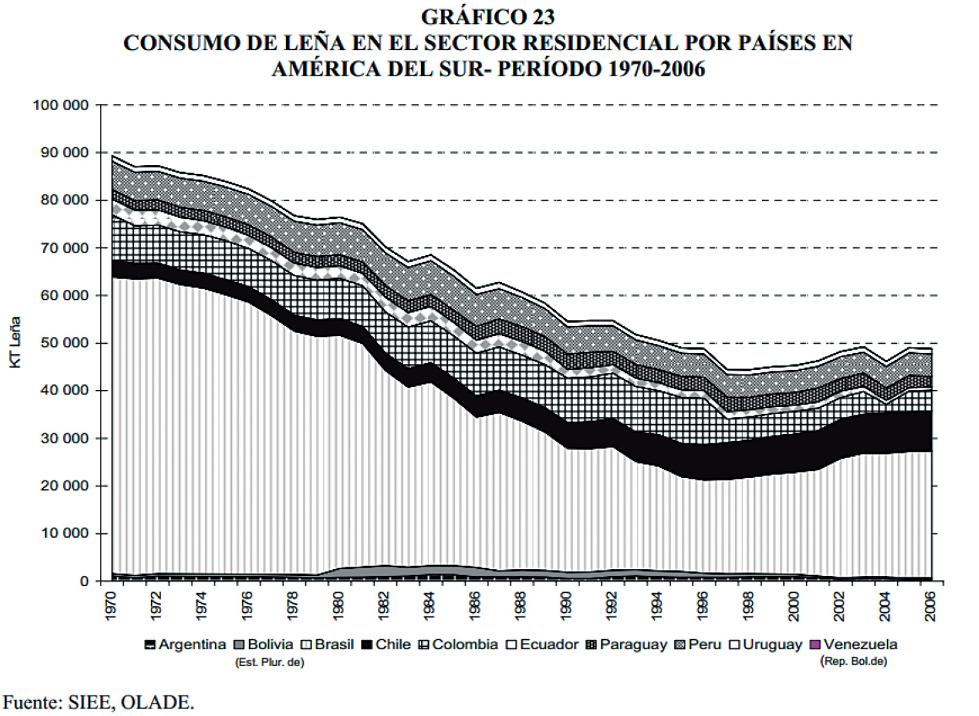
Chart nº 6: Residential consumption of firewood by rural inhabitants and HDI.



Source: ECLAC 2009, edited by the authors.

In the case of Chile, the use of wood for heating represents a problem for energy access goals, because the conditions of demand and final use make firewood a source of energy with low sustainability. Its main effect is a high emission of atmospheric pollutants, mainly particulate materials, which generate significant effects on the concentration of local pollution and on the health of the population, according to the aforementioned statistics. On the other hand, the consumption of firewood in Chile, besides being an important component of the energy matrix, is increasing, unlike the trends observed in the rest of Latin America.

Chart nº 7: Consumption of firewood in the residential sector by country in South America, period 1970-2006.



Source: ECLAC 2013.

In addition to the atmospheric polluting effects, the use of firewood is associated with pressures on the country's forests. In Chile, the supply of firewood comes from native forests and forest plantations (in 2012, 63% of the wood used for energy purposes came from native forest and 37% from forest plantations of eucalyptus and pine[17]). Of all the wood from native forests, only 19.6% is produced under management plans. Despite this, it is possible to meet the country's heating needs with native forests to the extent that the existing resource is subject to management plans. In fact, the current consumption of firewood represents 21% of the supply of potentially usable firewood through management plans[18].

[17] REYES, René. Agrupación de Ingenieros Forestales por el Bosque Nativo (AIFBN). **Leña, energía renovable para la conservación de los bosques nativos de Chile.** Chile: Mira ediciones, 2012, 79 p.

[18] Source: CORPORACION NACIONAL FORESTAL. **Estrategia Dendroenergía**: Chile, 2015.

Firewood consumption, as well as the effects it may have on air pollutant emissions, is determined by several factors. Household insulation conditions, firewood moisture indexes, instruments used for heating, firewood costs and cultural elements are the main factors considered in the studies that analyze the phenomenon.

Regarding the insulation conditions of the houses in Chile, the first thermal regulation was implemented in 2000 (for ceilings) and was later updated in 2007 (incorporating floors and walls), improving the level of requirements. Before this period, about 3.5 million homes were built not under the insulation requirements. A house built before 2000 can have more than twice as much heating demand compared to houses built later[19]. Despite this, the regulations are still deficient, since they only consider thermal insulation and the requirements are not adequately adapted to the climatic conditions of the country. Even with regulation, the demand for heating in some thermal zones remains very high. On the other hand, the regulations do not have requirements regarding air infiltration, humidity, condensation and ventilation - fundamental conditions to maintain indoor environmental comfort and to reduce energy demand for heating.

High levels of humidity characterize the wood used in Chilean homes. Analyzes carried out in some cities show moisture in the range of 50% to 100%, with half of the samples being in intervals of 75% to 100%, values much higher than those regulated in countries such as the USA or Canada, which are limited to 25%[20]. Wood moisture is a poorly controlled factor, because the firewood market is informal, i.e., it does not comply with any type of legislation. Currently, firewood certification programs have been developed, which encourage the trade of dry firewood, but this is a private initiative that has not become common practice among firewood producers.

The technology, and consequently the fuel combustion efficiency, varies according to the zone, with the average efficiency in urban areas being higher due to the greater presence of double and single combustion heaters (with efficiencies of 50% and 65%, respectively). On the other hand, less modern

[19] PROGRAMA DE GESTIÓN Y ECONOMÍA AMBIENTAL. **Alternativas tecnológicas para calefacción residencial con energías renovables no convencionales aplicables a la realidad chilena.** Chile, 2014, 130 p.

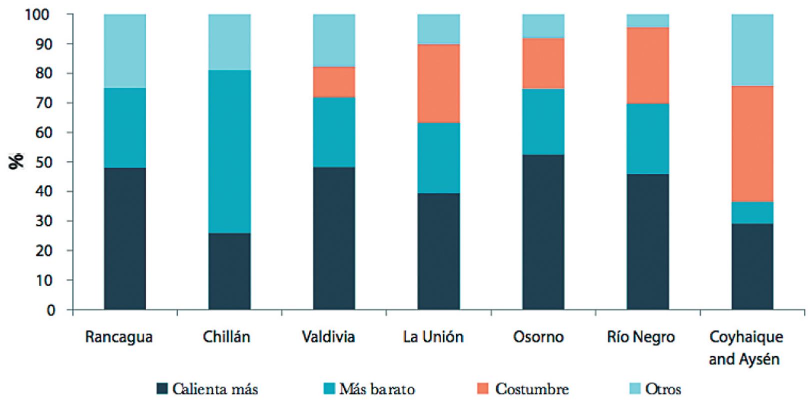
[20] Source: UNIVERSIDAD DE CONCEPCIÓN. **Priorización de Medidas de Reducción de Emisiones por Uso Residencial de Leña para la Gestión de la Calidad del Aire en Temuco y Padre Las Casas:** Chile, 2002

technologies, such as salamanders and wood stoves, have less efficiency - close to 30%. It is estimated that the average efficiency of the technologies used in urban areas is 42%[21].

The informality of the firewood market explains in part its low prices, which together with a steady rise in fossil fuel prices, creates consumers' preference for firewood. Compared with other alternatives, on average, firewood has a cost 4 times lower than that of paraffin; 4.6 times lower than that of liquefied gas and 5.3 times lower than that of electricity. The preference for firewood is partly justified by its price, because there are also cultural factors that determine its massive use, such as the custom or the belief that firewood "heats more", as can be seen from the results of a survey, presented in Figure 8. Regarding customs, studies show that people living in small towns maintain rural habits and customs associated with the use of wood-derived fuels.20

Chart nº 8: Main causes indicated by consumers for the combustion of firewood in different cities of Chile.

Figura 20. Principales causas del consumo de combustibles derivados de la madera



Fuente: elaboración propia en base a INFOR (2005a), INFOR (2005b), Universidad de Chile (2005) e INFOR (2004).

Source: REYES 2012.

[21] REYES, René. Agrupación de Ingenieros Forestales por el Bosque Nativo (AIFBN). **Leña, energía renovable para la conservación de los bosques nativos de Chile.** Chile: Mira ediciones, 2012, 79 p.

In Chile, biomass is the fuel that can meet the high heating needs in areas of the country's cold climate, where it is most extensively available locally. On the other hand, the extraction of firewood is a fundamental element in local economies and in smallholders' households, being the main source of income for these groups of the population.

In this context, the sector's main challenge is related to the utilization of the forest resource through the combustion of more efficient by-products in modern artifacts, with large-scale projects at the community level that improve the efficiency of technologies, and in households with good insulation conditions in order to reduce the heating demand. "Wood energy could thus have an important role in the forest for multiple uses; a management model for the production and combined harvesting of wood, fuel and non-timber forest products, providing an adequate complementation with productive uses of those countries where, for reasons of income and availability of supply, modern fuels cannot replace firewood".[22]

5. Chile´s key challenges for access to clean and safe energy

- *Access to clean and modern by-products of the forest resource:* fuels are needed to heat the houses. Biomass is the main option, given the characteristics mentioned above, but it is not sustainable to continue burning wood under current conditions given the negative effects on people's health. There are alternatives for this: the development of biomass by-products, such as pellets and chips, providing for a more efficient use of the energy content of the wood and generating lower emissions (up to 10 times lower than the heaters currently used in Chile[23]). This type of by-product may eventually have a higher price than that paid for firewood, but considering the latter's negative externalities associated with health problems, the use of these by-products would have an important social benefit and, thus, a cost-effective solution from a social point of view[24].

[22] ECLAC. **Contribución de los servicios energéticos a los Objetivos de Desarrollo del Milenio y a la mitigación de la pobreza en América Latina y el Caribe**. Chile, 2009, 82 p.

[23] CHILEAMBIENTE - CNE. **Análisis del Potencial Estratégico de la Leña en la Matriz Energética Chilena:** Chile, 2008, 290 p.

[24] PROGRAMA DE GESTIÓN Y ECONOMÍA AMBIENTAL. **Alternativas tecnológicas para calefacción residencial con energías renovables no convencionales aplicables a la realidad chilena.** Chile, 2014, 130 p.

- *Access to households with low thermal demands:* before promoting changes in the source of energy used for heating, we must work on reducing the demand for heating, because this would lead to less pressure on the demand for energy resources and their effects. Studies show that simple improvements in the insulation of houses can reduce emissions of air pollutants by about 30%23. The work should focus both on improving the thermal insulation of existing homes and on improving thermal regulation for new homes.

- *Access to efficient technologies for heating:* it is necessary to establish a transition in the form of heating houses. This transition begins with improving the quality of firewood and reducing the thermal demand of the houses, to finally establish a change in technologies, from individual combustion inside the houses, to district heating systems that would allow to improve the efficiency of the systems and contribute to reducing its effects on people's health. One study shows that the reduction of mortality can be at least 4,500 over a period of 30 years in cities declared to be saturated[25].

- *Access in isolated areas to projects of electrification with renewable energies:* Chile has great potential for the development of renewable energies, particularly of solar energy, but a significant part of the electrification solutions for isolated areas have been covered by diesel generation. In this sense, it is necessary to reinforce the implementation of energy solutions with renewable resources in isolated areas, through work methodologies that promote the appropriation of energy solutions by the communities in question.

In this context, the next chapter analyzes the experiences carried out by the *Energy Center of the Faculty of Physical and Mathematical Sciences of the University of Chile* in the development and implementation of energy solutions in isolated communities, highlighting the co-construction processes of these solutions. This implies a challenge for energy policy, which should give flexibility to the system in order to encourage the use of renewable energy sources, improving citizen participation in the decisions related to investments in the sector and their territorial expression.

[25] PROGRAMA DE GESTIÓN Y ECONOMÍA AMBIENTAL. **Alternativas tecnológicas para calefacción residencial con energías renovables no convencionales aplicables a la realidad chilena.** Chile, 2014, 130 p.

5. The Energy Center's experience and the Co-Construction Methodology

The growing interest in social initiative projects to bring electricity to remote areas involves both the opportunity to finance the development of technologies that positively impact the quality of life of the communities involved, such as the risk of project failure due to lack of financing for the maintenance and the monitoring of solutions, and the lack of a level of community involvement that allows the continuity of projects.

Since its creation in 2009, the *Energy Center of the Faculty of Physical and Mathematical Sciences of the University of Chile* has been working on the development of energy solutions for isolated areas, exploring methodologies for working together with the community through which the projects have been developed (co-construction), with the aim of giving sustainability to technological solutions. This methodology promotes the early integration of the community in the design, implementation, operation and evaluation of the initiatives, facilitating the active participation in all the relevant decisions of the project.

Among the principles that support the co-construction of energy solutions, we can mention: recognition of local knowledge and dynamics, valuing knowledge as an element of identity; the management of the project by an interdisciplinary team that facilitates the dialogue between the technical-scientific knowledge and the local knowledge; involvement of actors from the local community in all stages of the project; the technological appropriation by the community, in order to enable changes in the long term; training with a constructivist approach that facilitates informed decision-making by the community.

The main features of this system are: a flexible and participatory project design and community-based land management that defines resilient organizational structures to ensure proper operation and maintenance practices. The purpose of this approach is to ensure that the product adjusts itself to the local realities, according to their cultural, social, environmental and economic attributes.

Several projects carried out to date by the *Energy Center* have allowed the implementation and enrichment of the work methodology developed. A valuable experience was held in Huatacondo, a remote community inhabited by about 30 families in the northern part of the country. Huatacondo had an isolated power grid based on a diesel generator that operated 10 hours a day. The project consisted in the installation of a micro-grid that takes advantage of the abundant renewable energy resource (solar light and wind) to supply electricity continuously. The project also considered the demand management components that would handle generation fluctuations, minimize the use of diesel as backup, optimize battery usage, determine water pumping operations, and send signals to consumers to encourage behavioral changes. The project was developed in stages that allowed sustainability to be ensured over time: building trust, working together with the community in defining a management model, ensuring sustainability over time. According to community evaluations, the project had positive impacts on the environment and productive activities and received positive perception on the part of the community.

Chart nº 9: Solar panel installations that are part of the micro-grid in the community of Huatacondo.

Source: Energy Center.

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AN ANALYSIS OF THE ACCESS TO CLEAN ENERGY FOR THE CHILEAN RURAL POPULATION

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Abstract: In recent decades, Chile's rural population has undergone a major revolution in access to electricity. In the 1990s, Chile maintained low rates of energy access for populations inhabiting rural regions of the country. This scenario has changed due to the incisive action of the Chilean government through policies of subsidy of interconnection and energy generation projects. However, the goal of achieving 100% of the population remains unreached. Taking into account the objective set by the Chilean Government, the present paper develops an analysis of the access to energy in Chile and suggests a proposal to the country in order to reach the population that remains without access to energy, especially through the use of non-conventional renewable energy (NCRE). The hypothesis put forward here is that Chile should continue its subsidy policy, but change the current focus of this initiative, which has so far been on the extension of transmission lines. We suggest larger investments in micro generation projects using NCREs and more communication between regional and local governments in order to optimize the allocation of resources. These measures could further increase the access to clean energy by the Chilean rural populations.

Keywords: Non-Conventional Renewable Energy – Chile – Rural Population – Access to Energy.

Introduction

The goal of expanding the supply of electricity to rural populations is an issue that has led several public policies worldwide. The lack of access to energy by the inhabitants of these regions is a problem that affects mainly, but not only, underdeveloped countries, which still have unsatisfactory levels of energy access. Therefore, many governments around the world have developed electrification programs to reach this section of the population. However, there are several factors that hinder the implementation of such measures, which will be covered in this analysis of the energy access to in Chile.

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One of the major difficulties is to stimulate the interest of the private sector to invest in these enterprises, since the low density of rural populations and the reduced consumption demand a high level of investment to bring energy to those regions. Moreover, profits are often uncertain and, thus, the maintenance costs of the services become high for private companies[3]. Specifically regarding the Chilean case, we can mention the existence of isolated populations in the desert, mountainous regions and areas with consistent bad weather, which complicates the extension of transmission lines. The role of the Chilean State to ensure the interest of the private sector in these investments is of central importance, being one fundamental question to be analyzed in this text.

Furthermore, in order to achieve the purpose of this article (i.e., to expand energy access to Chile's rural population) one must necessarily take into account some key factors, such as the geographical distribution of the population throughout the country, which is largely concentrated in the metropolitan area of Santiago[4]. This geographic distribution is certainly one of the limiting factors to providing power for the entire Chilean population.

Moreover, Chile was, for several decades, one of the major importers of energy in South America, and most of this energy came from Southern Cone countries. This fact made Chile one of the most dependent countries in terms of South American energy resources and the efficiency of the regional coordination for the exploitation of those reserves. In the late 1990s, and especially mid-2000s, Chile faced a crisis in the natural gas supply imported from Argentina. This event increased domestic energy costs and reduced security of supply of natural gas needed for thermal power plants in the country. The 2000s crisis led the country to seek to optimize the exploitation of its own domestic energy resources, including alternative energy sources, which seems to have positively influenced the process towards access to clean energy by the Chilean rural populations.

This change of direction in Chile's energy policy aims to achieve a better use of Chilean conventional energy, as well as the use of conventional and

[3] BARNES, Douglas F. **Meeting the Challenge of Rural Electrification in Developing Nations: The Experience of Successful Programs**. 2005, p.1. Available at: <http://siteresources.worldbank.org/EXTRENENERGYTK/Resources/51382461237906527727/5950705-1239305592740/Meeting0the0Ch10Discussion0Version0.pdf> Access: 25 June 2016.

[4] BARNES, Douglas F. *Op. cit*.. p. 218.

non-conventional renewable energy sources. Thus, Chile opens itself to the possibility of making the national energy matrix more sustainable and clean, providing at the same time, greater energy security to the country and greater access to clean energy to rural populations.

It is clear, therefore, that the search for greater energy self-sufficiency could benefit rural populations, because innovative methods of generating electricity can be explored. Based on this integrated analysis of the Chilean energy sector, this descriptive and purposeful research on access to clean energy in rural areas of the country was held.

In the next section of the article is an overview of the energy scenario in Chile, pointing out the main issues relevant to analyzing the evolution of access to clean energy by the Chilean rural populations. In the subsequent section, the programs regarding the universal access to energy and the possibilities of exploiting clean and renewable sources in the country are discussed in more detail. Finally, in the last section of the article, a proposal for a public policy is presented to the Chilean government, seeking greater access to clean and renewable energy for inhabitants in rural areas.

1. The evolution of the Chilean energy sector

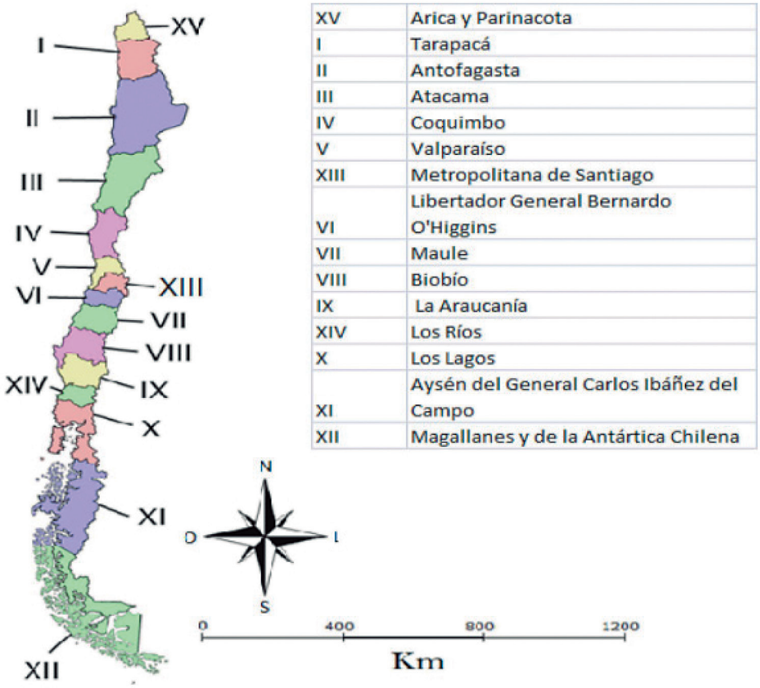
Nowadays, Chile faces a period of prosperity in which it aims to accelerate its economic growth. In this sense, the toughening of its energy matrix has proved crucial. This argument supports the idea advocated by the Chilean Ministry of Energy that as the country grows the need for energy grows as well; there is a natural link between development and energy supply[5]. In other words, Chile should seek to provide sufficient energy sources to support their economic development projects. The history of Chilean energy policy shows that the strategic vision of the energy issue has permeated the country's public policy for decades.

It is known that the Republic of Chile, located in South America, has an extensive Pacific coast line and a long border along the Andes Mountains, specifically with Argentina, Bolivia and Peru. For the understanding of power distribution in the country, it is important to expose the way its territory is

[5] CHILE, Ministério de Energia. *Op. Cit.*, 2012, p. 6.

divided. Thus, the Chilean territory is divided into fifteen regions, as shown in the map below:

Chart nº1: Regional Chilean map.[6]



XV	Arica y Parinacota
I	Tarapacá
II	Antofagasta
III	Atacama
IV	Coquimbo
V	Valparaíso
XIII	Metropolitana de Santiago
VI	Libertador General Bernardo O'Higgins
VII	Maule
VIII	Biobío
IX	La Araucanía
XIV	Los Ríos
X	Los Lagos
XI	Aysén del General Carlos Ibáñez del Campo
XII	Magallanes y de la Antártica Chilena

The current political-administrative design of the Chilean territory was developed during the twentieth century. The main objective of these divisions was to encourage the decentralization of the decision-making processes, which substantially influenced the electric and energy planning in the country. The last division, which is the one currently in force, segregates the State into twelve zones, plus the metropolitan area. The zones (as seen in the previous map) are: Tarapaca (I); Antofagasta (II); Atacama (III); Coquimbo (IV); Valparaíso (V); Libertador General Bernardo O'Higgins (VI); Maulé (VII); Bio-bio (VIII); Araucania (IX); Los Lagos (X); Aysén del General Carlos Ibañez del Campo

[6] CARDOZO, Daniela Peres; OLIVEIRA, Gilson Batista de. Evolução setorial do emprego nas regiões chilenas no período de 2007-2009. **Interações**, Campo Grande, v. 17, n. 1, 2016, p. 4. Available at: <http://www.scielo.br/pdf/inter/v17n1/1518-7012-inter-17-01-0022.pdf>. Access: 27 June 2016.

(XI); Magallanes e La Antártica Chilena; (XII) Metropolitana de Santiago[7]. In 2007, laws nº 20.174 and nº 21.175 created two more regions: the Región de Los Ríos y La Província de Ranco (XIV) and the Región de Arica y Parinacota y La província de Tamarugal in the region of Tarapacá[8]. This division has been used as the basis for the formation of the national electrical systems in Chile.

Each region has its own peculiarities, especially regarding geo-climatic aspects. These characteristics are very important for the articulation of electrification projects, in particular when seeking to implement the use of renewable sources, which are widely dependent on geographic and climatic aspects. Therefore, the study proposed here requires a rigorous analysis of this issue. The geo-climatic diversity of Chile indicates excellent potential for the use of sustainable energy across the country. Solar light is abundant in the North; the South has plentiful water and biomass resources; and the wind in the coastal and southern areas is suitable for energy production[9].

According to Virginia Fraille (2008), the geographical factors of the Chilean regions can be associated with the particular energy production potential of each of them. Regions I and IV show the highest levels of solar radiation in the country, which creates favorable conditions for the installation of solar parks. In this area, there's also a high potential for geothermal volcanic activity at the foot of the Andes. Moreover, it is still possible to exploit wind generated energy. In the regions V and VI there are agricultural activities, which can be a source of power generation from biomass. In these regions, there is also capacity for the generation of wind power and small hydroelectric power stations. Among the regions VII and XI, there is potential for hydroelectric projects of all sizes. It is also possible to generate wind power, geothermal, tidal (in the Chacao Channel) and biomass from intensive agricultural and industrial activity that can be found in that part of Chile's territory. Finally, region XII presents favorable wind and water activity[10].

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7 CHILE, Congresso Nacional do. Decreto Lei 2339/78. Available at: <http://www.leychile.cl/Navegar?idNorma=6889>. Access: 03 July 2016.

8 *Ibidem.*

9 CHILE. Ministerio de Energia; Global Environment Facility (GEF); Programa de Naciones Unidads para el Dessarrollo (PNUD). **Remocion de Barreras para la Eletrificación Rural con Energias Renovables.** Chile, 2011, p. 6.

10 FRAILE, Virginia Santa María. **Estudio de mercado energías renovables en chile.** Madrid, 2008, p. 33-34 Available at: <http://www.exportmadrid.com/documents/10157/60758/ESTUDIO+ENERGIAS+RENOVABLES+CHILE+08.pdf> Access: 27 June 2016.

However, although there is a high potential for the use of clean and renewable sources in Chile, the energy exploitation currently in place is based mainly on non-renewable resources. To comprehend this process, it is necessary to understand how the Chilean electricity market works. Regarding the country´s energy supply, the distribution companies operate under public service concession arrangements, with service obligations and regulated supply tariffs to established customers. These companies operate in a concession area, without any possibility of competition, since they are legal monopolies. The areas of operation are divided into four systems, which were established following the regional division presented above[11].

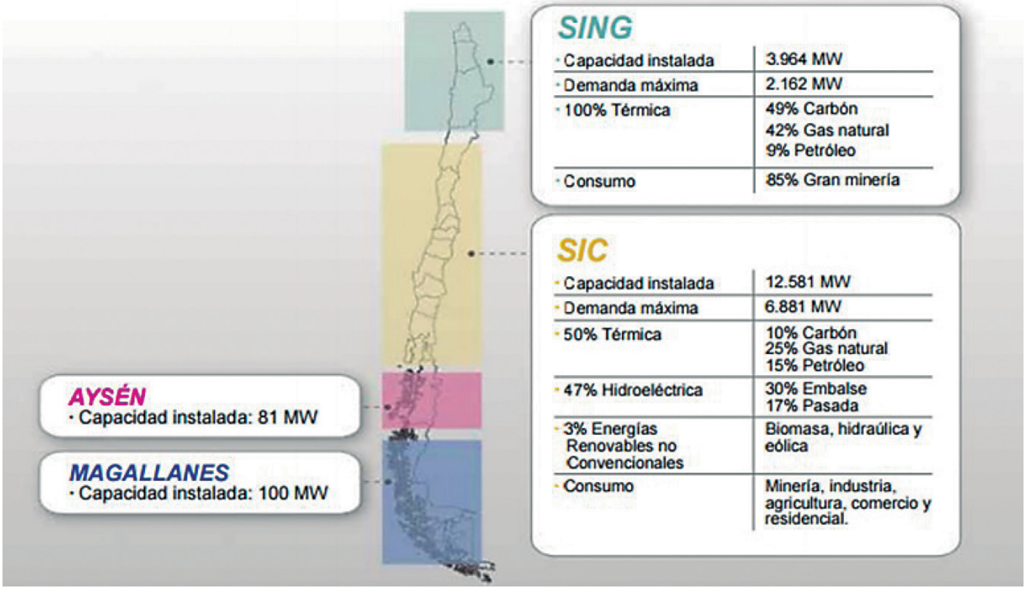
In the north, there is the *Sistema Interconectado del Norte Grande* (SING), which mainly supplies the mining industry. The SING is constituted of a set of generating stations and interconnected transmission lines that provide electrical power to the regions I and II. The generating capacity is predominantly thermoelectric, consisting of thermal power plants using coal, diesel and a natural gas combined cycle. There are hydropower plants in the Chapiquiña and Cavancha centrals, representing only 0.37% of installed capacity.[12]

The Chilean central areas rely on the *Sistema Interconectado Central* (SIC), the country's main electrical system. The SIC is responsible for 72.5% of installed capacity in Chile and it extends from the city of Taltal, in the North, to the Big Island of Chile, in the South. Its generating capacity consists of hydropower plants (60.13%) and thermal power plants using coal, diesel and a natural gas combined cycle (39.87%).[13]

The Aysén System supplies the region XI. It is consisted of thermoelectric plants (63.86%), hydroelectric units (27.68%) and wind energy (8.46%). Finally, the Magellan System comprises three electrical subsystems: the systems of Puenta Arenas, Puerto Natales and Puerto Porvenir, in the region XII, each being 100% thermal[14]. The domestic distribution of the energy supply in Chile can be seen in the chart below:

11 FRAILE, Virginia SantaMaría. *Op. cit*., p. 33-34.
12 FRAILE, Virginia SantaMaría. *Op. cit*., p. 33-34.
13 FRAILE, Virginia SantaMaría. *Op. cit*., p. 33-34.
14 FRAILE, Virginia SantaMaría. *Op. cit*., p. 33-34.

Chart nº 2: SING, SIC, Aysén and Magallanes systems. [15]



These systems have been able to supply the current Chilean demand for power, but, as already mentioned, there is an insufficient participation of renewable energy sources in the national energy matrix. In South America, particularly in Chile, the main source of power generation comes from fossil fuels - oil, natural gas and coal, which supply thermoelectric plants. Although the use of renewable energy sources is not very significant in Chile, investment in these particular sources, as observed in recent decades, demonstrates their potential and the fact that they can be effectively applied in order to replace polluting sources and to ensure greater efficiency in the Chilean energy matrix. The use of this kind of source has been used especially to bring energy to rural areas.

The search for better energy supply to rural areas has always been a central concern of the Chilean government, which considers the access to electricity by rural populations critical. As will be noted in this article, the benefits of guaranteeing access to energy in rural areas, mainly electricity, are extensive.

[15] CHILE, Ministerio de Energia. **Hoja De Ruta 2050:** Hacia Una Energía Sustentable E Inclusiva Para Chile. Santiago de Chile, September 2015. Available at: <http://www.energia2050.cl/uploads/libros/hojaderuta.pdf>. Access: 24 May 2016.

Basically, this importance can be divided into economic and social gains. The economic gains are clear, since the productivity of rural areas with access to energy would increase. Among the social gains, the access to electricity allows, for example, children to read easier and for longer periods. Similarly, individuals can listen to the radio, watch television, read and perform tasks that require adequate lighting, which is not provided by kerosene lamps or candles[16].

The history of rural electrification in Chile dates back to the 1930s, when the *Cooperativas Rurais Elétricas* (English: REC's - Rural Electric Cooperatives) was created in order to improve the agricultural development of fertile land surrounding the capital of the regions. Public energy companies - ENDESA and CHILECTRA - and the RECs shared the burden of ensuring the supply and distribution of energy. While the former supplied the capital of regional districts, the latter attended the countryside, which is less populated, but in need for energy[17]. This framework was effective in bringing development and access to electricity to remote areas of large population centers. However, a large part of Chile's rural areas remain without access to energy.

In order to ensure energy reach to all inhabitants of rural areas and expand the RECs program, the Rural Electrification Program (REP) was created in the 1990s and operates until today. This program is basically a subsidary policy to the energy sector by the Chilean government. Moreover, the REP has the vital task of promoting investments in each region, taking into account the remaining demand in light of the concessions previously described. It is emphasized that this grant is not absolute, as the individual user must contribute monetarily to the initial cost of the project, such as the provision of residential service and installation of inside wiring. Depending on the economic capacity of the user, it is possible that this cost will be financed by the company or by the REP with the amount to be recovered over time through energy bills[18].

Thus, the REP in Chile was and is of vital importance to developing the economy and improving the welfare of its population through decreasing the disparity in energy access between urban and rural populations. With

[16] BARNES, Douglas F. *Op. cit.*. p. 2.

[17] *Ibidem.*, p. 217.

[18] *Ibidem.*, p. 231.

this program, the Chilean rural population gained higher quality of life and means to bringing economic development to remote regions of the country were created. Furthermore, this project showed the potential of clean and renewable sources in expanding access to energy in the country.

It was found that the Chilean government had an important role in strengthening the national energy matrix and providing electricity to its rural populations. Although the Chilean energy sector had undergone an extensive process of privatization during the 1980s, incisive State action has been observed. The process of expanding energy access to the inhabitants of rural areas, as presented above, began mainly with the REP, created in the 1990s, when less than 50% of Chile's rural population had access to electricity[19]. This meant almost one million people were living in rural areas without access to electricity, while 97% of Chile's urban population had electricity in their homes[20].

Based on the data of this section, it is clear that Chile is a country largely dependent on non-renewable energy sources and their importation. In recent years the Chilean government has invested heavily in projects aimed at increasing use of clean and renewable sources. As noted, this process is related to the energy supply in rural areas, aiming to reduce the disparity between urban and rural populations in Chile, which was huge during the twentieth century, requiring positive actions of the Chilean government to ensure a more equitable and universal access. In the next section, this process will be analyzed in depth.

2. The rural electrification in Chile: features, challenges and projects promoting access to sustainable energy

Rural populations of many countries, especially those in development, tend to be deprived of many fundamental rights, including, access to energy.

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[19] WORLD BANK. **Rural Electricity Subsidies and the Private Sector in Chile**. 2005. Available at: <https://energypedia.info/wiki/File:Chile_Rural_Electricity_Subsidies_and_the_Private_Sector.pdf>. Access: 13 June 2016.

[20] JADRESIC, Alejandro. A case study on subsidizing rural electrification in Chile. In: **The World Bank Group ▪ Private Sector and Infrastructure Network, Note nº 214, 2000.** Available at: < http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Jadresic_Promoting_Private_Investment.pdf>. Access: 13 June 2016, p. 1.

It is seen as essential to the improvement of the living conditions of these people in order to achieve the development of production models, generate new revenue and jobs and provide quality of life in a sustainable way[21]. Accordingly, social, economic and educational benefits have motivated the implementation of rural electrification programs, which, when well planned and carefully articulated, provide these and other benefits to the citizens.

The electrification of rural areas in developing countries is an aspect of special interest of States and the local population. Generally, this process has developed in three different ways: the extension of electricity grids, the construction of individual renewable energy generation systems and the installation of microgrids. Moreover, there are alternatives for isolated generation, such as microhydro and photovoltaic plants[22].

Regarding energy access in rural areas, Chile has developed, as previously presented, the "*Programa Nacional de Eletrificación Rural*" (REP), which aims to bring electricity to rural communities with scarce resources and promotes the use of renewable sources in self-generation systems. There is also the project "*Remoción Barreras para la Rural Eletrificación con Energías Renovables*", a joint effort between the Government of Chile and the United Nations Development Programme (UNDP), whose main goals are to promote the use of non-conventional renewable energy sources and to improve living conditions in the poorest regions of the country. Some projects consist in installing photovoltaic panels in different communities in the Region IV (Coquimbo Region) and micro hydroelectric plants in the localities of Pallaco and San Pedro de Atacama (Region III). It is noteworthy that the use of solar and wind energy to electrify rural areas has been particularly common in the northern region of the country due to the availability of natural resources and the possibility of developing projects with private funding, mainly from mining companies[23].

In the structuring of the rural electrification model, there is the participation of actors from the public sector (central and regional) and private

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[21] FUENTE, Manuel; ALVAREZ, Marcelo. Modelos de electrificación rural dispersa mediante energías renovables en America Latina: un planteo alternativo basado en el desarrollo rural. **Cuaderno Urbano:** Argentina, 2004, n. 4, p. 206

[22] CODOCEO, Javiera Patricia Inostroza. **Propuesta metodológica para la evaluación socioeconómica y ambiental de proyectos de micro-redes con fuentes de energía renovable en comunidades rurales del Norte de Chile.** Santiago, Chile, Universidad de Chile, Facultad de Ciencias Agronómicas, 2012, p. 14. Available at: <http://repositorio.uchile.cl/handle/2250/112209> Access: 27 June 2016.

[23] CODOCEO, Javiera Patricia Inostroza. *Op. cit.*, p. 15.

sector (electricity distribution companies). It is noted that each energy project has its own very different characteristics and requirements, and it will also require specification of the performance of each of these entities.

The management frameworks, which have been applied in rural electrification projects with non-conventional renewable energy sources, include: (a) a private management scheme, such as the photovoltaic plant in the Coquimbo Region. Such a model, besides having been successfully implemented in the Coquimbo Region, has also been proposed to provide electricity to seven islands of the Deserters and Hualaihué group, in the region of Los Lagos, through hybrid systems. The implementation agreement was signed in August 2011; (b) a user management scheme through Electric Cooperatives, which has been used in the hybrid projects of Quenu and Tabon and the hydroelectric project of Llanada Grande, in the region of Los Lagos; and (c) a joint management scheme between users and municipalities, which has been implemented in several photovoltaic projects of small scale and in a wind/diesel project, in which the only viable option was management by municipalities[24].

It is necessary to mention that although the levels of rural electrification in Chile are at 96%, which is a remarkable success in the implementation of electricity access policies, the task is not finished.[25] Despite the different geographical and climatic features that allow the deployment of renewable energy, implementation of sustainable energy projects, consistent with the context of each Chilean region, is one of the remaining challenges. In view of this, it is relevant to highlight some bottlenecks found in electrical power distribution system for the Chilean rural population.

It is known that Chile is a country of large territorial extension and this feature hinders the implementation of good power infrastructure for rural areas. Therefore, this aspect is one of the barriers to the full achievement of rural electrification projects[26] and also strengthens disparities in the country. For example, in 2010, while the regions of Magallanes and Chilean Antarctica had a energy access level below 90%, rural electrification at the national level

[24] CHILE. Ministerio de Energia; GEF; PNUD. *Op. cit.*, p.15-16.

[25] CHILE. Ministerio de Energia; GEF; PNUD. *Op. cit.*, p. 17.

[26] BARNES, Douglas F. *Op. Cit.*, 2005 p. 219.

reached 96.1%. Therefore, it is clear that the country has good rates of access to rural energy on average, but there are still challenges such as equal access to energy for people of all regions[27].

There are also other barriers that prevent the use of the full potential for renewable energy exploitation in the Chilean countryside. Some of these consist of a combination of elements and disincentives that act jointly in the technical-institutional system. In general, these obstacles are related to the creation of markets and investments in renewable energy, in a socioeconomic context governed by the requirements of the electrical system and its centralized operation. Essentially, these are opposed to the idea of renewable energy sources, which values the decentralized accessibility to energy, individual and autonomous generation systems and decentralized energy production and distribution. Regarding access to energy to the poorest rural communities, the costs and risks of investments increase. Moreover, the method of operation of renewable energy projects differs from traditional energy technologies, requiring changes in the institutional, social, economic and technological system so it can be successfully implemented[28].

Another challenge is related to the mixed management scheme between users and municipalities. This management framework ensures only minimum elements to guarantee the technical, operational and financial continuity of the projects. Municipalities are the final tie in the chain of relevance regarding the decision-making process for the permanent support for the operation of the electricity systems and the first one concerning the relationship with users. However, although city officials have the necessary institutional duties to undertake the implementation of energy access policies in rural areas, they do not have the skills and expertise necessary to provide the operation of these policies. The financial resources available in municipalities for these purposes are also limited. Therefore, it is clear that this is a management system with risks and weaknesses, whose institutional framework is a pending issue for regional and central authorities[29].

In 2001, the capacity of renewable energy was extremely limited in different aspects and levels in Chile. There were only a few small-scale trials

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27 CHILE. Energia 2050. *Op. Cit*., p.58.

28 CHILE. Ministerio de Energia; GEF; PNUD. *Op. cit*., p.11 .

29 CHILE. Ministerio de Energia; GEF; PNUD. Op. *cit*., p.16.

with renewable energy, and the experience was insufficient to address a wider scope and coverage programs[30]. It is important to note that in the early years of implementation of energy distribution programs in rural areas, projects which used solar panels and small wind power generators malfunctioned, leading to loss of consumer confidence. For example, in region IX, a wind project experienced a premature battery failure, requiring numerous in loco visits of technical workers in order to diagnose and repair the problem, which led to huge dependence on the backup generator, given the high performance costs. In this example, the technical and managerial deficiencies aggravated the problems, which led to a reduction in quality of service, increased costs and caused distrust in new users[31].

Moreover, the 2010 Report of the International Energy Agency (IEA) highlighted the need to eliminate subsidies for fossil fuels, focusing efforts on non-conventional renewable energy sources in Chile. This kind of grant should be understood as an aid to the development of clean technologies and not as generic subsidies for any type of self-generation system. This should be done to avoid causing disincentive to non-conventional renewable energy and the application of credits in polluting systems, such as power generation by diesel[32].

In summary, the main problems faced by Chile in the development of non-conventional renewable energy are: (i) the non-incorporation of the environmental variable in benchmarking with conventional sources; (ii) the high cost of conversion: comparative analysis of conventional and non-conventional options that often considers the current price of conventional sources, without taking into account market trends; (iii) the lack of knowledge by the population regarding the renewable resources; (iv) the fragile institutional framework; (v) the lack of technical, financial and human resources[33].

After exposing the main challenges and obstacles faced by the Chilean energy sector, it is essential to make a brief retrospective of the rural electrification programs implemented in the country and their consequences

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30 CHILE. Ministerio de Energia; GEF; PNUD. Op. *cit*., p.16.

31 BARNES, Douglas F. *Op. cit*.. p. 249-250.

32 CHILE. Ministerio de Energia; GEF; PNUD. *Op. cit*., p. 15.

33 GANDOLFO, Franco Aceituno. Las Energías Renovables en la Electricidad Rural en Chile. In: **Encontro de energia no meio rural**, Campinas, ano. 6, 2006. Available at: < http://www.proceedings.scielo.br/scielo.php?script=sci_arttext&pid=MSC0000000022006000200006&lng=en&nrm=abn> Access: 27 June 2016.

for the population. Thus, it is possible to see how Chile has been articulating itself in order to overcome the imposed barriers to full access to energy in rural communities.

In mid-1990s, two out of five people living in the rural area of Chile did not have access to electricity. In view of this, there was a political and social consensus that the country faced a challenge to overcome poverty and to strengthen democracy. The planning of a social policy in the 1990s involved significant changes, reflecting previous decades. Hence, the definition of a rural electrification policy was guided by the government's strategy towards overcoming poverty, improving the quality of life in rural areas and the integration of the rural population into the economic and social development process of the country[34].

Accordingly, in 1994 the Rural Electrification Program (REP) was created, initially coordinated by the National Energy Commission (CNE). In 2003, after a loan agreement with the Inter-American Development Bank (IDB), the REP began to be executed by the Regional Development Secretariat (SUBDERE) through the National Control Unit (UCN) and its Regional Control Units (UCR)[35].

Although there was a marginal role for renewable energy in the Chilean energy gross consumption, in rural areas these sources had a significant role. This fact is evidenced by government policies to support rural electrification, such as *Remoción Program Barreras para la Rural Eletrificación con Energías Renovables*, previously mentioned in this paper. This project originally would have the duration of five years. However, there were successive extensions, the last one in 2009, which extended its duration to June 2011.

Hence, between 1994 and 2012, the REP of the Government of Chile has increased the electricity coverage in the country from 52% to 96%, and enabled the introduction of non-conventional renewable energy in providing isolated locations and remote homes. The table below (Chart nº 3) demonstrates the progress in rural electrification between 1995 and 2009[36].

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[34] CHILE. Ministerio de Energia; GEF; PNUD. Op. *cit*.,, p. 19.

[35] CHILE. Ministerio de Energia; GEF; PNUD. Op. *cit*., p.19.

[36] PROGRAMA das Nações Unidas para o Desenvolvimento (PNUD). **Diagnóstico sobre necesidades locales para desarrollar proyectos con Energías Renovables No Convencionales.** 2016. Available at: <http://www.cl.undp.org/content/chile/es/home/presscenter/articles/2016/01 May diagn-stico-sobre-necesidades-locales-para-desarrollar-proyectos-con-energ-as-renovables-no-convencionales.html> Access: 27 June 2016.

Chart nº 3: Evolution of rural electrification by region, under the PER[37].

Current and Planned NCRE Projects under the PER

Period covered	Households served	Region(s)	Technology
1995-2000	100	Araucania	Micro-hydro plant
	61	Maule	Individual photovoltaic systems
	36	Los Lagos	Biomass gasification system for lighting and other energy services
	70	Magallanes	Micro-hydro plant
2001-2009	171	Bío Bío	Natural gas
	3 300	Chloe Province, Los Lagos	Diesel-fired generation and submarine cables
	1 000	Antofagasta	First electricity co-operative administered by indigenous people
	110	Antofagasta	Micro-hydro plant
	89	Los Lagos	Hybrid wind-diesel system
	15	Bío Bío	Micro-hydro plant
	3 064	Coquimbo	Photovoltaic systems
	150	Valparaíso	Improvements in electricity distribution and generation
	42	Arica, Parinacota	Photovoltaic systems
	62	Atacama	PV-electricity generation
	35	Atacama	PV-electricity generation
	75	Valparaíso	PV-electricity generation
	42	Maule	PV-electricity generation
	154	Aysen	Micro-hydro plant
Projects under development (CNE, CNE-GEF study)	3 720	Arica and Parinacota, Antofagasta, Atacama, Coquimbo, Maule, Aysen	Photovoltaics

37 Table available at: International Energy Agency (IEA). **Chile Energy Police Review 2009**. p.204 Available at: <https://www.iea.org/publications/freepublications/publication/chile2009.pdf> Access: 21 May 2016.

It is worth noting that the project "*Remoción Barreras para la rural electrification con Energías Renovables*" revealed some indications as to the persistence of various lacunae and deficiencies at the regional and municipal level that set back the full implementation of renewable energy projects. Thus, the Chilean government has enacted, in partnership with the United Nations Development Programme (UNDP), the project "*Fortalecimiento de Capacidades Locales para el Desarrollo de Proyectos con Energías Renovables No Convencionales (ERNC) de pequeña escala*", in September 2014[38].

The development of this program will be made from a pilot model developed in two regions: Rivers and Antofagasta, lasting 24 months and with a funding of about 640 million pesos, provided by the Ministry of Energy and the UNDP. The different climatic and geographical characteristics of the two pilot regions will draw substantial conclusions to the Chilean national context, on what the priorities and needs of the training programs will rely. Based on this, the third phase of the project will develop a national action plan that takes into account the lessons and teachings drawn from regional plans, in order to expand these results to other regions of Chile. The project aim is to strengthen local capacities, assisting regional and local governments to formulate, manage and maintain projects with non-conventional renewable energy sources of a reduced scale. Such aid to municipalities will be essential to overcome one of the challenges presented above. This project is going to end in May 2017[39].

Moreover, in the actions within the 2016 Energy Agenda, the Chilean government promised investments of about 2,675 million pesos in the power supply program in rural areas. Furthermore, clean energy is also priority in the project, since, this year, the government will allocate 6,136 million pesos for the development of non-conventional renewable energy programs[40].

Therefore, the path to promote access to renewable energy in the Chilean countryside is challenging, especially because there are many setbacks and obstacles to overcome. However, the government of Chile has promoted

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[38] CHILE. Ministerio de Relaciones Exteriores. **Acuerdo con el Programa de las Naciones Unidas Para El Desarrollo sobre el proyecto: "Programa de Fortalecimento de las capacidades locales" para ele desarrollo de proyectos con Energías Renovables no Convencionales (ERNC) de pequeña escala**. Santigo, 2014. Available at: <http://www.minenergia.cl/archivos_bajar/2015/D_241_PNUD.pdf> Access: 27 June 2016.

[39] United Nations Development Programme (UNDP). *Op. cit.*

[40] CHILE. **Projecto Ley de Presupuestos 2016**. Available at: <http://www.gob.cl/wp-content/uploads/2015/09/Informativo_LeyPresupuesto2016.pdf> Access: 27 June 2016.

programs that reduce these barriers, providing better living conditions for the rural population through access to sustainable energy.

3. A proposal to Chile: improvements in access to clean energy for rural populations

As previously mentioned, the construction of a robust energy access program in Chile has a long history and broad involvement of the Chilean Government. Subsidy mechanisms have existed since the 1930s and they paved the way for rural electrification, enabling the implementation of projects specifically developed for rural populations[41]. However, there is still ample room for expansion of this project.

Back in 1990s, the search for greater equality of access to electricity among Chilean urban and rural populations was justified by the economic and social benefits that such measure would create to the country. That was the prevailing understanding of the technical Rural Electrification Program (REP), which considered access to electricity by rural people an investment that would seek the public good and could ensure wide range of benefits to the Chilean population as a whole.

The programs implemented during the 1990s generally achieved their goals. The Chilean energy policy has proven to be efficient, since over 99% of the current population (July 2016) has access to electricity. This percentage means that Chile is one of the countries with the highest coverage throughout Latin America. This data, however, must be contrasted with access to energy in some isolated parts of the country, such as the region of Magallanes and Chilean Antarctica, in which, as already explained, access to electricity reaches less than 90% of the population. It should be also noted that the energy supply to the rural population increased from less than 50% in the 1990s to 96.1 in 2010[42].

Although access to energy has progressed significantly, the Chilean government recognizes that there is still room for expansion. The goal is to advance access to energy substantially in the country by 2050. Under

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41 BARNES, Douglas F. *Op. cit*., p. 225.

42 CHILE, Op. *cit*., p. p. 56.

this goal, only an hour per year of power interruption in any region of the country is allowed. In addition, 100% of the houses in the Chilean territory must have continuous access to adequate energy services[43].

The country's leaders are aware that achieving the small portion of the population that remains without access to electricity will require continued investment, particularly through project financing. Nonetheless, it is argued that the energy policy that Chile has been implementing must undergo a reform on the way these investments are applied. These changes could contribute substantially to the goal of bringing electricity to 100% of the Chilean population, and generate larger volumes of clean energy, which could benefit the country as a whole.

The focus of the Chilean energy policy-makers must orbit around three main issues: 1 - Continuation of subsidy policies and increasing in investment in non-conventional renewable energy (NCRE); 2 - icro projects of energy generation; and 3 - Logistic partnerships with regional and local governments. In this section, these three points will be evaluated in detail, aiming to demonstrate how they can influence the outcome of achieving greater access to clean energy by the Chilean rural populations.

3.1 Subsidy policies and investment in Non-Conventional Renewable Energy (NCRE)

The continuation of the subsidy policies and larger investments in renewable energy are justified after analyzing Chilean history, which has very few incentives to bringing energy to rural populations, even after the transmission lines are already built. This is because energy consumption in rural areas is usually very low, a fact that makes these areas not economically attractive to private power companies[44]. This is one of the important arguments that support the subsidy policies conducted by the Government of Chile.

This kind of initiative (with the objective to financially support projects) is understood by the Government of Chile as effective in bringing energy to areas with little or no access to energy. According to the analysis of the history of energy supply to the Chilean population, it can be seen that this

[43] CHILE. Op. *cit*., p. 59.

[44] BARNES, Douglas F. *Op. cit*.. p. 8.

understanding is based on the success of the subsidy policy implemented in the country, which in the course of less than two decades, managed to increase significantly the number of homes in rural areas provided with electricity. These results would not have been possible without the active participation of the Chilean Government, subsidizing the supply of energy to rural populations. Therefore, the unequivocal conclusion reached here is that the subsidy policy has been and remains essential to the expansion of the REP.

Another relevant point is the promotion of access to NCREs for the Chilean rural populations. This understanding is justified based on the observation that there is a clear connection between the electrification of rural areas and a growth in the production of energy from renewable sources, mainly the NCREs. These sources include: energy production through Small Hydropower Plants, biomass (Biogas[45]), wind (wind energy[46]), geothermal and solar.

Besides the interest in increasing access of rural populations to electricity through NCREs and ensure environmental sustainability of the Chilean energy matrix, the Chilean Government also seeks to achieve energy self-sufficiency, especially since the mid-2000s, when the Chilean energy supply was compromised by the energy crisis in Argentina.

Moreover, the incentive to generate greater access to energy in the country, as well as promoting the use of NCREs are consistent with the objectives outlined by the Chilean National Energy Strategy to establish a cleaner and more robust national energy matrix. The sustainability of the energy matrix of a State is closely connected to the role of the government. According to Arriagada (2016):

> [...] to encourage the future use of other energy sources, the only way that has been successful in international experience is the government incentives through tax breaks for individuals and businesses. The so-called "green incentives" allow the implementation of proposals that are not financially attractive, but are attractive from a social approach or directly environmental (free translation).

45 About the use of biogas in Chile, see: CHAMY, Rolando; VIVANCO, Elba; PUCV. **Escuela de Ingeniería Bioquímica. Potencial de Biogás: Identificación y clasificación de los distintos tipos de biomasa disponibles en Chile para la generación de biogás**. Santiago of Chile, 2007.

46 About the wind potential in Chile, see: COMISIÓN NACIONAL DE ENERGÍA; **Proyectos Eólicos, guía para evaluación ambiental: energías renovables no convencionales**. Santiago of Chile, 2006.

In Chile, especially since 2004, with the Argentine crisis, the central government has invested heavily in research and projects involving NCREs. At this point, it is evident that the main objective of the energy policy of leadership of the country is to become less dependent on natural gas imported from South American countries through greater participation of NCREs and conventional energy sources in its energy matrix. However, the share of NCREs in the domestic energy supply is still a low percentage. How previously addressed, only 3% of the Chilean energy matrix is composed of NCREs; 34% is hydroelectricity and 63% is still generated by power plants fueled mainly with imported natural gas[47].

This goal of increasing energy production based on NCREs is present in a number of government initiatives in Chile, such as the Resolution no. 2576 and the Law no. 20,257. The Resolution No. 2576 was adopted in 2009 and aimed to introduce regulations dealing with the allocation of funds to projects focused on NCREs[48]. Based on this resolution, Chile sought to increase its production from NCREs. The evidence that these initiatives are becoming concrete projects is in the large number of works in progress and in the planning stage:

> The National Assets Minister, Victor Osorio, said the State Department approved, at the end of December 2015, a total of 207 concessions to use tax properties for projects of non-conventional renewable energy (NCRE).These are projects in the regions of Arica e Parinacota, Tarapaca, Antofagasta, Atacama and Maule, which are fundamental to the sustainable development of the country, corresponding to a total of 50,528 hectares of property tax. As a whole, they will reach the estimated generation of 8.45 Megawatts (MW) per year (free translation).[49]

These projects are based on the partnership held between the Ministry of National Assets[50] and the Ministry of Energy, since allocating sets of

[47] CHILE, Ministério de Energia. **Estrategia Nacional de Energía 2012-2030**. Santiago of Chile, 2012. Available at: <http://static.pulso.cl/20120228/1482744.pdf>. Access: 10 May 2016, p. 12.

[48] CHILE, Diario oficial de la República de Chile. **Resolución que ejecuta acuerdo de consejo nº2.576, y aprueba reglamento del comité de asignación de fondos a energías renovables no convencionales**, 2009a. Available at: < https://www.leychile.cl/Navegar?idNorma=1008539>. Access: 16 June 2016, p. 11.

[49] REVE, Revista Eólica y del Vehículo Eléctrico. **Chile aprueba 207 concesiones para la producción de energías renovables**. Available at: <http://www.evwind.com/2016/01 August chile-aprueba-207-concesiones-para-la-produccion-de-energias-renovables/>. Access: 15 June 2016.

[50] The mission of the National Assets Ministry is to recognize, administer and manage the tax heritage of all Chileans, to regularize the small private property, to keep the graphic record of the updated tax property, enhancing the natural and historical heritage of Chile. For more information, see: http://www.bienesnacionales.cl/?page_id=1567

photovoltaic panels and wind power generation fields requires large territorial extensions. According to the Reve Magazine, these projects should be primarily performed in the North of the country, where the National Assets Ministry has large territorial extensions that can be used for energy production[51]. Moreover, as already shown, this region has the environmental and solar conditions suitable for carrying out such projects[52].

By its turn, Law 20,257, of 2007, sought to promote energy production from NCREs. According to the Chilean Energy National Strategy, that law establishes that in 2024 10% of the Chilean energy matrix will be composed by NCREs. Although this law can be considered a major step forward towards building a clean and renewable energy matrix in Chile, it is seen by some as too conservative. This portion of the population considers the goal set by the Law 20,257 (expanding to 10% the utilization of NCREs) insufficient. As a result, in the Chilean Congress, there is a draft of a new law raising that goal to 20% already in 2020, and 30% in 2030[53]. These internal discussions in the Chilean Congress demonstrate that country's interest in expanding its energy supply, as well as making it clean and sustainable.

Therefore, it should be noted that the goal of the Chilean Government to encourage greater production of energy through NCREs is not justified only by an environmental perspective, but also by strategic reasons and energy security. Moreover, another reason is the great benefit that the increased use of NCREs could mean for rural populations. Even though currently Chile has enough energy to meet its domestic market, it is noticeable that in the near future energy supply should be expanded to cope with the economic development of the country:

> Analyzing the gross generation in 2011, production in the SIC was 46.095 GWh, an increase of 6.8% compared to 2010. Similarly, the gross production in 2011, in the SING reached 15,878 GWh, 5.2% higher than the previous year. By 2020, it is projected to increase in the country's electricity consumption rates by about 6% to

51 REVE, Revista Eólica y del Vehículo Eléctrico. Op. cit.

52 CHILE, Comisión Nacional de Energía (CNE). **Modelación del recurso solar y eólico en el Norte de Chile**. Santiago de Chile, 2009b. Available at: <http://ernc.dgf.uchile.cl/Explorador/E3S/Doc/RecursoSolarEolico.pdf>. Access: 22 May 2016.

53 DUFEY, Annie; PALMA, Rodrigo; BARRENECHEA, Gerardo; MATUS, Marcelo; MUÑOZ, Cristóbal; SOLÍS, Rodrigo; CERDA, Sebastián; TORRES, Rigoberto. **Escenarios Energéticos Chile 2030: visiones y temas clave para la matriz eléctrica**. Santiago de Chile, 2013. Available at: <http://www.fch.cl/wp-content/uploads/2013 August Escenarios_Energeticos_2013.pdf>. Access: 19 May 2016, p. 69.

> 7%, which means around 100,000 GWh of the total electricity demand of the year. This will require increasing the supply, only for that period, in more than 8,000 MW (free translation).[54]

However, the already significant role of conventional renewable energy sources is clear, especially water resources, which currently assume an important position in the national energy matrix. According to the National Energy Strategy, water resources are fundamental to the Chilean energy matrix. In 2011, the production of electricity through hydroelectric plants accounted for 34% of total production in Chile[55].

Note that already in the initial design of the rural electrification subsidy program, it was provided for the use of renewable sources of energy to bring electricity to rural areas. The subsidy funds could even be used for both the extension of the power grid and for energy generation. According to Jadresic, the sources that could be used are:

> Photovoltaic solutions for isolated rural dwellings; hybrid systems that reduce dependence on fossil and operating costs of fuels; small hydropower plants, independent or combined with other energy sources; experimental solutions based on wind power and biomass systems [...][56] (free translation).

However, extension projects of the transmission lines had prevalence. Thus, the use of renewable sources is still not the most common source applied in rural areas. As said by Jadresic: "The program also helped expand the technologies used in these projects, although the network extension has been the predominantly used approach"[57] (free translation).

Accordingly, the Chilean government has sought to expand energy access to rural populations by extending the lines and not through the development of clean energy projects. This trend is justified because initially the extension of transmission lines proved to be much more economically advantageous compared to the creation of energy generation projects.

[54] CHILE. *Op. cit*.. 2012, p. 7.

[55] CHILE. *Op. cit*.. 2012, p. 9.

[56] JADRESIC, Alejandro. Promoting Private Investment in Rural Electrification-The Case of Chile. In: **Energy services for the world's poor, s/d.** Available at: <http://www.worldbank.org/html/fpd/esmap/energy_report2000/ch9.pdf>. Access: 13 June 2016, p. 3.

[57] JADRESIC, Alejandro. *Op. Cit.* s/d, p. 5.

It should be pointed out that the infrastructure for power transmission is of fundamental importance so that electricity reaches the entire Chilean population, ensuring the reliability of supply and access to various sources of generation. According to the project *Estratégia Nacional de Energia 2012-2030*: "Currently, electric transmission has significant levels of fragility and raises serious difficulties to the implementation of projects, potentially affecting our entire system"[58] (free translation).

Therefore, in addition to having been in the past, the most economically viable solution, the extension of electrical transmission lines was a strategic concern to the country, which had major problems in its grid of power transmission. Accordingly: "Most of the projects involved extension of the network, a solution that usually means a lower cost for each connected house and a higher quality of service"[59] (free translation).

3.2 Focus on energy microgeneration projects

The Chilean government also aims to increase the use of alternative energy sources. In this sense, investment in micro energy generation (which is the second point of the hypothesis under discussion) is very important. The first and second part of the hypothesis here elaborated on the close relationship with each other, as larger investments in NCREs require greater investment in energy generation projects.

So far, the micro electricity generation system adopted in government programs has included the construction of solar panels from house to house. This type of installation is efficient in bringing power to isolated regions, especially ones located further North, where there are still communities without access to energy but also considerable solar radiation, which benefits the energy production from solar panels. To supply regions further South, other energy sources are necessary. According to Jadresic, "Micro wind farms, biomass and hydroelectric power generators were also used, mainly in the southern part of the country"[60] (free translation).

[58] CHILE. *Op. cit*.. 2012, p. 28.
[59] JADRESIC, Alejandro. *Op. Cit.* s/d, p. 3.
[60] JADRESIC, Alejandro. *Op. Cit.* s/d, p. 4.

The importance of the aforementioned energy sources is evident when one considers that the vast majority of homes still without power are in the southern portion of Chile. In addition to the sources previously mentioned, the southern region of Chile could benefit from biomass from forests and geothermal energy. According to studies conducted by Alarcón *et al.*, there is a large volume of forest biomass that can be extracted in a sustainable manner, from an extensive part of the Chilean territory, located mainly in the South[61]. This energy has the potential to create thermal and electrical energy. Geothermal energy is also interesting to Chile, since the country is located in the Pacific Ring, which features ideal geographical position to obtain energy from the Earth's heat[62].

The vast number of possible initiatives to bring power to the South is contrasted with access to energy in this part of the country. The South of Chile is undoubtedly the area that most required investments in the past and still remains with the lowest electric supply rate. Under the Rural Electrification Program, launched in 1994, the established goal was to ensure that 75% of the houses in the countryside of Chile have energy. It should be noted that more than 80% of the homes without electricity were located in the South of the country. The goal drawn by the Government, at that time, required that 120,000 houses receive energy[63]. This goal was particularly difficult to achieve given the mountainous terrain and severe weather cycles in the South. These factors ultimately increased the costs of production and operation of electrical systems in the region[64].

In these irregular and isolated places, NCREs are revealed to be an interesting option:

> Unconventional technologies generally provide electricity at a higher cost and lower quality (lower voltage, fewer hours of service). However, they have been an attractive alternative in a scenario in which the extension of the power grid is too expensive, because of the distance of the existing grid or the remoteness of the houses[65] (free translation).

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61 ALARCÓN *et Al.* **Evaluación de Mercado de Biomasa y su Potencial**. Ministério de Energia: Santiago de Chile, 2013. Available at: < http://sit.conaf.cl/varios/ebf/Resumen_Ejecutivo_Proyecto_Bioenergia.pdf>. Access: 19 May 2016, p. 28.

62 FUENTES, Francisca Valenzuela. Energía Geotérmica y su Implementación en Chile. In: **Revista Interamericana de Ambiente y Turismo**. Volumen 7, NÚMERO 1,PP.1 - 9, 2011. Access: 19 May 2016, p. 4.

63 BARNES, Douglas F. *Op. cit*.. p. 225.

64 BARNES, Douglas F. *Op. cit*.. p. 225.

65 JADRESIC, Alejandro. *Op. Cit.* s/d, p. 5.

Initially, during the 1990s and 2000s, there was an intense centralization of the subsidies in projects concerning the extension of transmission lines to regions without energy access. However, 3.9% of the Chilean population that still lacks access to electricity lives in remote areas, which makes it unfeasible or at least excessively costly to extend the transmission lines to these regions. For these people in particular, the production of energy from NCREs demonstrates the most viable option. This change of focus in investments requires a greater number of micro energy generation projects.

3.3 Logistics partnerships with regional and local governments

The third part of the hypothesis of this paper regards partnerships between the central government and regional and local governments. It is emphasized that the importance of regional governments promoting the electrification of rural areas is recognized by the leaders of the Chilean energy policy. According to Jadresic:

> Regional governments have developed the program in communities. As such, it was provided basic assistance in the preparation of projects, it was decided which energy source would be applied and resources were allocated in accordance with the projects. Governments have also coordinated and monitored the implementation of the projects. Some regions - especially those with the greatest needs and those where rural electrification is more politically sensitive - have created special units for rural electrification in some cases, based on their experience in the field[66] (free translation).

Another interesting proposal that falls into this partnership was guaranteed by Resolution No. 440, establishing citizen participation in the National Energy Commission[67]. This kind of initiative enables decisions on energy policies to occur in a more participatory manner, which allows for better allocation of resources and may contribute to the increase of access to energy in regions where electricity is not available yet.

Within this decentralization logic in the energy sector, its privatization, which took place from the 1980s, also deserves attention. This phenomenon is considered by the specialized literature as a factor that benefited the Chilean

66 JADRESIC, Alejandro. *Op. Cit.* s/d, p. 6.

67 CHILE. *Op. cit.*. 2012, p. 1.

population. It is interesting to note, therefore, that the regulatory framework for electricity in Chile differs considerably from the existing standard in other countries in the region.

> Chile pioneered the market liberalization of electricity around the world, being the first country to privatize the sector of electricity, which allowed for the amplification of four times of the installed capacity in the SIC and six times SING in the last twenty years. Therefore, a market that has been able to supply the maximum demand of the electrical system was created [...][68] (free translation).

Therefore, it is evident that greater coordination between the federal, regional and local governments and citizens may provide the best application of the subsidies available so that it's possible reach the parts of the rural population that still remain without access the energy. Moreover, this communication can contribute to a more efficient choice of which projects should be implemented based on their ability to bring benefits to local communities. Such decentralization is essential for optimal development of the rural electrification program and to achieve 100% access to electricity for the Chilean population.

Accordingly, all three measures previously suggested may increase the access to clean energy by the Chilean rural populations. Furthermore, it is understood that these measures will eventually also generate greater security for the energy supply throughout the whole country, since it aims to lower the energy dependence of Chile through the use of natural resources in national land. This would provide greater autonomy through lower dependence on the South American energy integration, which in recent years has been seen by the Chile as uncertain and a difficult negotiation.

Conclusion

Based on the foregoing, it is clear that the energy policies implemented by Chile are examples of well-executed policies to promote access to clean energy for rural populations. The success of the program placed in practice in the country is due to some key factors, such as a subsidy policy applied

[68] CHILE. *Op. cit.*. 2012, p. 32.

for a long period (Rural Electrification Program, which begins in the 1930s) and an effective partnership between the private and public initiatives. This is one of the conditions of success mentioned by the World Bank, which stated that rural infrastructure programs require a long time to achieve their purposes, needing more than one presidential term to be executed. Chile certainly fulfilled this requirement, since the programs implemented have been conducted for decades.

Accordingly, to ensure greater access to energy for rural populations, State policies and not government policies need to be implemented. The Chilean case, that has been seeking the universal energy access to their rural populations since the 1990s, highlights this fact.

Furthermore, also important is the compatibility between the implemented subsidy policies and the reforms undergone by the energy administration in Chile, target of deep privatizations, mainly since the 1980s. Therefore, the subsidy policy was developed to be consistent with the broad principles of the sector's privatization, including the decentralization of decisions to the regional and community level. The result was a 50% increase in rural electrification in just five years[69].

Hence, Chile has an example of a successful policy towards the universal access to clean energy by rural populations. This success is due to some basic principles that have guided this process. First, as noted in the course of this paper, it should be mentioned that the subsidy program implemented with the right participation of the Chilean Government, through the National Energy Commission, has sufficient powers to negotiate with regional governments the best mechanisms to ensure energy for rural populations. As argued, this contact at regional and local level should be explored more deeply, allowing the best allocation of resources.

The arguments previously shown expose that the increased access to energy by the inhabitants of the Chilean rural areas was intrinsically linked to government action. Chilean authorities intervened with substantial subsidies to the sector, enabling the poorest and most isolated populations to have access to this energy.

[69] JADRESIC, Alejandro. *Op. Cit.* s/d, p. 1.

It follows, therefore, that the subsidy policies should continue to be applied, but now with greater investment in NCREs and projects of micro energy generation. This funding framework requires a shift in focus: from investments in the extension of the power transmission lines to greater focus on projects aiming to achieve clean energy generation.

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MEXICO

ENERGY MATRIX AND SUSTAINABLE DEVELOPMENT IN MEXICO

Ricardo Beltrán Chacón[1]

Abstract: The production of primary energy in 2014 decreased 2.2% compared to the previous year due to declining oil production. However, the increase in the share of other energy sources moderated this production drop. The total energy exports in 2014 was 2.0% lower than the previous year. This decrease, mainly of oil, was made in order to meet domestic energy needs. In 2014, it imported 6.7% more than in 2013 - mainly gasoline and dry gas. The latter increased by 14.6% over the preceding year. Energy reform recently made by the government removed the federal monopoly power, allowing commercial and industrial sectors to purchase power from independent producers (renewable or conventional) in a regulated market. This competition scheme encourages private investment, allowing the fulfillment of national goals on renewable energy integration, in the short and long term, concerting into individual obligations with benefits for the final user. In 2015, the generating capacity from renewable energies in Mexico represented 25.3% of total generation capacity. The proven, probable and possible potential use of renewable energy can significantly contribute to achieve or even exceed the goal of having a generation of electricity from clean energy by 35% in 2024.

Keywords: Mexico – Energy - Renewable Energy Sources – Legal Framework – Rural Electrification.

Introduction

The description of the energy situation in Mexico is shown briefly by some energy indicators. The representation of the nature of the sources and destinations of the different energy sources constituting the energy matrix is possible through the indication of the destinations, transformations and distribution rates for the final sectors.

Within the legal framework of energy, one of the most important recent issues for the industry will be described, i.e., the energy reform, in addition to different laws, programs, strategies and tools created to direct, stimulate and plan the growth of a sustainable energy sector.

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Regarding the electrification of rural areas, some relevant practices will be described, as well as their relationship with the development program of the national power system aimed at achieving a degree of electrification of 99.8% of entire population in 2024.

1. Energy matrix

During 2014, the national power consumption in Mexico was 2.3% lower than the production of energy. This relationship reflects an energy independence rate of 1.02, which means that the amount of energy produced was 2.3% higher than the available in various consumer activities in the country. This energy independence indicator decreased at an annual rate of 3.3% since 2005. The per capita consumption of energy during the same year was 72.04 GJ (SENER, 2015a).

In Mexico, primary production during 2014 totaled 8,826.15 PJ, which in comparison to the production in 2013, decreased 2.2% due to the decline in oil production. However, the increased participation of other sources of power within the energy matrix moderated this decline in production.

The total energy exports in 2014 reached a figure of 3117.21 PJ, which is 2.0% lower than the previous year. The decrease in overseas energy shipping, especially oil, occurred in order to meet domestic energy needs, resulting in a total gross domestic supply of 8624.26 PJ during 2014.

In 2014, 2,560.99 PJ were imported into Mexico (6.7% more than in 2013) - mainly gas and dry gas. The latter increased by 14.6% over the previous year.

The generation of electricity with a total of 1,092.15 PJ showed an increase of 2.1% compared to 2013. Public power plants contributed with 56.9%, independent producers with 28.9% and self-generation of electricity, at 155.65 PJ, contributed with 14.3%.

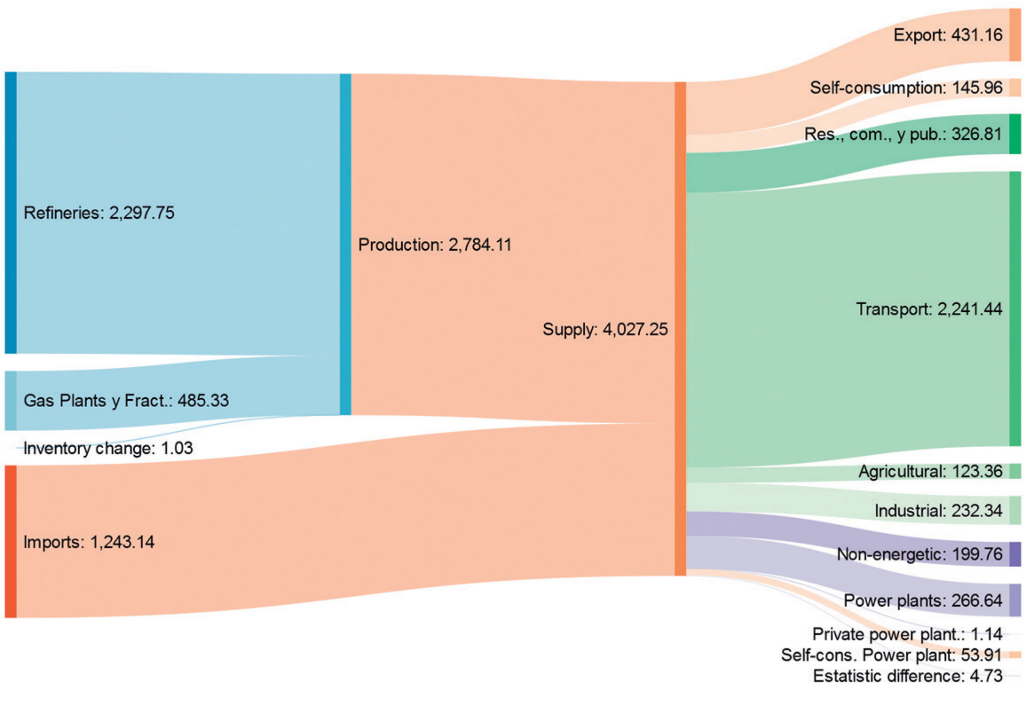
The final energy consumption in the year of 2014, according to the sector, had the following distribution: transportation - 45.9% (2,246.39 PJ), industry - 32% (1,568.44 PJ) and the combined domestic sectors, both commercial and public, accounted for 18.8% of the total.

The balance of oil is shown in Fig. 1, which points out that 44.6% of the total energy supply in Mexico comes mainly from oil imports and that, in addition to national production, 55.7% are directed to the transport sector.

The primary energy production according to the source is shown in Chart nº 2. While the energy contribution of the hydrocarbons is 87.8% of the total, the renewable sources represent 7.56%.

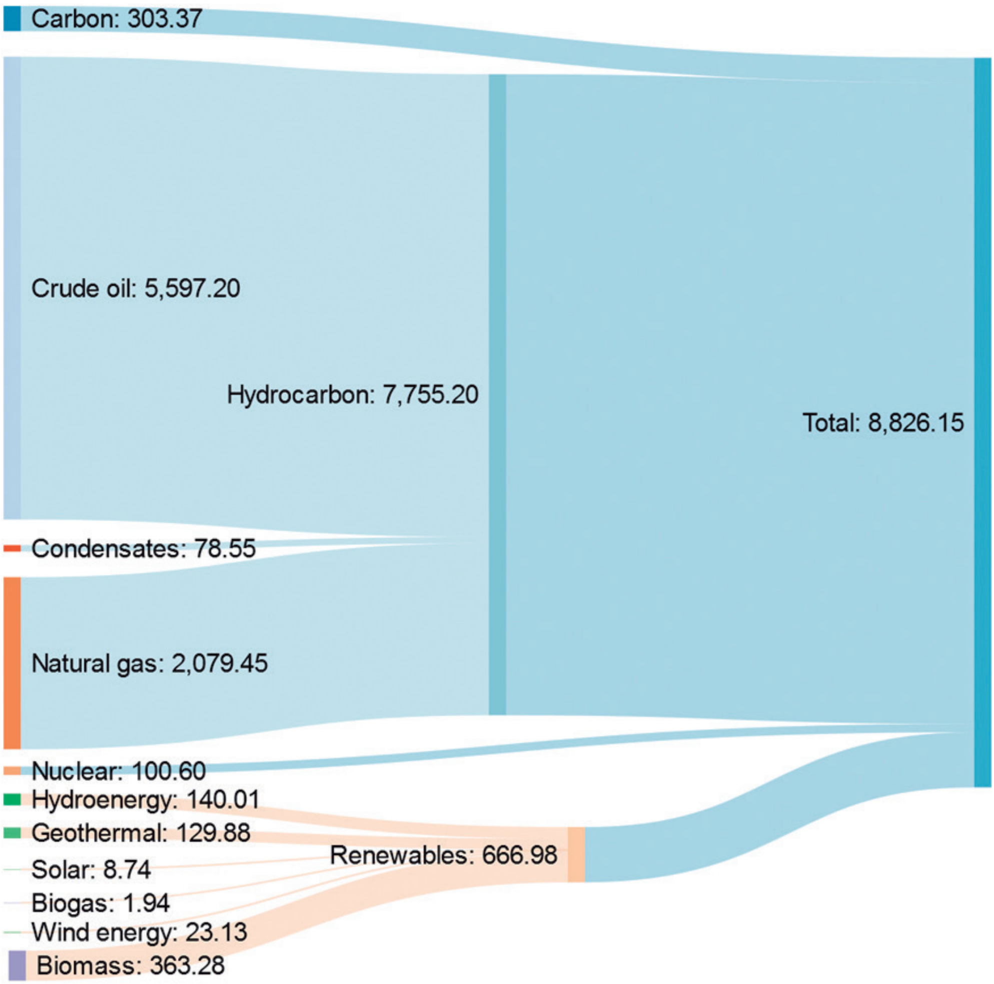
Comprising 30% of sugarcane bagasse and 70% of wood, biomass offers the largest renewable energy contribution - 363.28 PJ (Chart nº 3). On the other hand, the power generation in hydroelectric plants increased 38.9% in relation to the previous year, giving a total of 140.01 PJ. Wind power also had a significant growth compared to 2013, increasing 53.6% and producing a total of 23.13 PJ.

Chart nº 1: Oil Balance 2014, PJ/year.



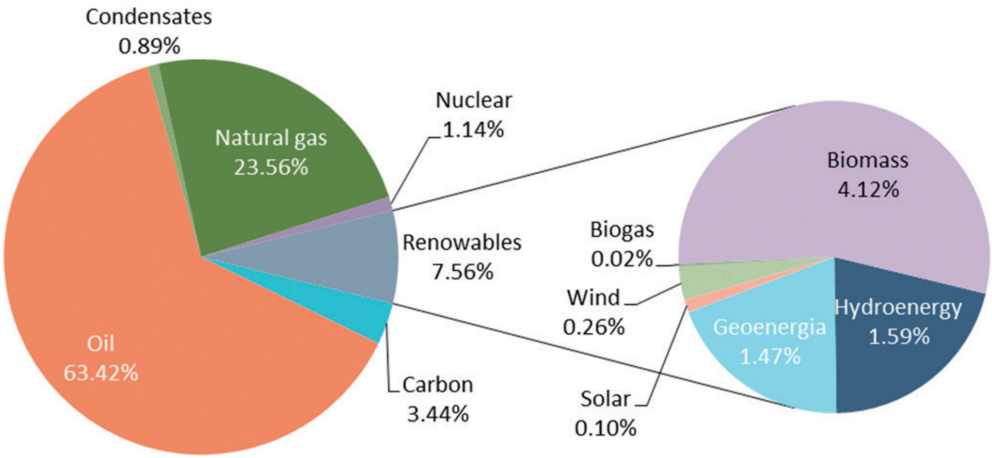
Source: Chart prepared by the author based on SENER's data (SENER, 2015).

Chart nº 2: Primary energy production (Petajoules).



Source: Chart prepared by the author based on SENER's data (SENER, 2015).

Chart nº 3: Percentage distribution according to the source for the production of primary energy.

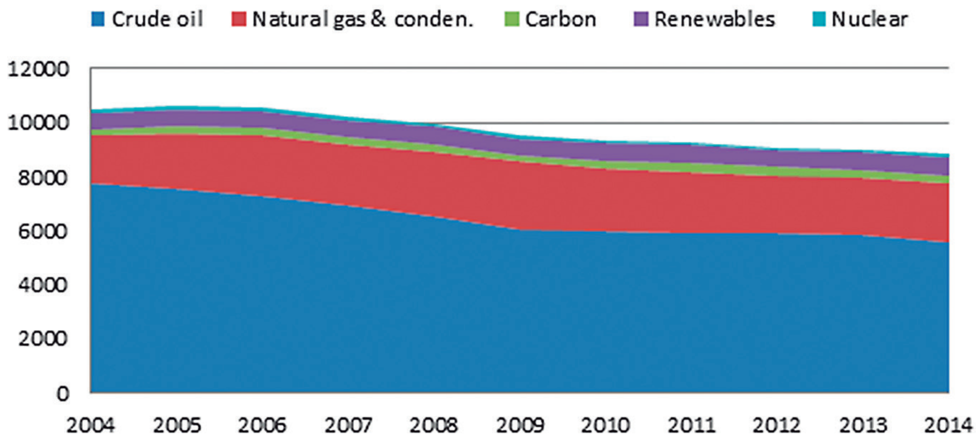


Source: Adapted by the author from: SENER, 2015a.

The historical behavior of primary energy production, as shown in Fig. 4, records a decrease due to a decline in crude oil production of 27.9% in 2014 compared to 2004. On the other hand, the production of natural gas, renewable energy and nuclear-power increased 23.52%, 23.29% and 10.63% compared to 2004. Even with the increase in the percentage of these energies, total production decreased by 13.02% in relation to 2004.

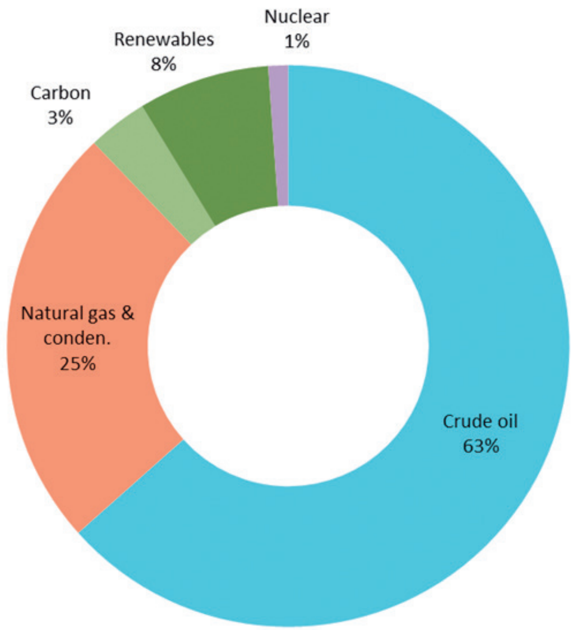
The distribution of primary energy in 2014 (Chart nº 5) reveals the dominant role of hydrocarbons in the Mexican matrix: while they comprehend 91% of the matrix, renewable and nuclear power contribute with 8% and 1% respectively.

Chart nº 4: Evolution of primary energy production 2004-2014 (PJ).



Source: Adapted by the author from: SENER, 2015a.

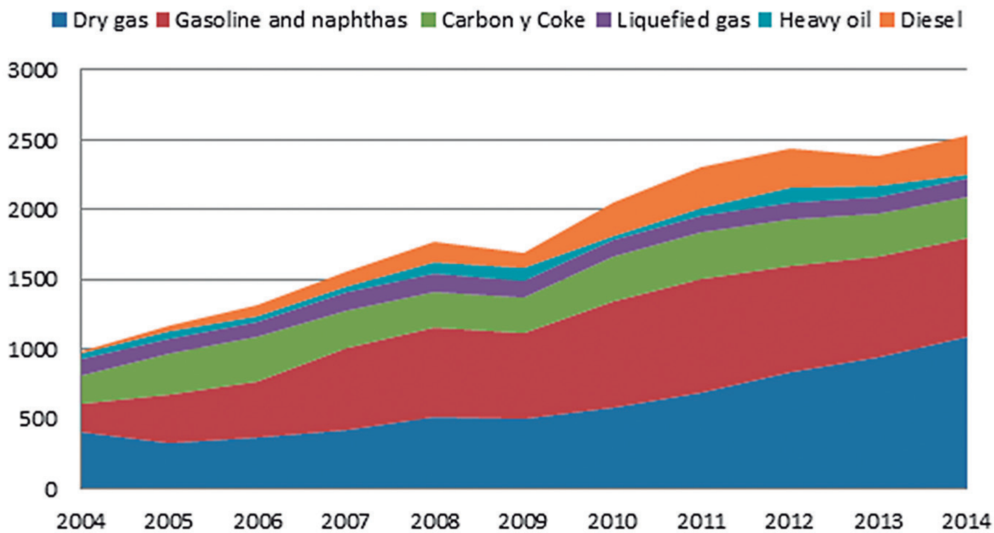
Chart nº 5: Primary power distribution in 2014.



Source: Adapted by the author from: SENER, 2015a.

The decrease in primary energy production is compensated by imports of energy (Chart nº 6). In 2014, the import of dry gas and gasoline accounted for 22.4% and 14.5% of total imports. A historical perspective discloses that the percentage of increase in the imports of diesel, gas and dry gas in 2014 compared to 2004 is 4319%, 238% and 168%, respectively.

Chart nº 6: Evolution of energy imports 2004-2014 (PJ).

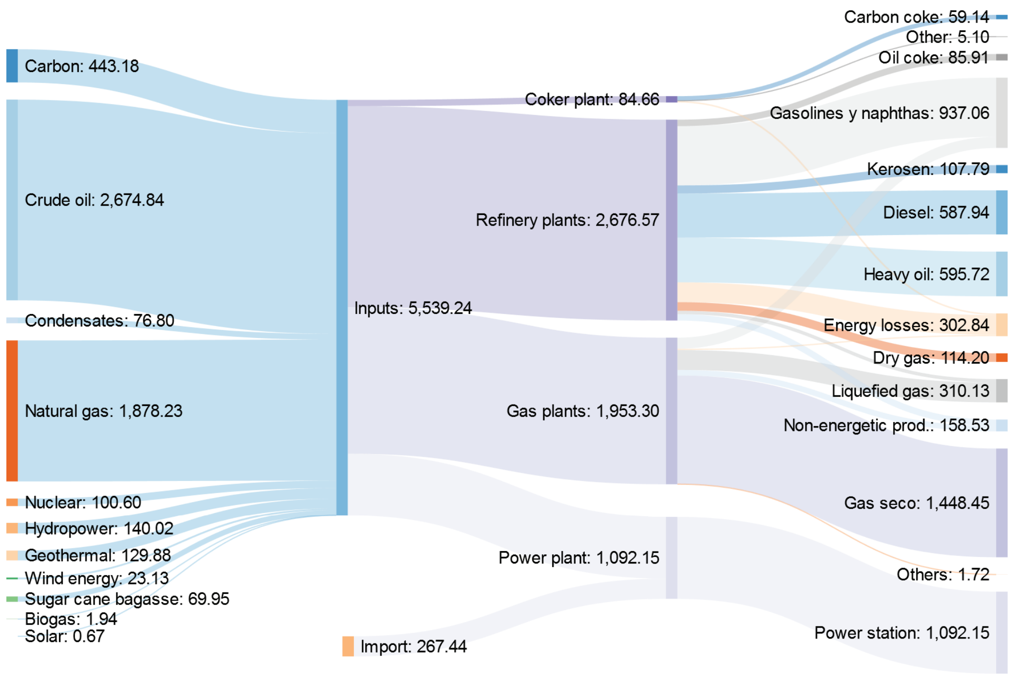


Source: Adapted by the author from: SENER, 2015a.

The allocation of primary energy to the processing centers and secondary energy production are shown in Chart nº 7. The main energy sources sent to transformation were oil (48.3%) and natural gas (33.9%). The main fuels produced in refineries are gasoline, oil fuels and diesel; 32.8%, 24.7% and 24.4%, respectively. The main product of the processing centers is dry gas (natural gas), which represents 74.8% of all processing centers. Public power plants contributed with 56.9% of the total power generation; independent power producers generated 28.9% and power self-generation participated with 14.3%. The main energy source of independent and self-generation power producers was dry gas, generating 80.3% of the total production (Chart nº 8).

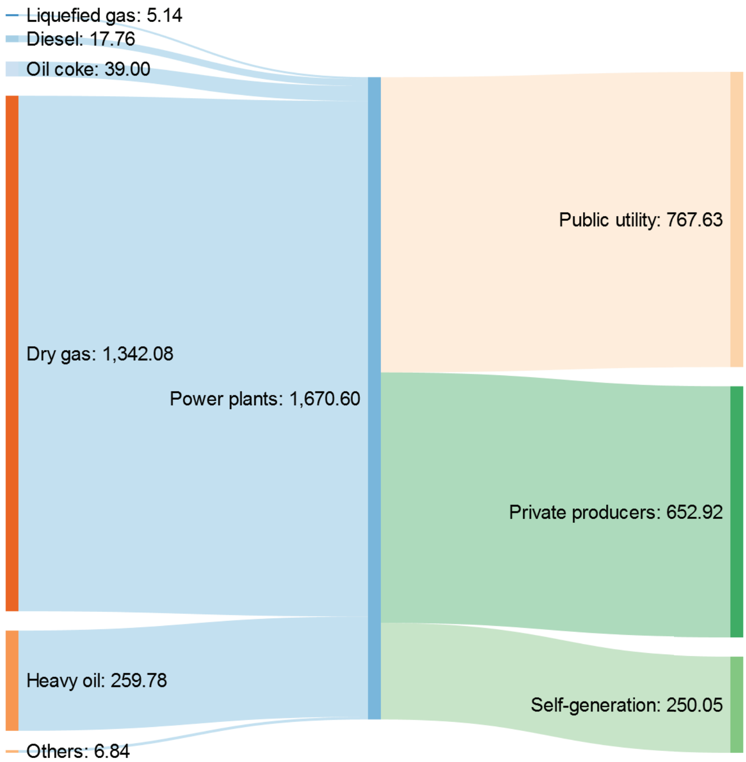
Figure 9 illustrates the scarce products in Mexico, which had to be imported to meet the domestic demand; in contrast, the energy surplus are also shown, which have been exported to various destinations. In this sense, the foreign trade of secondary energy had a negative balance of 1,880.23 PJ - 7.0% higher than in 2013. Dry gas recorded a trade deficit of 1,079.69 PJ - 14.7% higher than in 2013. The dry gas imports covered 12.6% of gross domestic energy supply in 2014.

Chart nº 7: Primary energy inputs, their distribution in the transformation centers and the corresponding gross production of secondary energy (PJ).



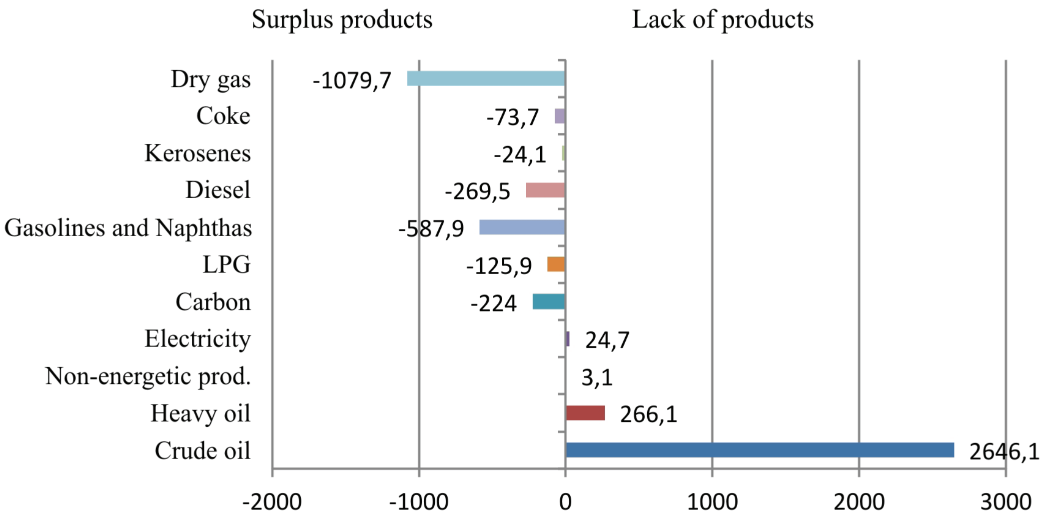
Source: Data compiled by the author (SENER, 2015a).

Chart nº 8: Secondary energy inputs in processing centers (PJ).



Source: Chart prepared by the author based on SENER's data (SENER, 2015).

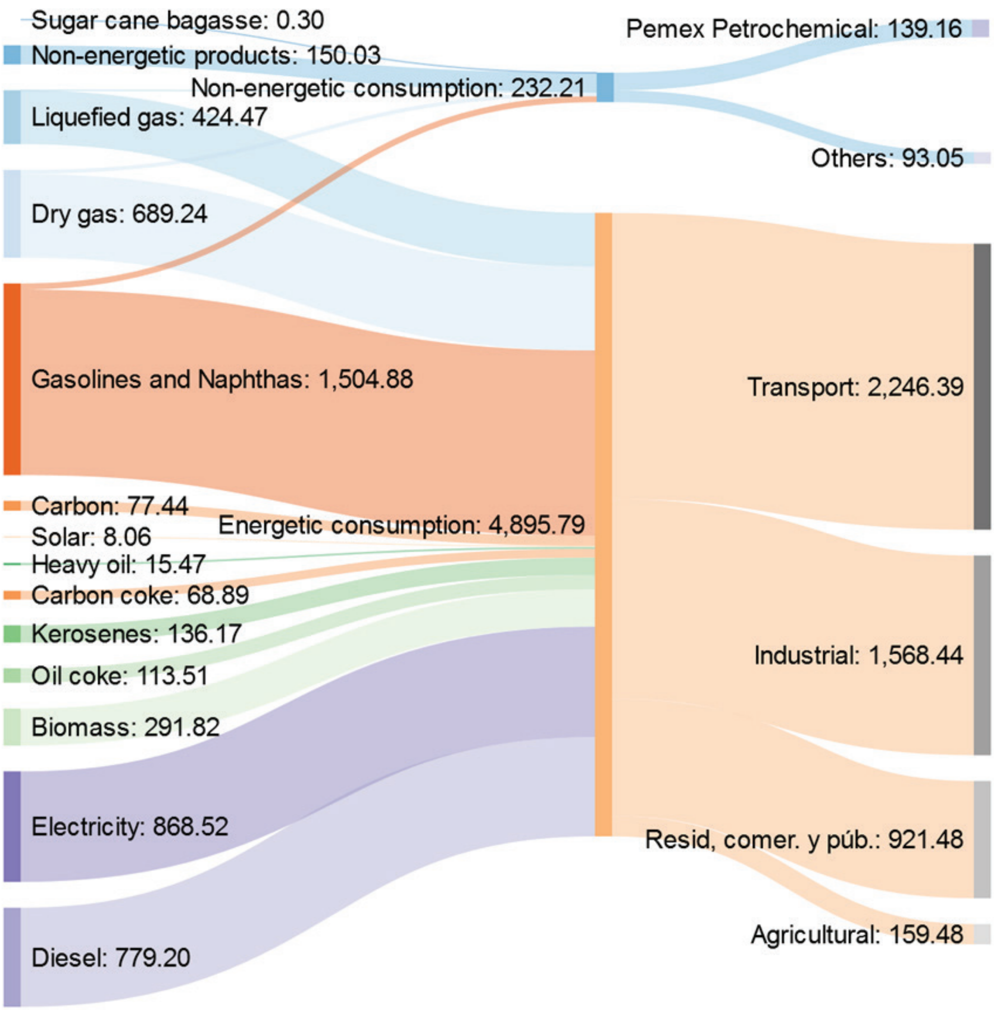
Chart nº 9: Balance of trade energy by source, 2014 (PJ).



Source: Adapted by the author from: SENER, 2015a.

The total final consumption - defined as the sum of energetic and non-energetic consumption - is the energy that is destined for the domestic market or production activities of the national economy. The total non-energetic consumption, which refers to those energetic and non-energetic petroleum inputs used for the production of different products, represented 4.5% of the final consumption (Chart nº 10). On the other hand, the total energy consumption refers to the energy used for burning in economic activities and processes and to fulfill the energy needs of society. It represented 95.5% of final consumption.

Chart nº 10: The total final energy consumption by energy use and fuel type 2014 (PJ).



Source: Compiled data from: SENER, 2015a.

Regarding the total energy consumption, gasoline was the most consumed type of energy - 29.8%. Electricity was the second highest in energy consumption - 17.7% (Chart nº 11). On the other hand, diesel covered 15.9% of final energy demand, followed by dry gas, with 13.4%.

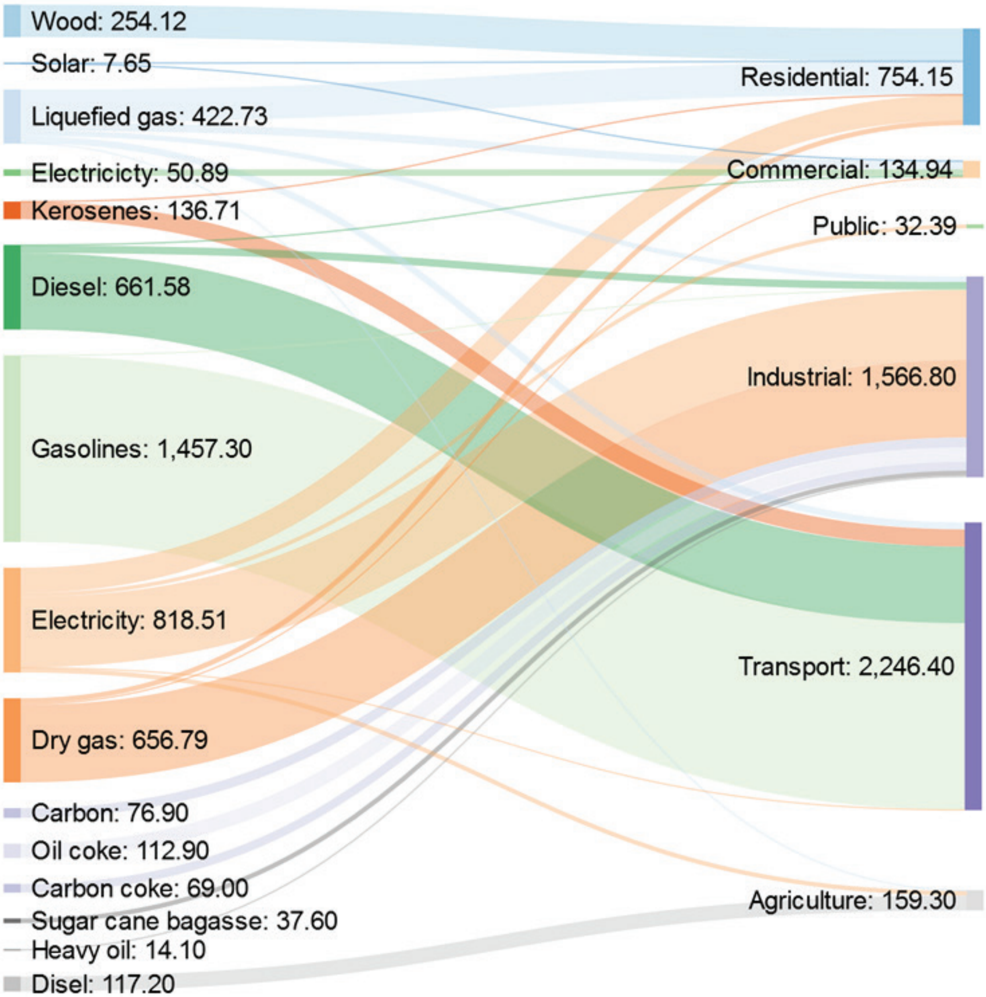
The sectors in which the total final consumption is unbundled are transport - which is the most intensive sector in energy use -, accounting for 45.9%; the industrial sector consumed 32.0%; the residential, commercial and public sectors consumed all together 18.8%; and agriculture amounted to 3.3% (Chart nº 11).

The energy imports to Mexico by country of origin are shown in Chart nº 12. The United States represent 78.51% of the total, with mainly dry gas and gasoline.

In contrast, the main export destination of energy is the United States, which is the recipient of 69.72% (Chart nº 13) of the total energy exported. 61.35% of the exports to United States were crude oil.

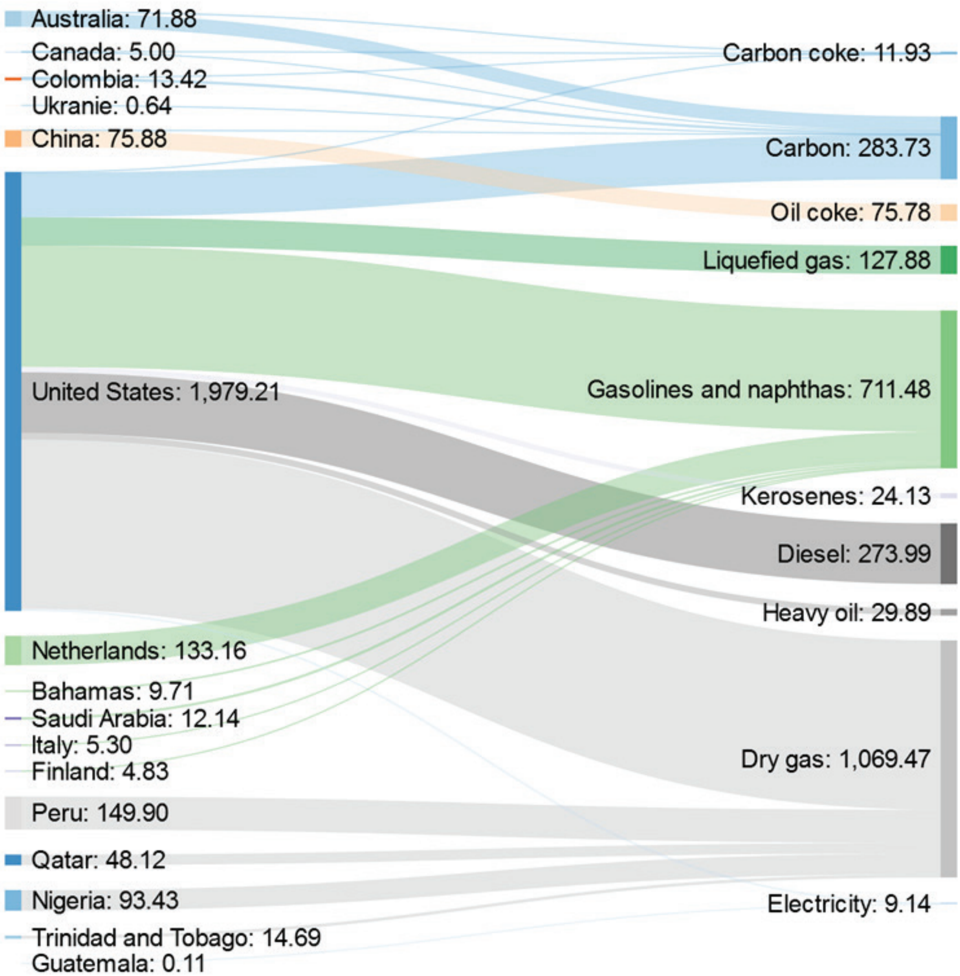
The use of solar energy through plan solar collectors and photovoltaic modules (Chart nº 14) reveals an average total of 290,000 square meters of solar collectors on the annual average of the last three years and an average of 27,716kW of photovoltaic systems on the same period. In general terms, the energy contribution made by solar thermal collectors represents an amount of power 21 times bigger than the photovoltaic production in 2014 (Chart nº 15). However, regarding the year 2013, while the installed capacity of photovoltaic modules increased 27.58%, the use of solar heaters increased 11.32%.

Chart nº 11: Final energy consumption by sector and energy 2014 (PJ).



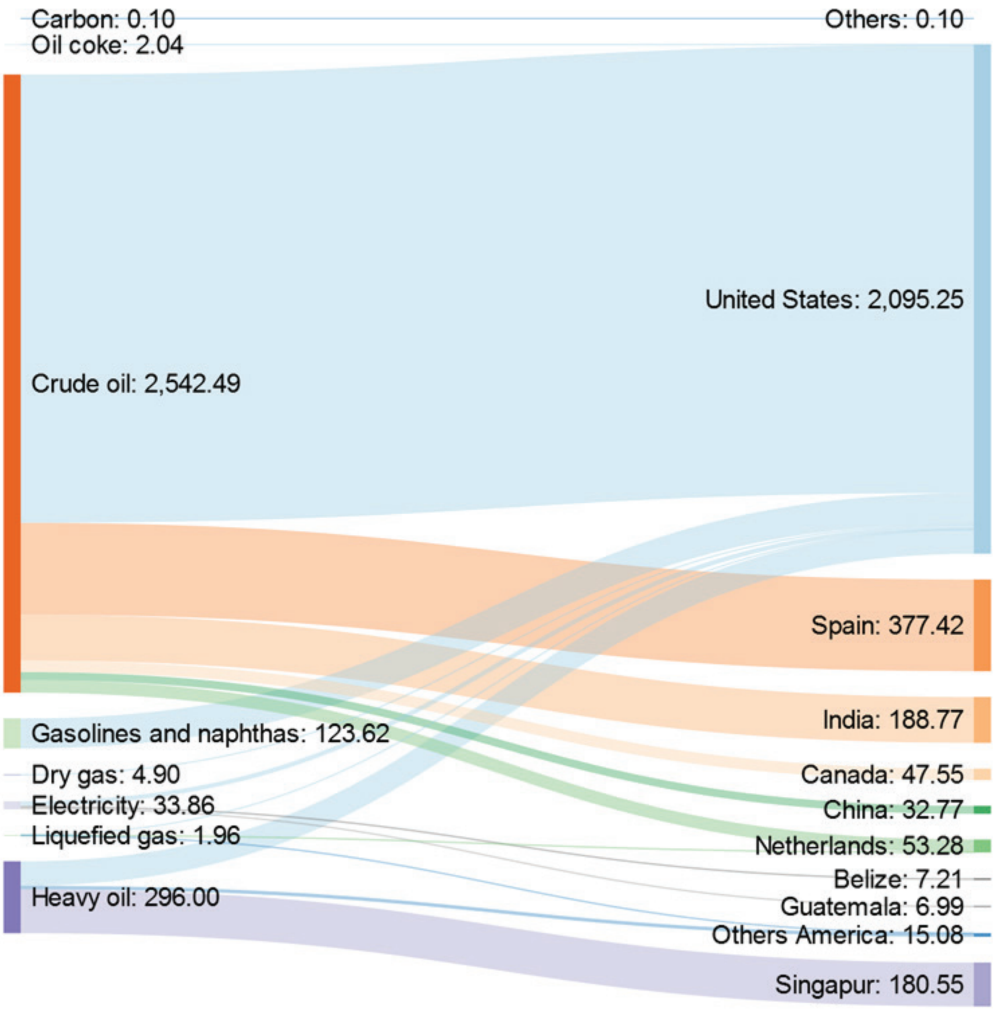
Source: Chart prepared by the author based on SENER's data (SENER, 2015a).

Chart nº 12: Power Import to Mexico by country of origin (PJ).



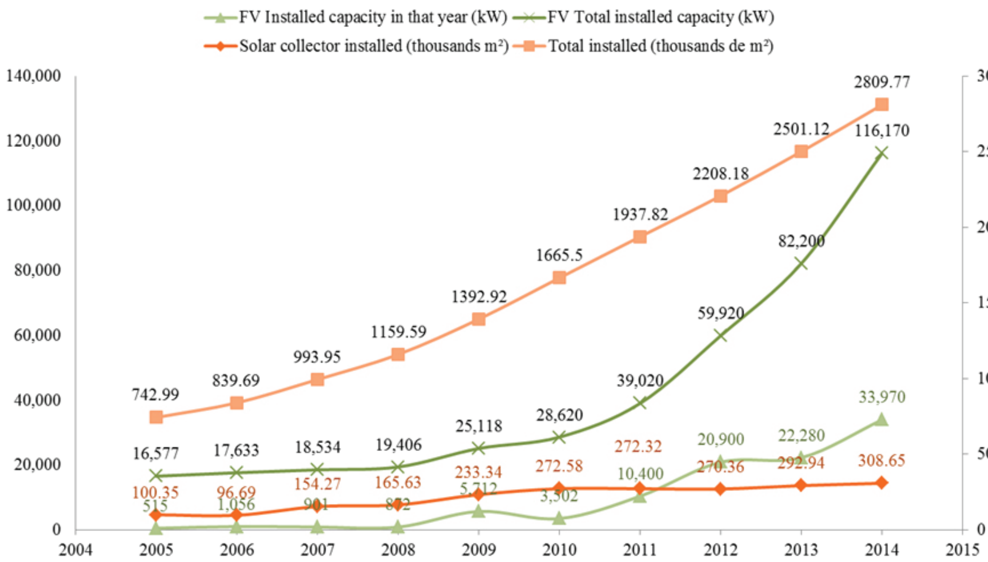
Source: Chart prepared by the author based on SENER's data (SENER, 2015a).

Chart nº 13: Exportation of energy by country destination (PJ).



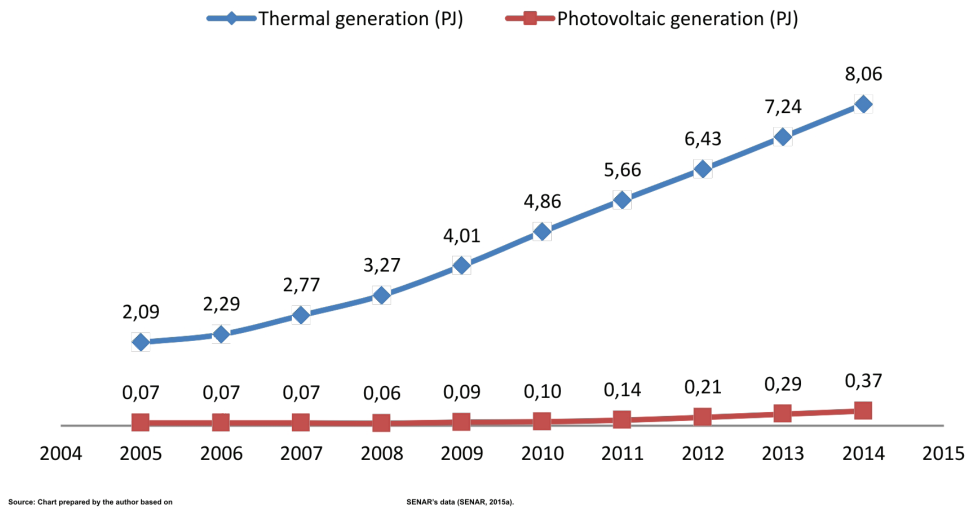
Source: Chart prepared by the author based on SENER's data (SENER, 2015a).

Chart nº 14: Use of solar thermal and photovoltaic energy.



Source: Chart prepared by the author based on SENER's data (SENER, 2015a).

Chart nº 15: Annual generation of thermal energy for solar water heaters and photovoltaic plans (PJ).



Source: Chart prepared by the author based on SENER's data (SENER, 2015a).

2. Sustainable Development

The Department of Energy, under the Law for the Use of Renewable Energies and Financing of Energy Transition (LAERFTE) sets a maximum stake of 65 percent of fossil fuels in power generation by 2024, 60 percent by 2035 and 50 percent in 2050 (DOF 2013).

In order to fulfill the commitments made in the Paris Agreement, Canada, The United States and Mexico set a joint goal to have an average generation of 50% power energy from clean energy by 2025, which apart from renewable energy sources, including nuclear, the capture and storage of CO2 (Jason Furman, 2016).

In 2014 investment in renewable energy amounted to USD 2 billion. Renewable energy sources are promoted through net metering schemes, energy auctions, clean energy certificates, tax credits for investment / production, loans and grants. The government made a reform that aims to increase competition in the energy market, enabling commercial and industrial companies to buy energy (including generated from renewable energy sources) from independent producers, instead of keeping the federal monopoly of the Federal Commission Electricity.

An important aspect added by the analysis of renewable energy capacity is the fulfillment of the goals set out in the Special Programme for the Utilization of Renewable Energy 2014-2028 (PEAER). According to PEAER, the percentage of installed capacity from renewable energy and clean technologies will have increased from 24.8% in 2013 to 34.6% in 2018. Similarly, the percentage of installed capacity with renewable energy projects should increase 25.32% in 2012 to at least 32.8% by 2018 (Rodriguez, 2015).

On the other hand, the Energy Transition Act (LTE) and the General Law on Climate Change (LGCC) state that by 2024 at least 35% of electricity generation should come from clean energy. Similarly, the LTE sets an intermediate target of 30% for 2021. In turn, the PEAER states that by 2018 at least 24.9% of the total generation is to come from renewable energies (Rodriguez, 2015).

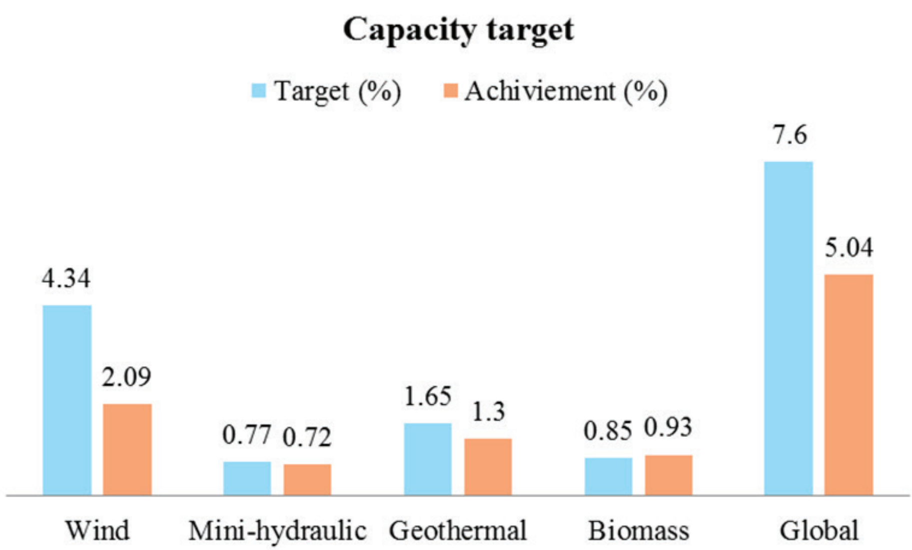
Mexico has one of the highest solar resources in the world, with a daily average irradiation of 5.5 kWh / m^2. However, even with such high potential, the installation of photovoltaic systems has been limited until now. It is expected that this situation will begin to change with the authorization of 3 GW of solar projects that should be in operation by the end of 2018.

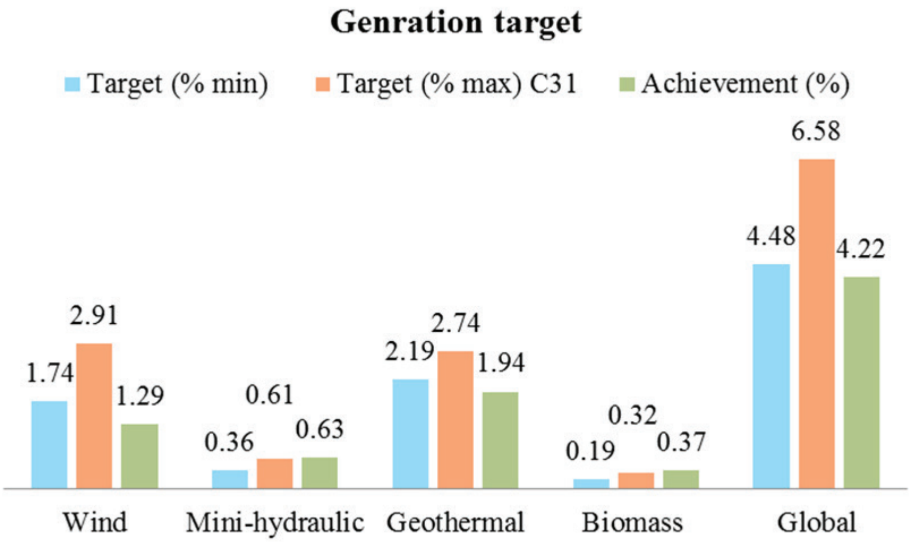
Under the conditions of the new electricity reform, all renewable energy producers compete with producers of energy from fossil fuels in the free market, which means that they can not set tariffs above the grid prices. The price of energy that ensures CFE in public auctions for industrial users is, on average, $ 1,273 MXN per kWh (USD $ 0.086 per kWh) (EMIS, 2015).

The first national targets for the generation of electricity from renewable sources were established in 2012. The results presented in Figure 16 correspond to a total installed capacity of 3,146.8 MW, the wind contributes to 1304.5 MW; in relation to generation, the targets set for mini hydro, biomass and biogas were overcome in 174% and 194% of target, respectively. During the evaluation of the program's goals, the following weaknesses were identified:

a) It does not identify clear responsibility to meet the target;
b) The objectives do not include hydroelectric plants outside the scope of LAERFTE or efficient cogeneration;
c) Areas of opportunity are excluded for thermal recovery or social and economic impact;
d) There are indicators to facilitate the assessment of compliance with targets for other years (2024, 2035 and 2050).

Chart nº 16: Compliance with the special program goals for use of renewable energy 2009-2012.



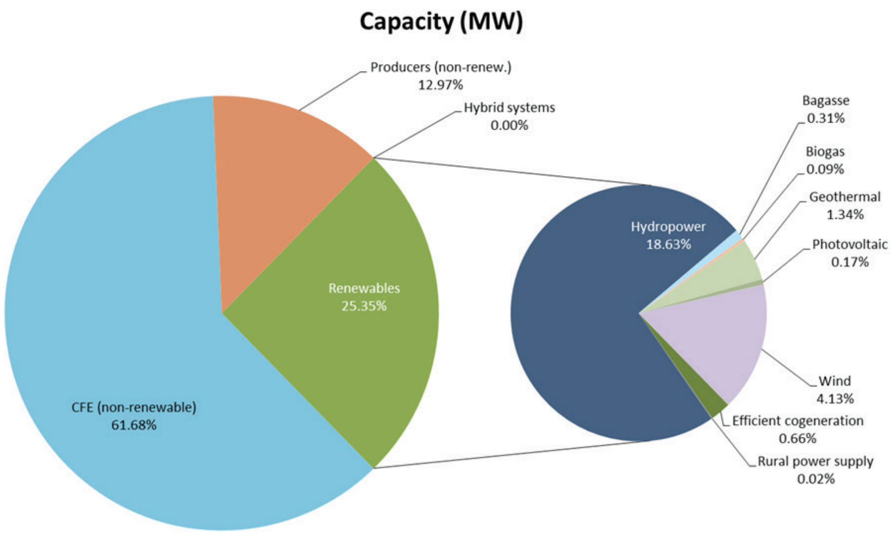


Source: (SENER, 2014).

In 2015, 98.4% of the Mexican population had electricity, which means supplying energy to 119.9 million inhabitants by means of a 879.691 kilometers long grid (transmission and distribution lines) and with a 190 generator centers infrastructure with an effective capacity of 45.516 MW. The service was provided to 38.4 million customers, of which 88.6% are in the domestic sector, while the highest percentage of sales corresponds to the industrial sector with 58.2%. In 2010, the per user dwell time was 60 minutes, while in 2014 it increased to 37 minutes, a reduction of 39% (Bravo, 2015).

On June 30th 2015, the generating capacity from renewable energies in Mexico represented 25.3% of total generation capacity (Chart nº 17). Most of this capacity corresponds to hydroelectric generation, which accounts for 18.6%, followed by wind power plants, which account for 4.1%.

Chart nº 17: Composition of the total capacity of the energy matrix, June 2015.



Source: Adapted by the author from: Rodriguez, 2015.

Although the generation capacity reached 25.3%, 55,002 GWh in 2014, it contributed only to 18.2% of the total generation, a percentage that in June 2015, remained unchanged (Table 1).

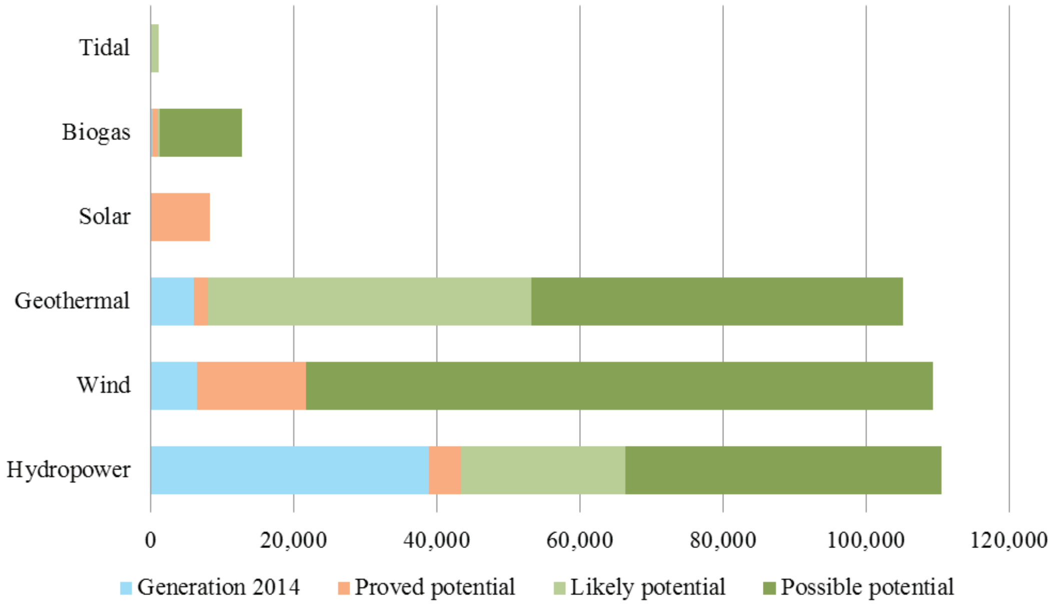
Table 1: Participation of renewable energy in total generation (GWh).

Technology	Ene-Jun 2015	(%)
Hydropower	17,885	11.9
Bagasse	362	0.2
Biogas	86	0.1
Geothermal	3,100	2.1
Photovoltaic	91	0.1
Wind	4,242	2.8
Hybrid systems	0.10	0.0
Efficient cogeneration	1,527	1.0
Rural power supply	14	0.0
Subtotal produced from renewable sources	**27,307**	**18.2**
Subtotal produced from non-renewable sources	**122,473**	**81.8**
Total electricity generation	**149,781**	**100.0**

Source: (Rodríguez, 2015).

The potential for use of renewable energy in Mexico is huge. A recognized potential, according to the national inventory of renewable energy, its confirmed and probable generation potential (Chart nº 18) is of 100 278 GWh per year, ie 33% of 301.462 GWh generated in 2014. The possible additional potential not counting the solar (195.278 GWh) represents 65% of the generation of 2014. It is worth mentioning that it is considered that the solar estimated potential is virtually unlimited (6,500.000 MWh). These resources could contribute significantly to achieve or even exceed the targets set in PEAER (Rodriguez, 2015).

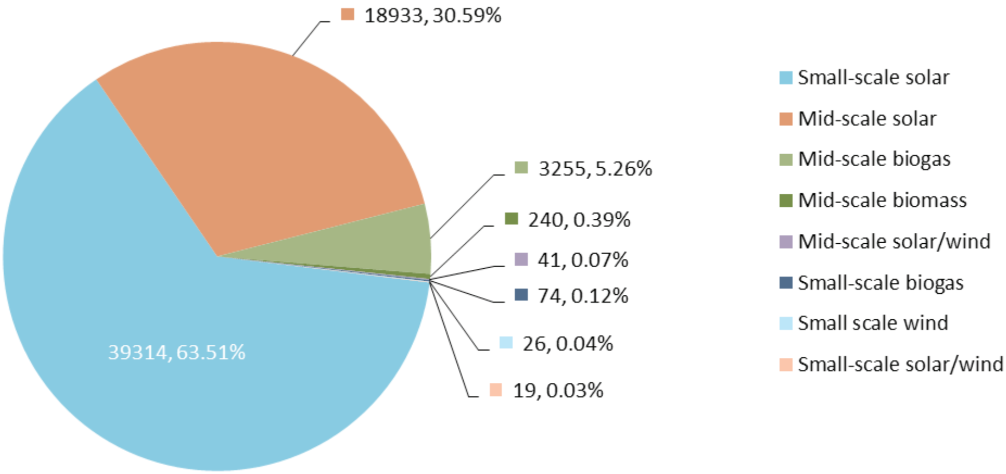
Chart nº 18: Current generation and generation potential with renewable energy, 2014 (GWh/year).



Source: Adapted by the author from: Rodriguez, 2015.

The generation currently distributed, as can be seen in Chart nº 19, it is mainly in photovoltaic solar technology in less than 30 kW installations (small scale under the interconnection contract basis) or above 30 kW and less than 500 kW (medium scale under the interconnection contract basis). In the first case, it is users of the residential sector and small and medium-sized enterprises connected to a low voltage network, while in the second, small or medium-sized enterprises connected to a medium voltage network.

Chart nº 19: Distribution of interconnection agreements under distributed generation schemes (kW%), 2014.



Source: Adapted by the author from: Rodriguez, 2015.

One of the areas of opportunity identified for the following planning exercises is to improve information about renewable energy investment costs, generation costs of different RE technologies, with emphasis on local conditions in Mexico and incorporating the benefits of scale and the learning curve. In addition, the design and implementation of complementary economic instruments to existing ones in the country would be desirable to accelerate the development of ER in Mexico (Rodriguez, 2015).

2.1. Legal framework

Energy reform has allowed the implementation of the Electricity Market Wholesale, begining operations on January 1, 2016. In addition, we complemented the industry transformation process with the decree creating the National Center for Energy Control (CENACE) as operator market, the establishment of the Electricity Industry Act and its regulations, the Clean Energy guidelines, establishing the requirements of the Clean Energy Certificates (CELS) and the formulation of the first rules of the Electricity market Wholesaler (Rionda, 2015). The modalities of the market in the short term (1 h - 1 day) include real-time market and the early hour market; in the medium term market (1 month - 3 years), early market day and auctions; while in the long-term market (3 - 10 years) arrangements are grants and funding.

The Clean Energy Certificates are issued by the CRE to believe the production of certain amount of electricity from Clean Energy, and serve to meet the requirements associated with the consumption of the freight centers. Thus, the national targets are converted into individual obligations.

Table 2: Policies for the promotion of renewable energies (Rodriguez, 2015).

Law	Goal	Publication
General Law on Climate Change	It establishes objectives in public policies for mitigation and adaptation to climate change.	06 Jun. 12
Law of the Regulating Agencies of the Energy Sector: Energy Regulatory Commission and National Hydrocarbons Commission. (CRE and CNH)	It promotes the efficient development of: transportation by pipelines, storage, distribution and expenditure of bioenergy; the generation, transmission, distribution (including the distribution outside of the public service) and commercialization of electricity.	11 Aug. 14
Energy Transition Law	It regulates the sustainable use of energy and the obligations concerning the reduction of emissions by the electric industry.	11 Dec. 2015
National Energy Strategy 2013-2027 (ENE)	It promotes social inclusion to the benefits of energy use, sustainability and mitigation of the negative impacts of energy production and consumption.	25 May 2013
Energy Sector Program 2013-2018 (PROSENER)	It contains the objectives, strategies and lines of action of organs and agencies to achieve the goal of 34.6% of installed capacity of electricity generation by renewable sources and clean technologies in 2018 (the baseline of 2013 was 28.4%).	13 Dec. -2013
Special Program for the Use of Renewable Energies 2014-2018 (PEAER)	It describes a reconstruction plan for public policies on renewable energy. One of its goals is to increase capacity and generation from renewable sources.	28 Apr. 2014
Strategic Program for Training Human Resources in Energy Matters (PEFRHME)	Its objective is to contribute in the hiring, development and retention of the necessary professionals for the construction of an attractive, dynamic and competitive national energy industry.	30 Sep. 2014
National Strategy for Energy Transition and Sustainable Energy Use (ENTEASE-2014)	It supports the energy policy in order to ensure energy security and economic development, taking into account energy sustainability.	Updated in 2014
Program for the Development of the National Electric System 2015-2029(PRODESEN)	It describes the programs for installation and removal of power generation plants and the programs for expansion and modernization of the national grid.	30 Jun. 2015

Source: (Rodríguez, 2015).

Table 3: Economic instruments for the promotion of renewable energy.

Law	Goal	Publication
Immediate deduction (Income Tax Law)	Encourage investment in power generation based on renewable sources or efficient cogeneration systems.	18 Nov. 15 (modification)
Sectorial Fund SENER-CONACYT for Energy Sustainability (FSE)	Fund scientific research, technological development, innovation, intellectual property registration, specialized human resources training, scholarships, renewable energy infrastructure, energy efficiency, use of clean technologies and diversification of primary energy sources	4 Aug. 2008
Fund for Energy Transition and the Sustainable Use of Energy (FOTEASE)	Finance and enhance energy transition, energy savings and clean and renewable technologies.	25 Feb. 2008
Externalities Methodology	It was created within the framework of LAERFTE to calculate the positive or negative impacts of electricity generation and resumed in the LTE to evaluate the costs associated with the operation and expansion of the electric industry.	Dec. 2012
Universal Electric Service Fund	Providing rural communities with electricity, promoting the use of clean energy, including the provision of efficient light bulbs and the basic supply to users in marginal conditions.	30 Sep. 2014
Clean Energy Certificates (CEL)	Contributing to diversifying the energy matrix through the integration of clean energies. Promote competition in the electricity sector and promote investment in new projects.	31 Oct. 2014
Long-term Auction for Power, Energy and CEL	Fulfill the requirements of clean energy and power; offer improvements to users and encourage investment in new projects.	19 Nov. 2014 (Call) 31 Mar. 2015 (Decision)

Source: (Rodriguez, 2015).

3. Renewable energy in rural areas

Efforts to solve the problem of rural electrification can be segmented into three major categories: a) public electricity service provided exclusively by CFE; b) specific actions that allow the use of electricity to different areas of rural Mexico (lighting, refrigeration, etc.); and c) projects with productive approaches to electrification and modernization of agricultural activities (pumping, agribusiness, etc.). Currently SENER and CFE develop the Comprehensive Services Project Energy (Psie) which aims to provide electricity through renewable energy systems in 86 remote rural communities. About 30 locations will be financed with World Bank funds and 53 through agreements with federal, state and municipal (SENER, 2014).

3.1. The development of the national electricity system

Among the themes of the Development Program of the National Electricity System (PRODESEN 2015-2029) is the extension of the distribution service. To this end, it is considered to promote distributed generation (DG), to study the feasibility urge Granjas Urban Solar (GSU) and to promote rural electrification. Distributed Generation (DG) refers to electricity generated by small sources, a power station connected to a distribution circuit that contains a high concentration of load centers. The standard capacities are in the range of 0.5 kW to 500 kW (Bravo, 2015). To promote the GD, it is necessary to:

- Promote the GD of renewable energy sources specifically;
- Study the next PRODESEN, expansion and modernization of general distribution networks that are necessary to connect the GD;
- Simplify interconnection procedures for GD projects;
- Promote the development of GD in areas where the benefits of this generation scheme bring the greatest benefits to the system;
- Promote the development of value chains and training the necessary human resources.

The Urban Solar Farms (GSU) consists in partially generating the electricity consumed by users in the very place of demand, by installing solar panels interconnected in generating collective farm mode. These projects use open spaces in places intended for developments such as residential developments, shopping centers and public lighting lots, boulevards and parks. The financing of schemes through Green Mortgages allow these places to be equipped with electricity developments by photovoltaic panels, solar water heaters, as well as efficient use of water systems.

The electrification of actions financed by the Electric Universal Service Fund will target rural communities and marginalized urban areas. To determine the attainable electrification needs is necessary to identify viable locations by analyzing them in a multidimensional way with the following variables:

- Technical aspects;
- Connectivity;
- Legality;

- Civil Security;
- Sustainability;
- Social Cohesion;
- Cost of installation and maintenance;
- Technical and economic feasibility.

3.2 Facilities experiences in rural areas

Between 1991 and 1997, the federal government implemented photovoltaic systems in 1,728 rural populations of 21 states of the republic. The program included a document containing "technical specifications for small photovoltaic systems for household lighting to rural areas" in which the minimum requirements for each component are considered, the technical bases to bid the purchase and installation centers, the training of engineers CFE and training of farmers, especially women and youth, which would permanently maintain the equipment. In total, 41,951 solar plants were installed in households and 667 community facilities, benefiting 233,634 people.

The program was a success in its construction phase due to the advice of the Institute for Electricity Research. To support the CFE, the decisive participation of state governments and the acceptance by the inhabitants of the communities, knowing the limitations of the service that would have been accepted. One of the elements for the functioning of the equipment is the support of the families who receive them, that, as always, have limited economic resources. For this reason, it is important to help and credit for spare batteries, lamps and other items for continuous operation. The federal government agreed with the governments of the states that they would be the ones who would offer the elements to support the continuity of service to beneficiary families. However, this situation did not occur in most cases (Escobar, 2011). A rigorous follow-up evaluation over a period of ten years, made in installed systems, indicates that although they did not receive help from the state or local governments, beneficiary families have kept working to the extent of their economic capabilities.

In 2010, as a result of the population census in 2010, it was found that most of the population without service corresponded to villages with over 100 inhabitants. Focusing on these populations, the program "White Flag" was structured, in order to electrify 1,160 rural populations by conventional farms and solar systems. The criteria for selecting the populations were determined as follows:

Conventional systems:
- With highway access.
- With advances in basic integration projects.
- With advances in management with the different entities.
- Located less than 10 km from the power line.

Non-conventional systems:
- More than 40 km of distribution network.
- Secure, not vulnerable to political and social problems or climatic and geological risks.
- With accessible roads.
- With users not dispersed.

Transcendence of the program is that the CFE will be responsible for operation and maintenance of facilities, will set the rates and charge the service to ensure continuity and sustainability. To prevent that the user exceeds the maximum demand, it was considered to install measurement equipment to temporarily disconnect service when this happens.

The following describes some renewable energy projects historically implemented in Mexico, emphasizing post-project observations and lessons learned (Huacuz, 2006).

Between 1970 and 1975, the "Tonatiuh" project was developed by applying heat pumps thermally activated by solar energy to improve the productive and health conditions in rural areas. The use of non-mature technology showed negative impacts on technological development, and caused the disenchantment of financial institutions, so it is not recommended to apply technology that has not been fully proved.

In early 1980, the project "Sonntlan" misaligned multistep for air conditioning of multi-family buildings with absorption systems (Solar settlement model). The technology used had an early development and technology wasn't scaled to the needs of the community that participated in the project definition. The lessons learned are that the systems should be designed to the actual needs and that the local community must be involved in the project. Due to the magnitude of project failure, the Mexican government has lost confidence in renewable energy.

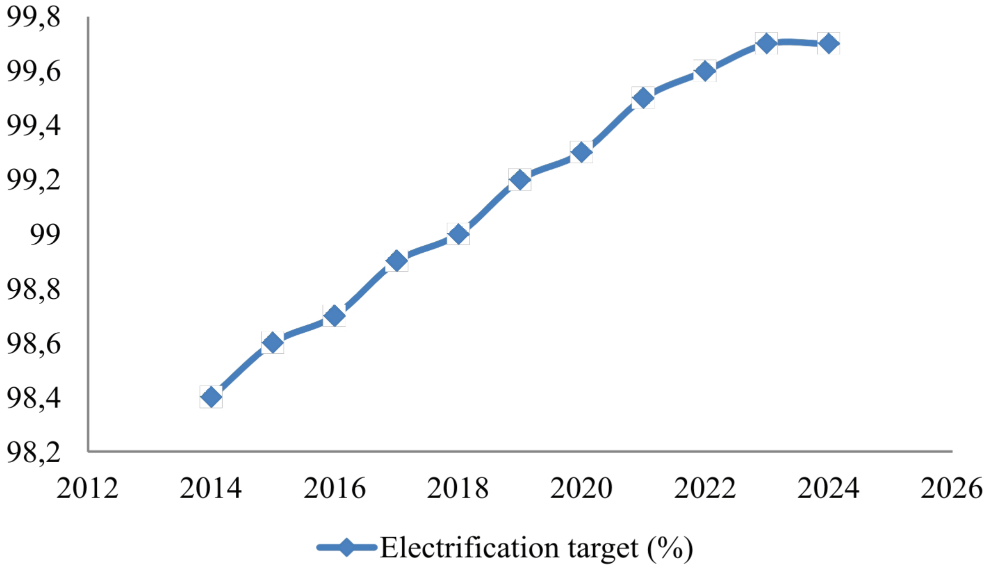
In the community of X'calak in the early 90s, mini community grids the basis of PV-wind-diesel were installed in a fishing community (~ 400 people). The system offered energy level of conventional network and included domestic, commercial and productive applications. Further analysis showed that the project failed to finish after-sales service contract. No measurement and / or tariff systems have been implemented, and some components proved not suitable for the coastal environment. The lessons learned indicate that the soft dimension is as important as the hard scale and that technology should be tested for the local environmental conditions, without giving by certain technical specifications. Finally, social issues also have great influence.

Among the lessons learned, the complementary aspects of the project that showed positive results always are: a) information, training and user participation; b) a solid normativity that at least apply parameters, qualifying companies, oversee the operation, make the components and protect the consumer, c) fed back financing with billing service resources in a community fund for maintenance of the project; d) quality assurance through technical specifications, design guides, laboratory tests and field evaluation procedures. Similarly, aspects that did not work: 1) after-sales service: supply of spare parts, technical assistance, etc .; 2) poor training and / or limited to the use of the systems; 3) building capacity to manage local communities funds; 4) capacity building for management of the systems; and 5) implementation of projects by municipal entities.

In late 2014, the country had an electric cover 98.4% of the population, representing 119,969,191 inhabitants and is still pending the provision 1,917,774 inhabitants, representing 1.57% of the total population. To promote rural electrification, isolated and highly dispersed communities should be considered, the use of renewable energy sources technologies, where this is most appropriate technical and economic solution.

In Mexico, there are 42,053 lacking of electric services locations, of which 2,056 correspond to places with more than 50 people (Bravo, 2015). Once the electrification needs were established, it was determined that the degree of electrification of 2024 is 99.8% for the benefit of 1,772,182 inhabitants, as shown in Chart nº 20.

Chart nº 20: Electrification target 2014-2024.



In 2015 the Comprehensive Service Energy Project, funded by the World Bank, coordinated by the Secretariat of Energy and executed by CFE aims to provide electricity to remote rural communities the power grid. The project began in October 2012, contemplating a simpler and reliable technology, centralized in solar farms. The aggregate amount of this project on June 2, 2015 is $ 433,313,683 MXN (SENER, 2015b).

Recently one of the systems for the electrification of small communities installed in Mexico, which integrated elements to take advantage of the experiences of other projects is the "micro sustainable network of community energy services" carried out by researchers from the Engineering Institute of the Autonomous University of Baja California. This micro network provides power during the 24 hours the 365 days a year for 20 families of Matomí plot in the municipality of Ensenada, Baja California. The system comprises 184 photovoltaic panels of 300 watts, connected in 12 arrays of 14 panels each, and other arrangements of two panels, 14, a total capacity of 55.2 kW; a wind turbine of 5 kW operating at 20 m in height; a diesel generator 75 kVA; 174, and batteries.

Funding for the development of the project came from the Convocation of the Sector Fund of Sustainable Energy of the National Council of Science and Technology, which contributed 7 million pesos, of which 5 were invested in the construction of micro network. The project, in addition to equipment installation, included the development of a manual and courseware for an awareness campaign on the efficient and rational use of energy; the training of personnel who would perform the operation, maintenance and fault detection in the device; and a network with smart meters with the ability to transmit information to prepare accounts and invoices.

Among the contributions of greater impact in terms of administration and management for the continued operation of the system, is the creation of an organizational manual for the operation of the network and regulation of the electricity service to residential and commercial use in the community.

The network organization manual describes the micro network will be managed by a cooperative society is constituted and formed by community members. It also indicates the mission, objectives and functions necessary to facilitate coordination between the units and additional participants, defining at the same time, the responsibilities of each. As a management tool, the manual provides and offers guidance for users who eventually integrate into the project.

The organizational model proposes a cooperative society formed by householders as a representative figure of the users, for the proposition and decision making related to micro network; a local assistant in charge of the monitor, maintenance, reading of consumption, production and delivery to users of accountability; technical support, which will provide the necessary technical support to the local assistant; and a financial services provider (bank), responsible for receiving, protecting and distributing funds from the payment of users (EEC, 2015).

The regulation sets, in detail, the terms used in the description of the procedures, schedule of contributions, obligations of members, business conditions, and the actions in case of eventualities in consumption or the service, such as inconveniences in measurement, measurement periods, user notice, payment of invoices, due invoices, suspension or interruption in the supply, receipt of complaints, claims, deadline for service reconnection and responsibilities limit the utility and users. They also describe the procedure and organization for the billing process, service payment, soliciting funds, technical support, preventive maintenance, membership users, membership TAs, receiving complaints and suggestions, reports, analysis, service conditions to public, recover damages, application of the contribution, in addition to the technical requirements for the meter installation (UABC, 2015).

Conclusion

The energy reform recently made by the government promotes competition and encourages private investment, facilitating the integration of renewable energy, through the incorporation of individual producers in a market where they compete with conventional energy sources. In 2015 the generating capacity from renewable energies in Mexico represented 25.3% of total generation capacity and considering the existence and viability of renewable resources still untapped, it is feasible that 35% of electricity generation by 2024 comes from clean energy. The growth of the electric system coverage for rural communities began with the demands of the sector and began its development with the federal government's efforts through collaboration with CFE and research centers.

The success of projects on renewable energy in these areas depends largely on the degree of community involvement for its design, operation, maintenance and self economic sustainability, so that training in an administrative level becomes an important addition to technical training. Recent projects of electrical service extension in rural communities are performed by the Secretariat of the joint action of Energy and CFE, with the financial support of the World Bank.

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GENERATION AND ACCESS TO RENEWABLE ENERGY IN MEXICO

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Abstract: Climate change and the energy sector are deeply connected, since the combustion of fossil fuels for power generation plays an important role in increasing the concentration of GHGs in the atmosphere, and because the energy sector itself is vulnerable to the effects of climate change. However, while the energy sector may negatively impact climate stability, it may also contribute to a positive change. In Latin America, there is plenty of natural resources and also potential to expand the use of renewable sources for self-supply and even exportation. Given this context and Mexico's role in the regional energy transition, this paper aims to analyze the current conditions of the energy sector in the country, with special emphasis on the transition to a renewable matrix and on rural population's access to electrification. We believe that in spite of having a largely fossil matrix, Mexico has been implementing domestic regulatory and institutional reforms as part of a strategy to enable the expansion of renewable energy in its local matrix in the coming decades. This research constitutes an exploratory case-study, using bibliographic and documentary sources, and holds descriptive and purposeful aspects.

Keywords: Renewable Energy – Rural Electrification – Mexico – Energy Transition – Energy Security.

Introduction

The planet is currently experiencing a period of ecosystem changes that send a warning to the international community. After centuries of Industrial Revolution and a model of production and consumption that does not internalize environmental costs or exploits natural resources in a way that exceeds the renewal capacity of the Earth's cycles, problems such as water

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scarcity, soil contamination, desertification, climate change, biodiversity loss and the deterioration of air quality provoke an intense debate in the international sphere and spark reflection in various fields of knowledge in search of alternatives and solutions. There is no doubt that human activity is causing environmental changes in a way never experienced before[4].

Environmental problems and human development are deeply connected issues - as discussed at the 1972 Stockholm Conference and consolidated in the following decades. Desertification and extreme weather events, for instance, affect rural and traditional populations, especially in developing countries, whose survival is linked to agriculture and livestock. Deforestation and the consequent loss of biodiversity impact the lives of countless communities that rely on forests for food, medicines, and even their cultural and spiritual identity[5]. The dissemination of environmental liabilities causes death and illnesses in both developing and developed countries[6]. The scarcity of water and other natural resources, and environmental disasters – in direct or indirect consequence of human activity - trigger political instability, catalyze the occurrence of armed conflicts and generate environmental migrants[7]. This reality imposes numerous political and technological challenges, especially regarding energy production and consumption. In addition to the importance of ensuring energy security (energy supply and access to energy) for the next decades, this issue is directly related to climate change and it's consequences tend to especially affect the most vulnerable populations, undermining the possibility of overcoming poverty.

The Intergovernmental Panel on Climate Change (IPCC) already attested to a high degree of certainty[8] that climate change is an anthropogenic phenomenon. Fossil fuels have been the main energy source of contemporary society, especially oil, coal and natural gas. In addition to the environmental impacts caused by their exploitation, our high dependence on these resources has geopolitical consequences due to the location of the reserves, creating

4 ELLIOT, Lorraine. **The Global Politics of the Environment**. Basinstocke: Macmillan Press, 1998, 1ª ed.

5 *Ibidem.*

6 *Ibidem.*

7 LE PRESTE, Phillipe. **Ecopolítica Internacional**. São Paulo: Editora Senac São Paulo, 2005, 3ª ed.

8 The climate science does not work with evidence, but with models, confirming trends and likely scenarios. ELLIOTT, Op. Cit.

energy security issues, as these non-renewable resources are limited[9]. Climate change and the energy sector have a deep relationship with each other, as the combustion of fossil fuels for power generation plays an important role in increasing the concentration of greenhouse gases (GHGs) in the atmosphere, and also because the energy sector itself is vulnerable to the effects of climate change[10]. However, while the energy sector can negatively harm the climate stability, it can also contribute to positive changes. There are two main lines of action to combat this phenomenon: the mitigation of emissions and adaptation. Therefore, investing in renewable energy and energy transition towards a low carbon economy are not sufficient conditions, but are necessary to limit emissions at a level considered safe, which for the IPCC[11] is of 450-550 ppm[12].

Globally speaking, Latin America has a leading position in the production of low-carbon energy, mainly because of its hydroelectricity and biomass resources[13]. The region is abundant in natural resources and has the potential to expand its usage of renewable sources for self-supply and even for export. Moreover, as recalled by Flavin *et. al*[14], "the production and consumption of electricity are positively correlated with economic growth." Although most countries have a small fossil energy matrix, Argentina, Ecuador, Mexico and Venezuela and some Caribbean islands, are exceptions[15]. Among the countries of the region, Mexico is the largest emitter of CO_2 from electricity generation, releasing two times more GHGs in the atmosphere than the second-placed

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10 FLAVIN, Christopher; GONZALEZ, Gonzalez; MAJANO, Ana Maria; OCHS, Alexander; ROCHA, Maria da; TAGWERKER, Philipp. **Study on the Development of the Renewable Energy Market in Latin America and the Caribbean**. Inter-American Development Bank (IDB), Washington, DC, 2014.

11 IPCC. **Climate Change 2014 Synthesis Report: Summary for Policymakers.** Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 2014, 151 pp.

12 Before the Industrial Revolution, the concentration of GHGs in the atmosphere was 280 parts per million (ppm), and the current level is approximately 430 parts per million (ppm) of CO2. To prevent the rising of the global temperature above 2°C - which is one of the goals of the climate regime - it is necessary to stabilize emissions between 450 and 550 ppm (*idem).*

13 FLAVIN *et al*., Op. Cit.

14 *Ibidem,* p. 14.

15 ICSU - LAC. Science for a Better Life: Developing Regional Scientific Programs in Priority Areas for Latin America and the Caribbean. Volume 3. Gazzoni, D.L., Azurdia, I., Blanco, G., Estrada, C.A., and Macedo, I. de C. **Sustainable Energy in Latin America and the Caribbean: Potential for the Future**. ICSU-LAC / CONACYT, Rio de Janeiro and Mexico City, 2010, 114 pp.

State (Argentina)[16]. However, under the United Nations Framework Convention on Climate Change (UNFCCC), Mexico is bound to reduce 25% of its GHGs emissions by 2030[17], and, since 2008, it has been promoting normative and institutional domestic reforms in order to seek diversification in its energy matrix with more renewable sources. While about 98% of the Mexican population has access to electricity[18], the people without it live in isolated areas, mostly rural and dispersed throughout the territory, which creates a challenge to the expansion of the power grid and, in this case, renewable energy can be an economically more efficient alternative.

Considering the importance of the previously exposed context and the role that Mexico has in the regional energy progress, the present paper aims to analyze the current circumstances of the Mexican energy sector, with emphasis on its transition to a cleaner energy matrix and the access to electricity by rural populations. Despite having a largely fossil matrix, Mexico is carrying out a series of domestic regulatory and institutional reforms as part of a strategy to enable the expansion of renewable energy in the upcoming decades. This research is an exploratory case-study survey, applying bibliographic and documentary sources, with a descriptive and purposeful nature. As it describes Mexico's current energy situation, as well as its challenges and potential, we suggest possible improvements in Mexican energy plans and policies in order to achieve universal access to clean energy by the general and rural population.

This article is structured as follows: the first section describes the electricity generation in Mexico, focusing on renewable energy (RE). It emphasizes the potential exploitation of water, wind, solar light, geothermal

[16] FLAVIN *et al.*, Op. Cit.

[17] According to Mexico's communication document to the Convention on Climate Change, sent during the preparation of COP 21, in Paris, and regarding the Intended Nationally Determined Contribution, the country "is committed to unconditionally reduce 25% of its greenhouse gas emissions and climate pollutant emissions of short-lived (below BAU) for the year 2030. This commitment implies a 22% reduction of greenhouse gases and a 51% reduction of black carbon emission" based on emissions of 2013. UNFCCC. **Intended Nationally Determined Contribution**, México, 30/03/2015. Available at: <http://www4.unfccc.int/submissions/INDC/Published%20Documents/Mexico/1/MEXICO%20INDC%2003.30.2015.pdf>. Access: 23 August 2016. However, in terms of national commitment, the guidelines of the *Ley General de Cambio Climático* (LGCC) of 2012 set a 30% reduction of GHG emissions by 2020 and 50% by 2050, based on 2000 emissions. SECRETARIA DE MEDIO AMBIENTE Y RECURSOS NATURALES. Guía de Programas de Fomento a la Generación de Energía com Recursos Renovables. México, Secretaria de Medio Ambiente y Recursos Naturales, 2015, 3 ed. Available at: <http://www.gob.mx/cms/uploads/attachment/file/47854/Guia_de_programas_de_fomento.pdf>. Access: 25 August 2016.

[18] CFE. **Programa de Ampliación y Modernización de las Redes Generales de Distribución 2015 – 2019**. Mexico, April 2015.

energy and biomass, as well as the existing power plants and the advantages and disadvantages of investing in each source in the Mexican context. After describing the power production, the second section details the energy access frame with special attention to rural electrification. The third section discusses the legislation and the institutional framework in force in Mexico's energy sector and presents the currently reform being implemented in the country. All sections identify problems in infrastructure and public policies adopted to achieve universal access to energy as well as the obstacles to a more intense use of renewable energy sources. Finally, based on gathered elements, we will present some suggestions for Mexico, in order to increase energy access among rural population, expand the use of renewable sources and ensure the implementation of an energy reform that promotes transition to clean and renewable energy matrix.

1. Current scenario and the potential for electricity generation from renewable sources in Mexico

Mexico, alongside Brazil, is the largest economy in Latin America and the Caribbean. With a population of approximately 123.8 million inhabitants, it has an installed power capacity of 64 GW, with only about 25% of which coming from renewable sources[19]. Electricity production in Mexico is based on high-cost fossil fuel, with supply deficiencies[20]. In 2014, the energy framework of the power sector was composed of natural gas (56%), major hydropower plants (19%), oil and diesel (13%), coal (4%), wind (3%), nuclear plants (2%), geothermal energy (1.3%), small hydropower plants - SHP (1%), biomass and waste (0.4%) and solar energy (0.1%)[21]. Despite the massive presence of non-renewable fossil fuels in the Mexican energy matrix, the country currently faces a trend of expanding the use of clean energy sources, whether for environmental, health or economic reasons. If the current rate of consumption is preserved, the useful

[19] GLOBAL CLIMATE SCOPE. **Climate Scope 2015: The Clean Energy Country Competitiveness Index**, 2015. Available at: <http://global-climatescope.org/en/download/>. Access: 05 June 2016.

[20] CANCINO SOLORZANO, Yoreley; VILLICAÑA ORTIZ, Eunice; GUTIERREZ TRASHORRAS, Antonio; XIBERTA BERNAT, Jorge. **Electricity sector in Mexico: Current status. Contribution of renewable energy sources.** Elsevier, 13/07/2009, 454p -461p.

[21] GLOBAL CLIMATE SCOPE, Op. Cit.

life of Mexico's national reserves is, for example, less than 10 years for crude oil and natural gas[22], which is an incentive to invest in new energy sources.

The country has great potential and growth capacity in the area of sustainable energy, given the fact that its geographical location is favorable for the use of clean and renewable energy sources[23]. Due to the high incidence of solar radiation, Mexico has one of the largest potentials for exploitation of photovoltaic energy in the world[24]. Moreover, this is a viable alternative to areas not connected to the regular power grid for both electricity generation and solar thermal heating. Its position between the air currents of the Gulf of Mexico and the Pacific Ocean is also ideal for wind energy production. Furthermore, the wind conditions in the Isthmus of Tehuantepec, in the state of Oaxaca, in southern Mexico, are one of the world's best[25]. This is because the Isthmus is the narrow strip of land in the Mexican territory, where only 200 kilometers separate the Gulf of Mexico from the Pacific Ocean. Other features of the territory provide the country with great advantages in this sector, such as high tectonic and volcanic activity, with potential for the use of geothermal energy, and the river rapids and large lakes, which represent opportunities for hydroelectricity[26]. The latter is the most exploited renewable energy source in Mexico, with approximately 64 hydroelectric plants (57 operating and 7 not operating)[27]. Referring to geothermal energy - despite representing just over 1% of the Mexican matrix -, its current usage is enough to rank the country as the third in the global geothermal energy production[28].

The states of Veracruz, Puebla, Chiapas, Nayarit and Guerrero, all located in the center-south portion of the Mexican territory, have great potential for the hydropower generation. Specifically in the states of Nayarit (Midwest) and Guerrero (Southwest), the power plants of El Cajon and La Parota, respectively,

22 CANCINO-SOLÓRZANO *et al.*,Op. Cit.

23 *Ibidem.*

24 ROLDÁN, Francisco Torres; MORALES, Emmanuel Gómez. **Energías Renovables para el Desarrollo Sustentable en México**. México: SENER - Secretaría de Energía; GTZ - Deutsche Gesellschaft für Technische Zusammenarbeit, 2006.

25 *Ibidem*.

26 CANCINO-SOLÓRZANO *et al.*, Op. Cit.

27 BAZAN NAVARRETE, Gerardo; ORTIZ MUÑIZ, Gilberto. **Uma mirada a la electicidad.** Available at: <http://energiaadebate.com/una-mirada-a-la-hidroelectricidad/>. Access: 16 July 2016.

28 REUTERS. México y Costa Rica buscan energías limpias en sus volcanes. **La jornada en línea,** 03/05/2016. Available at: <http://www.jornada.unam.mx/ultimas/2016/05/03/mexico-y-costa-rica-buscan-energias-limpias-en-sus-volcanes>. Access: 14 August 2016.

can be found. Both of them faced opposition from environmental institutions and challenges of economic, social and political nature during their installation process[29].

Other relevant plants are Infernillo, in the state of Guerrero, and Manuel Moreno Torres and Mal Passo, both located in Chiapas. Despite the growth of the sector, there are difficulties to consolidate its expansion, mainly since local groups oppose to the construction or operation of hydroelectric plants. This is because some plants are located in the upstream portion of the rivers, impacting biodiversity and the local population, especially given the reduction of water flows that would impact the local flora and fauna and, consequently, the way of life of the population. In addition to the problems with local groups, installation costs are also relevant. Spending on the construction of these projects are generally higher than foreseen during planning, and there are also high costs with environmental impact analysis, licensing, historical and archaeological mitigation, water quality monitoring, etc[30]. Although the installation costs are significant, the costs of maintenance and operation of major hydropower plants and SHPs are low, being an attractive source of clean and renewable energy.

As for wind power, Mexico has 31 parks in operation or under construction, with more than 1,660 wind generators[31]. The states with the most significant wind power production are Oaxaca with an installed capacity of 2695.97 MW, San Luis Potosi with 200MW, Baja California with 166 MW, Puebla with 66MW, Tamaulipas with 54 MW, Jalisco 50 MW, Chiapas with 29 MW and Nuevo León with 22 MW[32]. In Oaxaca, one can find the La Venta II park, built in an area regarded as the best in the world for electricity production [33], as its conditions allow the production of energy during both day and night.

In total, Mexico uses only 3.2% of its wind power production capacity, which translates into an attractive sector for investments. Moreover, generation costs have dropped significantly in recent years (not counting the state incentives) as to compete with traditional energy sources. Therefore, 78%

29 INSPIRACTION. **Contaminación del aire em México**. Available at: <https://www.inspiraction.org/cambio-climatico/contaminacion/contaminacion-del-aire-en-mexico>. Access: 16 July 2016.

30 BAZAN NAVARRETE; ORTIZ MUÑIZ; *idem.*

31 SECRETARIA DE MEDIO AMBIENTE Y RECURSOS NATURALES, 2015, Op. Cit.

32 *Ibidem.*

33 INSPIRACTION, Op. Cit.

of wind farms in Oaxaca are in the hands of the private sector and 22% are state owned facilities[34]. Among the main challenges for the sector's expansion is the difficulty faced in the installation of wind plants, which often face resistance from with local communities (especially indigenous). This is because companies, especially private ones, demand large tracts of land and sea to the development of its activities, removing populations from their land interfering their traditions, beliefs and economic activities[35].

Despite it's huge potential, the exploitation of solar energy in Mexico is currently undeveloped. About 75% of the territory receives an average 5kWh/m²/day, which makes it ideal for the use of photovoltaic panels. Also, it is worth noting that such panels have very simple installation processes[36].

There are regions in the Northwest part of the Mexican territory with an even higher radiation rate (6kWh/m²/day)[37]. According to the *Asociación Mexicana de Energia Solar*, Mexico has 36 photovoltaic projects in different implementation stages[38]. One of the most important parks is *Aura Solar I*, in the state of Baja Califórnia (Northwest), which supplies the demand of 164,000 inhabitants. The project has a lifespan of 30 years and US$ 100 million were spent in its construction (75% of this amount were contributed by the International Financial Corporation of the World Bank and by the *Nacional Financeira*, and 25% by the Corporation Solar Aura). It occupies an area of 100 hectares, with 132,000 solar panels installed, and generated 400 jobs in its construction[39]. The operation of this solar park significantly reduces the burning of fossil fuels, avoiding the emission of 60,000 tons of CO_2 per year and mitigates risks in the transport of oil in environmentally sensitive areas, such as the Sea of Cortés (World Heritage Site by UNESCO). Another important project

34 FLORES, Pepe. Energia eólica en mexico, en manos de iniciativa privada. **Veo Verde.** 2 January 2014. Available at: <https://www.veoverde.com/2014/01/energia-eolica-en-mexico-en-manos-de-la-iniciativa-privada/>. Access: 16 July 2016.

35 BARRAGAN, Daniela. Parques eólicos: la cara del despojo em el istmo de Tehuantepec. **Sin embargo.mx.** 1 April 2015. Available at: <http://www.sinembargo.mx/01-04-2015/1298234>. Access: 16 July 2016.

36 INSPIRACTION, Op. Cit.

37 ICSU-LAC, Op. Cit.

38 NOTIMEX. Conermex inagura el parque fotovoltaico mas grande del sureste de Mexico. **El financeiro**. 11 November 2014. Available at: <http://www.elfinanciero.com.mx/empresas/conermex-inaugura-el-parque-fotovoltaico-mas-grande-del-sureste-de-mexico.html>. Access: 17 July 2016.

39 CALDERON, Carla. El parque solar mas grande de AL está e Mexico. **Manufactura.** 26 March 2014. Available at: <http://www.manufactura.mx/energia/2014/03/26/el-parque-solar-mas-grande-de-al-esta-en-mexico>. Access: 17 July 2016.

was developed in the Southeast, in Yucatan, which, with an investment of 13 million Mexican pesos, produces 4.324KW through 208 solar panels, provides electricity to a local factory, and prevents the emission of 7,000 tons of CO2 into the atmosphere[40]. Currently, the solar parks of Sonora and Chihuahua, in the north, are under construction[41]. There are other solar power plants being constructed in Durango, Jalisco, Guanajuato, San Luis Potosi and Yucatan[42].

In comparison with other REs, the solar power generation has a high energy yield per hectare (five times more than wind and ten times more than cane sugar) and a high thermodynamic efficiency[43]. In spite of being one of the highest initial costs to build the installation - due to the fact that the materials necessary for its construction are imported - its operating and maintenance costs are low[44]. Accordingly, the central aspect for the development and expansion of the use of solar energy in Mexico is the investment in research and technology in developing a domestic market for the sector[45]. This objective can be achieved through appropriate public policies to encourage university research in the area, promoting innovation. In Mexico, the main institutions that have developed research in this field are: the *Centro de Investigación en Energía de la Universidad Nacional Autónoma de México* (UNAM), the *Instituto de Ingeniería* (also from UNAM), the *Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional*, the *Instituto de Investigaciones Eléctricas* and the *Asociación Nacional de Energía Solar*[46]. Other obstacles to this kind of energy are the enormous amount of land necessary for the installation of the solar parks and the material's life span, which may vary from 15 to 30 years, depending on the technology used. However, it is an energy source that can be distributed

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40 NOTIMEX, Op. Cit.

41 With an investment of US$70 million and forecast to generate 40,1GWh in the first year, supplying 5,838 families, it is expected to be the second largest park in the country. RODRIGUEZ, Carla. Arranca el segundo parque solar más grande de Mexico. **El financiero.** 18 April 2016. Available at: <http://www.elfinanciero.com.mx/economia/arranca-el-segundo-parque-solar-mas-grande-de-mexico.html>. Access: 17 August 2016.

42 GARCIA, Karol. **Energía fotovoltaica brillará con fuerza en los próximos cinco años**. El economista. 19 November 2014. Available at: <http://eleconomista.com.mx/industrias/2014/11/19/brillara-fuerza-energia-fotovoltaica>. Access: 14 August 2016.

43 ELY, Fernando; SWART, Jacobus W. Energia solar fotovoltaica de terceira geração. O Setor Elétrico, Espaço IEEE - Institute of Electrical and Electronic Engineers, Out. 2014, p. 138-139. Available at: <http://www.ieee.org.br/wp-content/uploads/2014/05/energia-solar-fotovoltaica-terceira-geracao.pdf>. Access: 23 August 2016.

44 *Ibidem.*

45 ICSU-LAC, Op. Cit.

46 ICSU-LAC, Op. Cit.

in various parts of the country, including areas of difficult access, unreached by conventional power.

The renewable energy source with the lowest cost of generation is the geothermal. While it demands only US$ 52 per MWh produced, solar energy has a cost of US$ 280, biomass costs US$ 131 and wind power costs US$ 100[47]. Mexico is among the four countries, alongside the United States, the Philippines and Indonesia, with the largest production of geothermal energy. Among the five existing geothermal fields in the country, four of them are operated by the State-owned *Comisión Federal de Electricidad* (CFE) and one by the private company Dragón Group[48]. The plant *Cerro Prieto*, in the state of Baja California, is considered the second largest in the world and has a generating capacity of 720MW - of which only 540MW are effectively produced[49]. The energy produced there supplies nearly half of the power demand of Baja California and also allows exportation to the United States[50]. Another important plant is the *Los Azufres,* in Michoacan, which has been operating since 1982 and continues to expand. In the neighboring state of Puebla, the *Los Humeros* plant received investment of 1,748 million Mexican pesos (in 2014) for the installation of geothermal equipments[51]. The *Humeros III fase A* has an installed capacity of 25MW, which produces 200GWh per year, providing power to 40,000 people a year[52].

While the cost of generating this type of energy is low, the investment for the installation of geothermal plants is significant. As it is energy extracted from the subsoil, its installation process is very time-consuming and expensive, in addition to the specific machinery costs, environmental impact analysis, soil analysis, etc. Furthermore, the geothermal power generation may create risks, such as toxic emissions that,in the event of an accident, can be lethal.

47 MEANA, Sergio. Energia geotérmica, una de las apuestas fuertes del futuro. **El financiero.** 01 April 2014. Available at: <http://www.elfinanciero.com.mx/economia/energia-geotermica-una-de-las-apuestas-fuertes-del-futuro.html>. Access: 17 July 2016.

48 SECRETARIA DE MEDIO AMBIENTE Y RECURSOS NATURALES, 2015, Op. Cit.

49 RODRIGUEZ, Eugenio. Las plantas de energía geotérmicas más grandes del mundo. **Fieras de la ingeniería.** 03/11/2014. Available at: <http://www.fierasdelaingenieria.com/las-plantas-de-energia-geotermica-mas-grandes-del-mundo/>. Access: 17 July 2016.

50 SECRETARIA DE MEDIO AMBIENTE Y RECURSOS NATURALES, 2015, Op. Cit.

51 TIRZO, Ivan. Los humeros, volcán que produce energía. **Milenio.** 08 May 2014. Available at: <http://www.milenio.com/region/Humeros-volcan-produce-energia_0_295170485.html>. Access: 17 July 2016.

52 *Ibidem.*

The energy produced cannot be transported, since it must be consumed in the same place where it is generated, and has limited availability because only few parts of the country have the necessary requirements for its exploitation. On the other hand, it has the advantage of being a continuously available resource, as it does not rely on variables such as rain or wind. It also doesn't demand large territorial areas for their installation, doesn't generate significant emissions nor it requires improper water drainage.

Finally, one of the energy sources most used by the general population until the Industrial Revolution and still being used on a small scale nowadays, is the generation of biomass. In Mexico, biomass represents 4.22% of total primary energy, and its production basically uses forest wood in the form of firewood and charcoal. From all that is produced, 66% goes to the domestic industry. The installed capacity for the generation of biomass in Mexico is 680,6 MW[53], 90% of which coming from combustion of sugarcane, and the remainder of biogas from various sources. In the state of Veracruz, a biomass power generation plant from sugar cane can be found, which, after an investment of 200 million Mexican pesos, prevents the emission of 3.6 million tons of CO_2 in the atmosphere - the equivalent to the removal of 70,000 cars from the roads[54]. Another interesting plant is located in the state of Aguascalientes. This was the first in the country to generate energy from biomass of nopal[55]. In Calvillo - a community of Aguascalientes - it is produced 150 tons of nopal per day. This production can generate little more than 1 MW, considering that the production of 1 MW requires 120 tons of nopal[56]. Another kind of material useful for the

53 HUACUZ VILLAMAR, Jorge Maximiliano. La biomasa en la transición energética de Mexico. **Instituto Nacional de Electricidad y Energias Limpias**. June 2015. Available at: <http://www.iie.org.mx/boletin022015/divulga.pdf>. Access: 20 July 2016.

54 ADRIANA. Mexico y su nueva planta de biomasa. **Renovables Verdes.** 17 May 2011. Available at: <http://www.renovablesverdes.com/mexico-y-su-nueva-planta-de-biomasa/#comments>. Access: 19 July 2016.

55 Nopal is a Mexican term for Opuntia cactus, which grows naturally in most parts of Latin America. In Mexico, nopal is an ingredient in traditional cooking, and is known as a source of life - even used by the Aztecs. (INNATIA. O que é o nopal. **Innatia.** Available at: <http://br.innatia.com/c-frutas-propriedades-fr-pt/a-o-que-e-o-nopal-8466.html>. Access: 15 June 2016). As it demands small amounts of water and minimal care, nopal grows intensely in the desert regions of Mexico, and it is a good source of biogas, since it does not imply deforestation and all waste produced by the power generation process can be used as biofertilizers. Thus, it is a sustainable source (AUSTRYJAK, Dania Vargas. *Mexico turning to nopales to produce energy*. México News Network, 30 March 2015. Available at: <http://www.mexiconewsnetwork.com/adventure/nopal-energy/>. Access: 15 August 2016).

56 WONG, Alma Paola. Alistan planta que genera electicidad con nopal. **Milenio.** 10 May 2015. Available at: <http://www.milenio.com/cultura/Alistan-planta-genera-electricidad-nopal_0_515348478.html>. Access: 19 July 2016.

generation of energy from biomass is urban waste, as applied, for example, in the operation of the subway in the city of Monterrey. It operates through to the use of biogas produced during the decomposition of waste and transports 470 citizens per day[57]. Although the generation of energy from biomass is very positive for the environment, it faces challenges related to the costs for storage and transport. It is also important to highlight that it takes a very large quantity of biomass to produce the same amount of energy as a fossil fuel.

It is clear that Mexico has great potential for the exploitation of clean and renewable electricity. As noted, there are economic and technological challenges for the implementation and maintenance of REs generation. The production cost also is a decisive factor in encouraging or delaying investments in this sector. Plants that require vast land area to operate still face social issues as they involve negotiating with local traditional populations that inhabit the region. However, since excessive dependence on a single energy source - such as natural gas, whose national reserves are finite- threatens the country's energy safety, investment in REs is a viable alternative to the diversification of the Mexican matrix. Moreover, in addition to helping Mexico to comply with its international commitments under the climate regime, the REs are an economically viable alternative for rural electrification in the country. Thus, after presenting Mexico's energy conditions focusing on its potential for the exploitation of renewable and clean energy sources, the present paper will analyze the access to energy and electrification in rural areas.

2. Rural Mexico: features and access to energy

As disclosed by the Rural Policy Reviews (2007, Organization for Economic Cooperation and Development), between 24% and 38% of the Mexican population lives in rural areas (according to different definitions). These people contribute with only 2% of the Mexican Gross Domestic Product (GDP). As they constitute low-income regions, with widespread low agricultural production or even subsistence production, a considerable portion of the economically active

[57] GUERRERO, Luz. Metro de Monterrey: un ejemplo de energía sustentable. **Vida Verde.** 20 April 2016. Available at: <http://vidaverde.about.com/od/Energias-renovables/a/Metro-De-Monterrey-Un-Ejemplo-De-Energia-Sustentable.htm>. Access: 19 July 2016.

rural population migrates to urban areas looking for better opportunities. This reality intensifies the lower growth of the rural population when compared to the national and urban growth rates. This scenario consolidates the low economic productivity of the rural regions[58], as shown in Figure 1 on the next page. This framework, however, is not homogeneous. Although Mexican rural area has lower development indicators in comparison to urban areas, the former has well-developed regions and a small portion of the population has high income levels, mainly in the sectors of agriculture, forestry extraction and fishing, in addition to an increasing development in the sectors of tourism and services. These regions are also marked by a high dispersion, because 24% of the rural population lives in more than 196,000 remote locations, which have less than 2,500 inhabitants each, occupying approximately 76% of the total national territory[59]. In Chart nº 2, this profile can be seen. The white areas represent urban regions, according to the OECD classification, and the blue areas are rural zones, which, when very concentrated, are shown in dark blue. The complexity of access to rural areas is aggravated by the lack of local infrastructure such as roads, transport, electricity and services in general[60].

58 OCDE - Organização para a Cooperação e Desenvolvimento Econômico. **OECD Rural Policy Reviews Mexico**. Paris, France2007. ISBN 978-92-64-01152-6.

59 *Ibidem.*

60 M. HUACUZ, Jorge, MARTÍNEZ, Ana Maria. *Renewable energy rural electrification – Sustainability aspects of the Mexican programme in practice.* **Natural Resources Forum**, Estados Unidos, Vol. 19, Nº 3, pp. 223 – 231, 1995.

Chart nº 1: Relationship between rural and urban areas in Mexico: GDP, population and territory.[61]

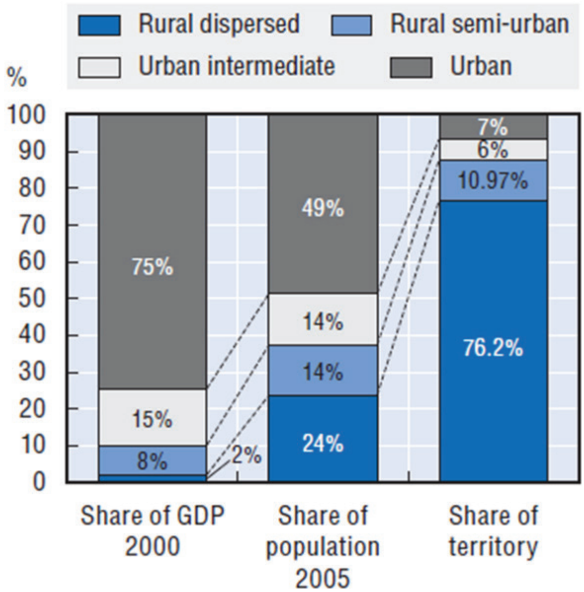

Chart nº 2: Map of urban and rural locations.[62]

- Localities with less than 2,500 inhabitants;
o Urban areas.

[61] *Ibidem.*

[62] OCDE, Op. Cit.

Regarding the distribution of power, these rural areas with small population and low income are the ones with the least access to electrification and with energy consumption that is significantly lower than the standards of urban centers. According to Huacuz *et al*, only the richest 10% of the people in these communities have an electricity consumption equivalent to the urban average rate. While the consumption in urban areas is 234kWh/month, in the smaller rural communities the average is 16kWh/month. In addition, power application also has a distinct pattern in more restricted rural areas. In those, electricity is used primarily for lighting and entertainment[63], while in urban zones it is applied mostly to run refrigerators, televisions and air[64]. In contrast to this profile, the Mexican states with less access to electrification are also those with great potential for exploration of REs, as Oaxaca (4.36% of the population with no energy access), Guerrero (4.05%), Chiapas (3.96), San Luis Potosi (3.48%), Durango (3.18%), Chihuahua (3.04%), Tamaulipas (2.62%), Nayarit (2.34) and Veracruz (2 32) 65.

It is possible to list various social benefits from the access to electricity in rural communities, such as operating services during the night - education, for example; the ability to store and refrigerate food, vaccines and other goods; access to information and communication mainly through radio, TV and telephone; and increased productivity through automated irrigation and harvest processing. These are just some of the advantages from rural electrification that can generate significant impacts on the safety, public health, education, entertainment and economy of these communities. Therefore, access to electricity is considered a necessary condition for regional development.

In Mexico, the beginning of the development and implementation of rural electrification from renewable energy was more motivated by the characteristics of the concerned regions than by a genuine effort of the Mexican government to prioritize this type of endeavor[66]. In view of the difficult access, the fact that

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63 *Ibidem*.

64 ROSAS-FLORES, Jorge Alberto; ROSAS-FLORES, Dionício; GÁLVEZ, David Morillón. *Saturation, energy consumption, CO_2 emission and energy efficiency from urban and rural households appliances in Mexico*. **Energy and Buildings**. Suíça, Vol. 43, Nº 1, 10 – 18. Available at: <http://www.sciencedirect.com/science/article/pii/S0378778810002951>. Access: 15 July 2016.

65 CFE. **Programa de Ampliación y Modernización de las Redes Generales de Distribución 2015 – 2019**. México, April 2015, 91p.

66 M. HUACUZ, Jorge, MARTÍNEZ, Ana Maria. *Renewable energy rural electrification – Sustainability aspects of the Mexican programme in practice*. **Natural Resources Forum**, United States, Vol. 19, Nº 3, pp. 223 – 231, 1995.

these areas do not constitute centers of great economic relevance, and given their lower energy consumption compared to metropolises, it was found that it would be impractical to invest in the extension of the conventional power grid to supply and distribute power to rural areas. After all, the necessary infrastructure to expand the power grid to these areas requires large initial amounts of capital that are not justified by the proportion of the prospecting power consumption or economic returns in these communities. Accordingly, in the mid-1990s, it was noted that renewable energies, particularly photovoltaic and wind-photovoltaic hybrid systems, constitute a more economically viable source than the traditional ones in order to achieve rural electrification, since they were relatively cheaper and adaptable to the local conditions than the power grid extension[67].

However, it must be emphasized that at the beginning of this process, the implementation of renewable electrical systems was seen as means to provide a minimum amount of electricity consumption - increasing usage and the demand for electricity by the benefiting community - to finally make the extension of the traditional power grid financially attractive. However, such approach was discouraged right after the successful implementation of the first systems, and since then the REs have received more and more support as one of the most viable choices for rural electrification[68].

Many of the difficulties arising from the electrification through ERs in rural Mexico are the same experienced in the process of introducing other services and infrastructure, mainly due to the high dispersion and the difficult access to these regions. However, there are obstacles related exclusively to the implementation phase of clean energy sources. Scholars like Huacuz, who have long field experience on the implementation and analysis of electrification projects in rural Mexico in recent decades, have identified the following factors as the major obstacles to be overcame in order to ensure the sustainability and prolonged existence of rural electrification through renewable sources: the role of the users, the cost of the systems and adequate human resources[69].

[67] *Ibidem*.

[68] *Ibidem*.

[69] M. HUACUZ, Jorge. *RE in Mexico – Barriers and strategies*. **RE Focus**, United Kingdom, 2001, pp. 18 – 19, 2001.

The role of the users

Many projects of rural electrification in Mexico, especially through the photovoltaic systems, prove that the active involvement of the users is a central factor for the success of the implementation of these projects, even more crucial than technical and economic obstacles. Unlike programs of power grid extensions – where the users are actors with little to no participation in the process, in the case of electrification using REs it is vital that the community, starting from the internalization of improvement coming from the introduction of this technologies, genuinely wishes the implementation of these systems and gets directly involved in the process[70].

Considering the characteristics of the rural communities mentioned above, the users will be, in the last analysis, the ones responsible for maintaining and, in consequence, for the longevity of these projects. For being, in its majority, domestic and decentralized systems, it's impossible to imagine the availability of a technical local staff to maintain the systems. It is necessary, as seen in the projects implemented by the National Program of Solidarity (Pronasol, 1900)[71], that users are trained and familiarized with the compositions of these equipments, so they can do necessary repairs, avoiding malfunctions that would risk projects. Implemented programs consolidate as a good practice the involvement of the users in all of the project's phases, including the collection of funds to finance the systems, for instance. Thereby, besides reducing the burden of the governmental and private investments, the required involvement for this active participation makes the users the owners of these systems and thus people interested in their preservation.

Costs of the Systems

As presented in the first section, despite the potential for exploitation of REs, fossil fuels remain the main source of power generation in Mexico, with a sector income representing 4.9% of its GDP[72]. Therefore, hydrocarbons still have great incentives and even hidden subsidies[73], further diminishing the

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70 M. HUACUZ; MARTÍNEZ, Op. Cit.

71 Pronasol will be discussed in more detail in the section below.

72 BANCO MUNDIAL. **Rentas del petróleo (% del PIB)**. Available at: <http://datos.bancomundial.org/indicador/NY.GDP.PETR.RT.ZS?locations=MX>. Access: 22 August 2016.

73 M. HUACUZ, Op. Cit.

competitiveness of clean energy sources. These incentives - also directed to research and development of fossil fuels - lead to technological contributions that reduce the cost of using this type of energy source, which in turn places them as an economically attractive option. Although resources for research and development of REs have increased substantially in recent years, they are still insignificant when compared to conventional energy - so that technological advances in the field of RE haven't been sufficient to make them more competitive. Finally, the costs of environmental impacts caused by traditional sources are not really considered in the cost-effectiveness assessments and, when the values of investment and acquisition are prioritized in isolation, renewable sources do not constitute an economically viable alternative.

Human Resources

Currently, the existence of programs such as CONACYT - Sustainable Energy, of the Department of Energy of Mexico[74], demonstrates efforts towards technical training of specialized human resources in various stages of REs power development and implementation. However, a consolidated training in this area is still necessary, both in academia and in industry, in order to identify and overcome challenges for the introduction of this type of infrastructure.

Since the beginning, in the mid-1990s, programs of rural electrification with REs have been mainly developed through the National Solidarity Program (Pronasol). It is important to note that the first projects implemented took into account the aforementioned challenges, such as the role of users different stages of the process. Moreover, due to the fact that the *Comisión Federal de Electricidad* (CFE) is a public company, the partnership with the private sector or through the community funding was a fundamental condition to this process. Considering that the investments made by CFE in rural electrification will not be recovered through a significant increase in economic productivity, to prioritize investment in these areas is a complicated trade-off when compared to the returns that these funds would bring if applied in regions with a higher relevance to Mexican GDP. The following projects[75] are just a small sample of

[74] SECRETARIA DE ENERGIAc. **Fondos Sectoriales de Energía, Secretaría de Energía**. Available at: <http://www.gob.mx/sener/acciones-y-programas/fondos-sectoriales-de-energia?idiom=es>. Access: 18 July 2016.

[75] We gave precedence to the projects that are landmarks or to those that although have a secondary importance, illustrate the relevance of involving the private sector and/or dialogue with the issues raised throughout this article.

programs that directly or indirectly have contributed to the distribution and access of electricity through renewable energy in rural Mexico.

Pronasol[76]

The National Solidarity Program (Pronasol) was created in 1990, by the Mexican federal government, to financially support the construction of infrastructure in the less developed regions of the country, including funding from local resources of rural electrification. Through Pronasol, small scale and home photovoltaic systems have been installed in rural Mexico, totaling approximately 24,000 systems.

The annual budget for rural electrification under the auspices of the Pronasol was approximately US$ 10 million (US$ of 1995), and one of the conditions was the creation of an internal financial fund with resources of the beneficiaries themselves, which would be used for both repair and maintenance, and for possible future expansion of the systems. It was established two distinct lines to grant resources or funding:

a) Improving quality of life: provision of public resources for projects that promote access to lighting and entertainment from photovoltaic panels in houses and public roads of rural communities. Projects in this category were mainly implemented through government funds (50% federal, 30% state and 20% from the local government and the benefiting community). A condition for this concession was the active participation of users in the structuring and implementation phases.
b) Productive use: This category included agribusiness-related projects that were viable and presented economic returns. Unlike projects related to increasing quality of life, the funding of productive use projects was not through concessions, but through loans made by Mexican development banks[77].

[76] M. HUACUZ, Jorge, MARTÍNEZ, Ana Maria. *Renewable energy rural electrification – Sustainability aspects of the Mexican programme in practice*. **Natural Resources Forum**, United States, Vol. 19, Nº 3, pp. 223 – 231, 1995.

[77] MEXICOc. Secretaria de Hacienda y Crédito Público, Portal internet, **Development Banks**. Available at: <http://www.cnbv.gob.mx/en/Supervised-Entities/Development-Banks/Paginas/Development-Banks.aspx>. Access: 21 July 2016.

Luz en Casa Oaxaca[78]

The public-private partnership between *ACCIONA Microenergia México*, the Government of the State of Oaxaca and the Spanish Agency for International Development Cooperation , the program *Luz en Casa Oaxaca* implements domestic photovoltaic systems in rural communities of Oaxaca, among the states with least access to electricity in rural areas. Until October 2015, the program implemented more than 3,600 systems for low-income families in 175 cities. It provides a three-month training to users about the installation, use and maintenance of the systems. Oaxaca, besides being one of the states with less access to electrification, is also the one with the highest ethnic diversity in Mexico (16 ethnic groups), and the program *Luz en Casa Oaxaca* included half of these ethnic groups.[79]

Iluméxico[80]

The private company Iluméxico invests in low cost photovoltaic installations in rural Mexico. With an initial investment of US$ 50 and within a period of three to eighteen months, the program provides solar energy access for several Mexican rural communities. Approximately 80% of photovoltaic systems provided by Iluméxico are between 15 and 25 watts, i.e., low-power systems. However, these projects fulfill the needs of those families, considering that, in average, the beneficiaries have significantly lower power consumption than that of urban areas. The fact that they are low-power systems has a direct impact in reducing acquisition costs and in attracting rural families with low income - beneficiary families have a mean monthly income of less than $ 200 per month, of which 15% used to be spent, before the program implementation, in the acquisition of light and energy[81], which is a major factor motivating *Iluméxico*. The company has several partnerships with the Mexican government like the partnership that resulted in the installation of more than 900 photovoltaic systems in the state of Oaxaca between 2013 and 2014. For this project, the government subsidized 40% of the costs with equipment. To

78 ALLIANCE FOR RURAL ELECTRIFICATION. **The "Luz en Casa Oaxaca" programme brings access to energy for 15,000 people**, Oaxaca, News, 02/10/2015. Available at: <http://www.ruralelec.org/news-from-are/luz-en-casa-oaxaca-programme-brings-access-energy-15000-people>. Access: 04 July 2016.

79 *Ibidem.*

80 ILUMÉXICO. Iluméxico. Available at: <http://ilumexico.mx/>. Access: 08 August 2016.

81 M. HUACUZ; MARTÍNEZ, Op. Cit.

date, *Iluméxico* has been responsible for installing 6,200 photovoltaic systems with a total power capacity of 206 kW, reaching 25,800 users and avoiding the emission of 3,300 tons of CO_2.

Beyond this scenario, the institutional and regulatory structure are also important factors for boosting the energy transition process in Mexico. Accordingly, the next section analyzes the Mexican legal and institutional frameworks, with emphasis on the Energy Reform.

3. Normative and institutional frameworks: the ongoing energy reform

Mexico's Secretariat of Energy (SENER) is responsible for designing the country's energy policy and for planning the National Electric System (NES). According to the agency, the Mexican energy sector faces several problems in the stages of generation, transmission and distribution[82], which must be overcome. Even with governmental funding, energy fees are considered high and uncompetitive, negatively impacting homes as well as commercial and industrial establishments. To give an idea of the price of this service, the Mexican energy fee in 2015 was 25% more expensive than the one in United States and, without government funding, this figure would rise to 73%[83].

The Constitution of Mexico states that the entire chain of energy production is a State monopoly. Private and individual companies are allowed to generate electricity, but according to SENER[84], the low-cost production remains in the hands of a few. Moreover, the system lacks an impartial arbitrator to decide which electricity can be sold, given that the CFE is responsible for power generation and also for deciding from which plants the electricity will be purchased and which companies are authorized to sell to the final consumers. These restraints reduce competitiveness and result in high prices on the bills. Such factors are also responsible for delays in the process of expansion of the use of clean energy in Mexico.

82 SECRETARIA DE ENERGIAa. **Reforma Energética**, 2015. Available at: <http://www.gob.mx/sener/documentos/explicacion-ampliada-de-la-reforma-energetica>. Access: 10 July 2016.

83 SECRETARIA DE ENERGIAa, Op. Cit.

84 *Ibidem.*

Regarding energy transmission, the biggest challenge is the lack of investment in the power grid. In order to increase access to electricity and make it cheaper and more efficient, it is necessary to increase the grid's mesh and interconnect the areas of the country with potential to generate clean energy. After all, one of the main challenges for the expansion of wind and solar plants is precisely the lack of interconnection capacity. In the energy distribution segment, the most important challenge regards its operation, as there is a considerable energy loss and the billing and collection processes are not efficient. Hence, more than 15% of the energy produced by CFE is not charged[85].

Considering the Mexican energy framework, its shortcomings and the need to ensure energy safety for the next decades, President Enrique Peña Neto (in office since December 2012) sent, in 2013, a draft containing constitutional amendments related to energy to the Mexican Congress. In December of the same year, after intense debate, the Energy Reform was approved in the Chamber of the Representatives, by 354 votes in favor and 134 against, and in the Senate by 78 votes in favor and 26 against.[86] The main opposition came from left sectors, on the grounds that the project would privatize a strategic sector of the economy - the oil industry, a fact that would represent nothing less than the sale of the country[87].

The amendments changed Articles 27 and 28 of the Constitution in order to allow the State to enter into agreements with private individuals and companies regarding the public service of transmission and distribution of electricity. However, these agreements ensure that "the planning and control of the national electrical system, as well as the publics services of transmission and distribution are State exclusive areas[88]". The *Petroleos Mexicanos - Pemex* and the CFE were both established as public production companies, with more freedom to improve themselves and to act as productive State companies[89].

85 *Ibidem.*

86 ESTADÃO. **México: Senado aprova últimas leis da reforma energética**, 7 August 2014. Available at: <http://economia.estadao.com.br/noticias/mercados,mexico-senado-aprova-ultimas-leis-da-reforma-energetica,1540173>. Access: 20 July 2016.

87 EL PAÌS. **México cambia su historia energética a contrarreloj**. Mexico, 12 December 2013. Available at: <http://internacional.elpais.com/internacional/2013/12/12/actualidad/1386888542_011957.html>. Access: 20 July 2016.

88 SECRETARÍA DE ENERGÍAa. Op. Cit.

89 IRENA. **Renewable Energy Prospects: Mexico, REmap 2030 analysis**. *International Renewable Energy Agency* - IRENA, Abu Dhabi, 2015. Available at: <http://www.irena.org/remap/>. Access: 05 July 2016.

In regard to the private sector, now it can generate electricity, once it has a license, and can transmit and distribute energy under prearranged contracts.

Therefore, since 2013, the Mexican Energy Reform is in progress, resulting in the creation and updating of the legislative and institutional frameworks for the fuel and electricity sectors. As the scope of this paper relates exclusively to energy as electricity, we will focus only on this feature of the Reform.

According to SENER[90], the main benefits of the Mexican Reform for the electricity sector are basically: enable a competitive national electric power system with price reductions; to attract investments to the sector and thus boost the country's development; to achieve greater energy supply; to ensure international standards of efficiency, quality and reliability; to combat corruption in the energy sector; and to promote development with social responsibility. SENER through the Foresight report *Energías Renovables 2015 - 2029*[91], also shows additional benefits for the renewable segment, namely: (i) the creation of Clean Energy Certificates; (ii) the elimination of barriers that inhibit the growth of renewable energy; (iii) facilitating REs trade by creating an electricity market; (iv) the creation of interconnection arrangements without delays or additional costs in distributed generation; (v) the establishment of financing mechanisms for new REs projects; and (vi) the creation of a regulatory framework for consultation and social impact assessments.

Apart from the 2013 constitutional changes, the reform also created or promoted changes in secondary legislation, as Table 1 below shows.

[90] SECRETARÍA DE ENERGÍAa. Op. Cit.

[91] SECRETARÍA DE ENERGÍAb. **Prospectiva de Energías Renovables 2015 - 2029**. Mexico: SENER, 2015.

Table 1: Legislation for renewable energy in the electricity sector of Mexico.[92]

Law	Object	Publication
Ley de Promoción y Desarollo de los Biocombustibles (LPDB)	To promote the introduction of bio-energy in the energy matrix in the context of sustainable development schemes in production of supplies and encouraging regional development and development in rural communities.	1 February 2008
~~Ley para el Aprovechamiento de las Energías Renovables y el Financiamiento a la Transición Energética (LAERFTE)~~ – revoked	It regulates the use of renewable energy and clean technologies to generate electricity for purposes other than the provision of the public service of electricity, as well as the national strategy purposes and instruments for the funding of energy transition.	28 November 2008
~~Ley para el Aprovechamiento Sustentable de Energía (LASE)~~ - revoked	It aims to promote the sustainable development of the energy sector through the optimal use of energy in all its processes and activities, from exploration to consumption.	11 September 2009
Ley General de Cambio Climático (LGCC)	The LGCC seeks to establish objectives in public policies to mitigate and adapt to climate change; and to promote the transition to a competitive, sustainable and low carbon energy matrix.	6 January 2012
Ley de Industria Elétrica (LIE)	It regulates the planning and control of the National Electric System, Transmission Public Service and Distribution of Electricity and other activities of the electrical industry.	11 August 2014
Ley de Energía Geotérmica (LEG)	It regulates the recognition, exploration and exploitation of geothermal resources for the use of thermal energy from underground within the boundaries of the national territory, with the purpose of generating electricity or its application to various uses.	11 August 2014
Ley de los Órganos Reguladores del Sector Energético: Comisión Reguladora de Energía y Commisión Nacional de Hidrocarburos (CRE y CNH)	It aims to regulate the organization and functioning of Coordinated Regulating Organs in Energy Matter and to establish their competence. The CRE shall regulate and promote the efficient development of transport pipelines, storage, distribution and sale of bioenergetic resources to the public, the generation of electricity, the public services of electric transmission and distribution and electric transmission and distribution not part of the public service, trade of electricity, among others.	11 August 2014
Regulamento Interior de la Secretaría de Energía	It establishes the obligations of public officials associated with the Secretariat of Energy.	31 October 2014
Ley de Transición Energética (LTE)	It regulates the sustainable use of energy as well as the obligations on clean energy and reduction of polluting emissions from the electrical industry, while maintaining the competitiveness of productive sectors.	11 December 2015

[92] Extraído de SECRETARIA DE ENERGÍAb, *idem*; MEXICOa. **Ley para el Aprovechamiento Sustentable de la Energía**, de 28 de noviembre 2008. Available at: <http://dof.gob.mx/nota_detalle.php?codigo=5070928&fecha=28/11/2008>. Access: 20 July 2016; MEXICOb. **Ley para el Aprovechamiento de las Energías Renovables y el Financiamiento a la Transición Energética**, de 28 de noviembre 2008. Available at: <http://www.cre.gob.mx/documento/3870.pdf>. Access: 20 July 2016.

The Energy Transition Act of December 2015 overturned two previous laws for the sector, namely, *Ley para el Aprovechamiento Sustentable de Energía* (LASE) and *Ley para el Aprovechamiento de las Energías Renovables y el Financing a la Transición Energy* (LAERFTE), unifying elements of both with other laws of the Energy Reform. The LAERFTE (adopted in 2008, revised in 2013 and revoked in 2015) set as goal the maximum rate of 65% of fossil fuels in power generation for the year 2024, 60% for 2035 and 50% for the year 2050[93]. This goal harmonizes with the 2012 LGCC, which also set a goal to have 35% of electricity generated in Mexico through clean sources, until 2024. LTE reaffirmed these goals and established intermediate ones, 25% for 2018, 30% for 2021 and 35% for 2024[94].

The Reform establishes that the planning and control of the electric power system and the public services of power transmission and distribution will remain under State jurisdiction – and the latter will be under the responsibility of CFE. In the generation stage (first stage) and trade (final stage), however, it opened a space for the role of private enterprise. Therefore, the Law of Electrical Industry (LIE) was established in 2014 in order to ensure fairness in competition between public and private companies and in the use of transmission and distribution grids. With LIE, the private sector acquired the power to carry out projects independently of the CFE, assuming the projects' costs and risks.[95] The law created three categories for private power generation: self-sufficiency, small production (less than or equal to 30 MW) or independent producer (generation superior to 30MW aimed at sale to the CFE or exportation)[96]. Under the new legal framework, another possibility of participation for companies and individuals is through contracts between the State and private sector, so that the latter can assist the expansion and improvement of transmission and distribution network through its technologies and knowledge of best practices[97].

Regarding trade, LIE classifies users according to their consumption: *qualified users* and the *basic supply*. *Qualified users* have a consumption superior

[93] MEXICOb, Op. Cit.

[94] SECRETARÍA DE ENERGÍAb, Op. Cit.

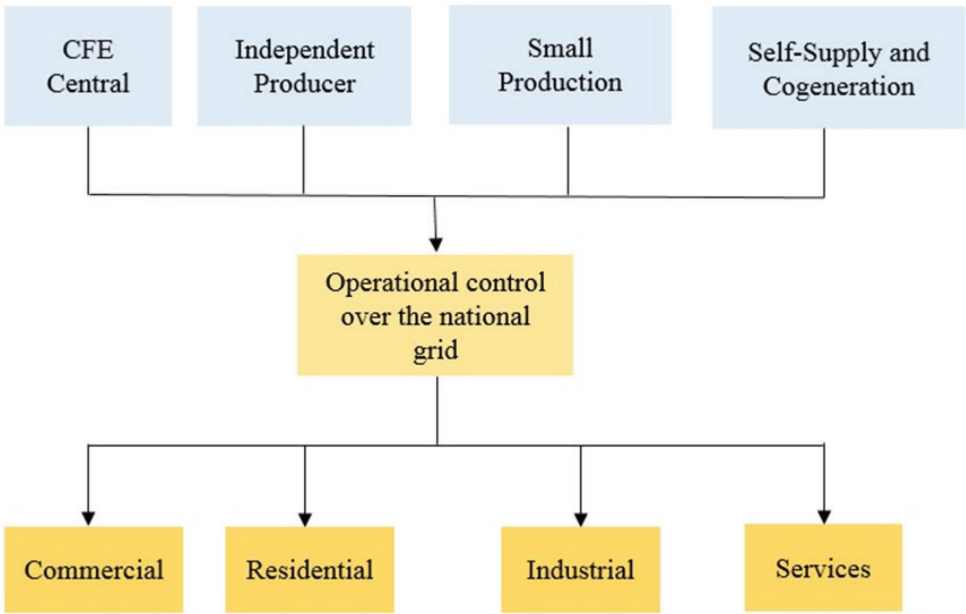
[95] SECRETARÍA DE ENERGÍAa, Op. Cit.

[96] SECRETARIA DE MEDIO AMBIENTE Y RECURSOS NATURALES, 2015, Op. Cit.

[97] *Ibidem*.

to 3MW and can choose between acquiring electricity in the *Mercado Mayorista* or buying from *qualified suppliers*. On the other hand, the users of *basic supply* will be serviced by CFE, as pointed out in Figure 3. The negotiated tariff will not be regulated, in order to encourage competition[98].

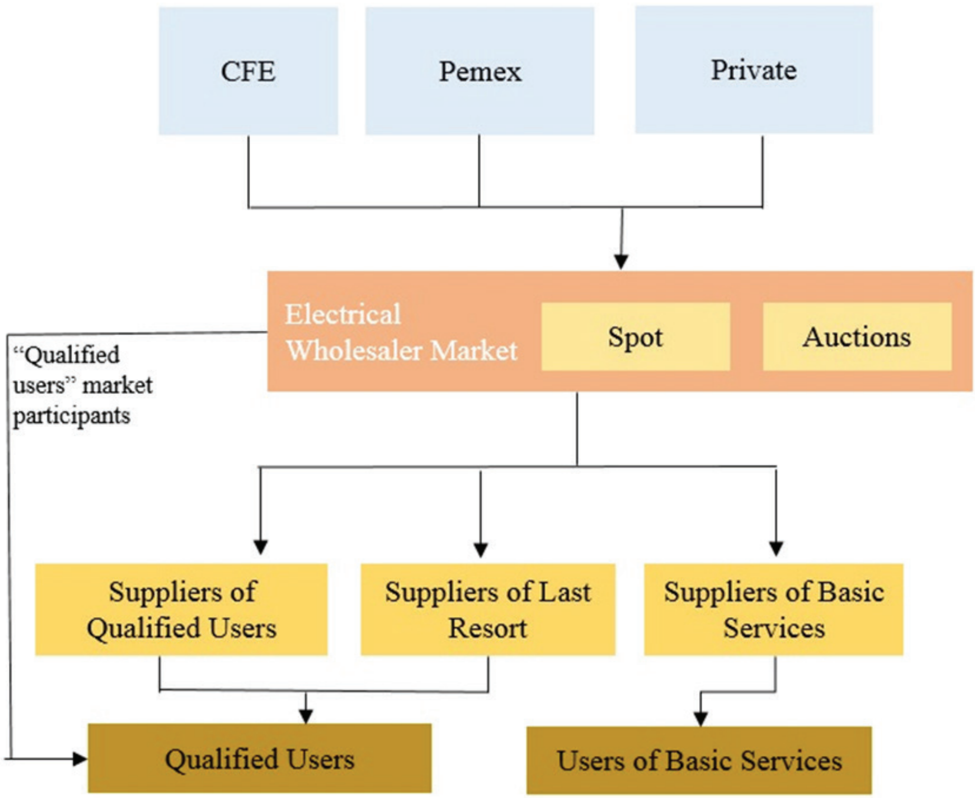
Chart nº 3: Pre energetic reform model.[99]



[98] PWC. **Transformación del sector eléctrico mexicano: Implicaciones de la Ley de la Industria Eléctrica y la Ley de la CFE**. PricewaterhouseCoopers, 2014. Available at: <http://www.pwc.com/mx/es/industrias/archivo/2014-05-secundarias-electricidad.pdf>. Access: 12 July 2016.

[99] Adaptado de PWC, Op. Cit., p. 4.

Chart nº 4: Post energetic reform model.[100]



One of the innovative mechanisms proposed by the reform is the creation of the Clean Energy Certificate (CEL), which aims to distribute, in the form of individual obligation, the national burden to expand the share of renewable energies in the Mexican energy matrix to 35% by 2024[101]. The CEL was proposed in mid-2013 to improve the competitiveness of REs in the electricity supply. This happens as follows: all *qualified users* must purchase a percentage of their energy needs from renewable sources, and this percentage follows the national goal, i.e., 25% by 2018 and 35% by 2024. Thus, *qualified users* who do not achieve

[100] *Ibidem*.

[101] DELOITTE. **Certificado de Energías Limpias**. Deloitte, 2015. Available at: <https://www2.deloitte.com/content/dam/Deloitte/mx/Documents/energy-resources/Certificados_Energias_Limpias_2015.pdf>. Access: 18 July 2016.

this goal, and wish to avoid fines, shall buy CELs in order to achieve the stipulated quota. Each CEL is equivalent to 1 MW/h, and the companies that produce clean energy and are registered by the responsible agency will receive 1 CEL per MW/h produced[102]. The SENER has the competence to establish the criteria for obtaining and granting the certificate[103] (LEL, 2014). Such criteria were published in the first quarter of 2015 and the CEL is expected to come into force in 2018[104].

As part of the Energy Reform, the Mexican government also introduced policies to promote REs,: (a) the *National Energy Strategy 2013 - 2027* (ENE); (b) the *Energy Sector Program 2013 - 2018* (PRONESER); (c) Special Program for the Development of Renewable Energies *2014 - 2018* (PEAER); (d) o Strategic Program for Human Resources Trainning on Energy Matter (PEFRHME); (e) the Interministerial Commision on Bioenergy (CIB); (f) Energy Transition Strategy and Sustainable Energy Use (ENTEASE-2014); and (g) the Development Program for the National Electrical System *2015 - 2029* (PRODESEN).[105]

Another milestone of the energy transition in Mexico is the *Inventario Nacional de las Energías Renovables* (INERE), a public geographical and statistical data system on the potential of renewable energy and on the projects of power generation by renewable sources that are in course in the country. Under the authority of the SENER, the INERE is updated annually, and is funded by the Energy Fund of Transition and Sustainable Energy Use (FOTEASE). According[106] to the Assistant Secretary for Planning and Energy Transition of the SENER, Leonardo Beltran Rodriguez, the INERE is the result of the first task carried out by the Advisory Council for Renewable Energy, which is formed by representatives of academia, industry, public sector and legislative. The Council is the agent responsible for advising on the development of sectorial public policies.

Matters of competence, power generation, transmission, supply and

102 Lineamentos que establecen los criterios para el otorgamiento de Certificados de Energías Limpias, Sección III. Available at: <http://www.amdee.org/Marco_regulatorio/Lineamientos_Cels.pdf>. Access: 20 July 2016.

103 MEXICOd. **Ley de la Indústria Elétrica**. Available at: <http://www.dof.gob.mx/nota_to_doc.php?codnota=5355985>. Access: 10 June 2016.
Ibidem.

104 *Ibidem*.

105 SECRETARÍA DE ENERGÍA, 2015.

106 IRENE, Op. Cit.

distribution are mainly operated by two entities: CFE and *Compañía de Luz y Fuerza del Centro* (LFC). The system is coordinated by SENER, the *Comissión Reguladora de Energía* (CRE) and the *Comisión Nacional para el Efficient de la Energía* (CONUEE). While SENER basically leads the Mexican energy policy, the CFE regulates private participation in the energy system and CONUEE promotes energy savings and use of renewable energy.[107] In the context of the energy reform, SENER also becomes responsible for establishing criteria for obtaining and granting the Clean Energy Certificates and to coordinate and oversee the transformation of the CFE in a productive State company, capable of generating economic value and profitability to the Mexican State[108].

Other important actors in the Mexican energy scenario are: the *Comisión Nacional para el Ahorro de la Energía* (CONAE), the *Instituto de Investigaciones Eléctricas* (IIE), the *Secretariat del Medio Ambiente y Recursos Naturales* (SEMARNAT), the *Secretaria de Desarrollo Social* (SEDESOL), the *Fideicomiso de Riesgo Compartido* (FIRCO), and some associations that promote the REs in the country, such as the National Solar Energy Association (ANES), the Mexican Wind Energy Association (AMDEE), the Mexican Network of Bioenergy and Mexican Association for Energy Economics (AMEE)[109].

Conclusion

The electricity generation in Mexico is still very dependent on non-renewable fossil fuels, which account for more than 60% of the national matrix. This is because in recent decades the federal government has chosen to encourage the construction of natural gas plants and to provide subsidies for this sector. However, natural gas stocks in Mexico are running out, and the international commitments made by the country - as to achieve a reduction of 22% in emissions of GHGs and of 51% in the emissions of black carbon by 2030[110] - demand investments in clean energy sources, given the need to reduce emissions while ensuring energy security.

107 CANCINO-SOLÓRZANO *et al.*, Op. Cit.; ROLDÁN, MORALES, Op. Cit.
108 PWC, Op. Cit.
109 ROLDAN MORALES.
110 UNFCCC, Op. Cit.

The country has a huge potential for energy generation from renewable sources, mainly hydroelectric, wind, solar and geothermal. However, it is necessary to invest in systems with transmission capacity, mainly because the regions with the greatest potential are also the most isolated from major urban centers. Aware of this potential, and due to the various problems identified in the energy sector, Mexico is implementing a large energy reform since 2013, with constitutional, legislative and institutional changes.

It is estimated that just over 98% of the Mexican population has access to electricity[111]. Most people without electrification are widely dispersed in the Mexican territory, located in isolated communities in rural areas, mainly in the states of Chiapas, Oaxaca, Guerrero and Veracruz. Interestingly, these regions are also the ones with great potential for energy generation from renewable sources, as demonstrated in the first section of this paper. Therefore, the energy supply from renewable sources is a feasible solution in areas where it is not technically and economically viable to extend the traditional grid[112].

In relation specifically to rural electrification from renewable sources, the availability of natural resources is not a limiting factor in Mexico, but most of these resources are not currently being used. However, to ensure that the exploitation of these energy sources benefit the areas with less access to electrification, it is necessary that the ongoing institutional reform encompasses guidelines specially drafted for rural regions and areas with low economic relevance. Moreover, in order to guarantee universal energy supply in Mexico it is essential to improve the development and expansion of government funding programs to enterprises that invest in these regions. This is because while the CFE spends public funds in their infrastructure investments, we recognize the existing dilemma regarding prioritizing public investments to areas that *a priori* do not bring significant economic profits. Thus, the partnership with the private sector is fundamental to achieving rural electrification in Mexico, as evidenced by the aforementioned projects in the second section.

Finally, the participation of beneficiaries in any prioritized investment model, should not be neglected in order to ensure the prolonged existence of these systems. To this end, public initiatives on training of human

111 CFE, Op. Cit.

112 CANCINO-SOLÓRZANO *et al.*, Op. Cit.; ROLDÁN, MORALES, Op. Cit..

resources, such as CONACYT - Sustainable Energy[113], should include potential beneficiaries in their training programs, contributing to their familiarity with the systems and to the promotion of renewable energy as one of the main sources of electricity supply in Mexico.

The legislative and institutional changes that are being implemented under the energy reform in Mexico are undoubtedly of great dimension and boldness. The main controversies and criticisms focus on the on innovations for the hydrocarbon sector, which was not addressed by this work. However, for the electricity sector, which was for decades under State monopoly, facing problems such as high cost of tariffs, energy transmission losses and disincentive to innovation, the changes that have been proposed should encourage the participation of private initiative and competitiveness in the sector, causing price reductions of tariffs for both domestic/residential and commercial and industrial purposes.

Fossil fuels still have large public incentives and even hidden subsidies, which reduces the competitiveness of clean energy sources. A gradual reduction of these incentives and subsidies is imperative in order to eradicate a model that is no longer economically and environmentally adequate, and to direct funds to the REs. Investments in the generation of REs should grow over the next decade due to the goal of having 35% of electricity generation from renewable sources by 2024, and this market should become more competitive in light of the new obligations brought by the reform - which, in addition to ensure greater energy security to the country, will bring benefits for the environment and the population. It is essential to ensure that the reform produces an economically competitive renewable energy market in relation to the traditional prices, and encourages research, development and innovation in this sector in order to enable technological advances to reduce the manufacturing costs, to expand the energy efficiency and to enlarge the production scale. Therefore, together with the incentives to clean energy policies, the reduction of investments in the hydrocarbon sector is necessary.

As the reform process is still being implemented, it is difficult to assess its effects and to establish a comparison between its benefits and challenges. However, critics have been presented by different Mexican sectors. Forbes

113 SECRETARÍA DE ENERGÍAc, Op. Cit.

Magazine, for example, said that the government will continue to dominate the National Eletric System (SEN) through SENER and CFE, when the responsible entity should be public, but autonomous[114]. Legal uncertainty about the implementation of the changes still remains, and there are also uncertainties about the necessary amount of time that all the goals will demand to be achieved. Anyway, there is no doubt that Mexico is at an important historical moment from the energy transition point of view. It's an interesting model to be observed in the upcoming years, especially by other Latin American countries.

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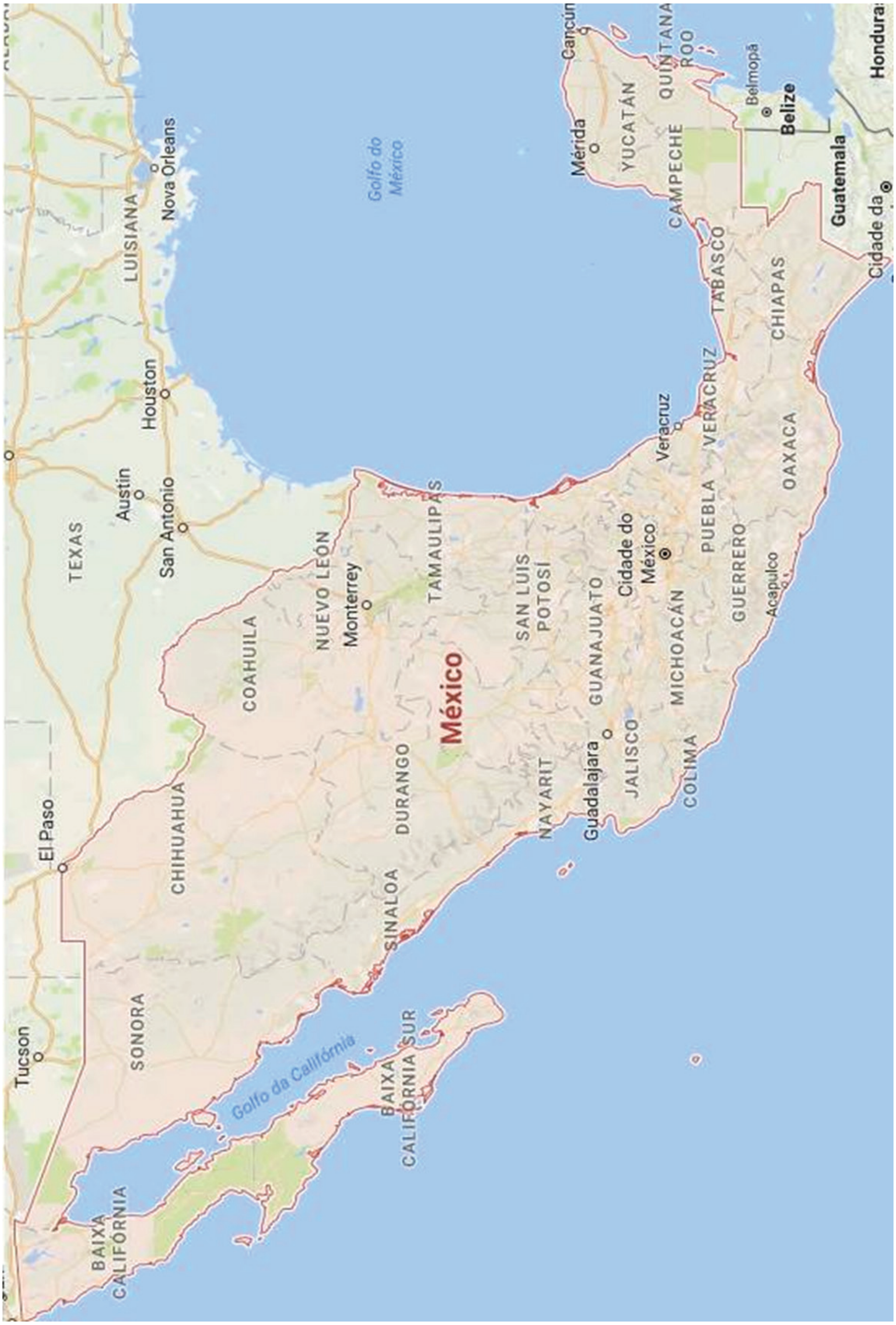

[115] GOOGLE MAPS. Map of Mexico. Available at: <https://www.google.com.br/maps>. Access: 23 August 2016.

COLOMBIA

COLOMBIA'S ENERGY MATRIX AND A PLAN TO GUARANTEE SUSTAINABLE ENERGY IN THE COUNTRY

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Odara Gonzaga de Andrade[3]

Abstract: In terms of the universal and cheap access to sustainable energy, as one of the goals to ensure the Sustainable Development (Goal 7 of the Sustainable Development Goals), the present paper aims, from a data collection on Colombia's energy matrix and the conditions of its rural population, to suggest terms of a plan to guarantee sustainable energy and to analyze the current stage of energy access in the country. In other words, its main objective is to analyze if the energy supply in Colombia follows the Sustainable Development Goal 7. Moreover, it aims to provide information for the drafting the other plans and policies to guarantee democratic energy access to the rural population in Colombia. The study revealed the latter's incentive for the elaboration of sustainable development policies as well as the fact that its energy matrix has a considerable potential to the production of clean energy. However, it noticed a serious lack of energy for the rural population.

Keywords: Sustainable Development – Colombia – Democratic Access to Energy – Rural Population.

Introduction

This study is based on the sustainable development goals found on Agenda 2030, in the year of 2015, from an inclusive and transparent

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intergovernmental process. More precisely, this study is based on the Objective of Sustainable Development number 7 [4]. Thus, it is emphasized that the principle of sustainable development is understood here as the interweaving of social, environmental and economic perspectives, having great role in the development of a policy to eradicate the lack of access to energy.

For this line, firstly the study focuses on analyzes of the Colombian energy matrix and the legal order of the country on the subject. Then it discuss the problems faced by a portion of the Colombian population as access to energy, the rural one. Thus, it analyzes the whole context of the Colombian countryside, demonstrating: (1) who composes it, (2) the obstacles faced, and (3) the need to eradicate the bad energy distribution in the country with the inclusion of the population in the power distribution. All this, to achieve, within Colombia, sustainable development. Namely to ensure the Social, Environmental and Economic rights.

In the end, the study describes an alternative proposal to ensure the distribution of energy to the Colombian rural population, composed by a practice plan (implementation of the pumped-storage hydroeletricity) and a public policy. This is supported by the very Colombian legislation. In sum, the proposal attempts to trace means to eradicate unfair energy distribution in Latin America, focusing mainly on Colombia. All this to ensure the principle of sustainable development in the region and especially the goal of Sustainable Development 7 as a necessary vehicle for the achievement of other objectives present in Agenda 2030.

1. Necessary aspects for comprehention: an analysis of the Colombian energy matrix

According to Climatescope (2015)[5], clean sources of energy[6] compose the core of the Latin America and Caribbean's energy matrix, including Colombia's. According to the study, at the end of 2014, 11% of the energy sources in the region generated energy with no CO2 emissions. Latin America, therefore,

4 Which seeks to promote access to affordable, reliable, sustainable and renewable energy for all.

5 CLIMATESCOPE 2015.**Latin American and The Caribbean**, Available at: http://global-climatescope.org/en/region/lac/. Access: 26 June 2016.

6 By clean energy, we mean those sources which do not emit polluters.

can count on all desirable factors[7] for sustainable development and equitable distribution of resources. In contrast with that trajectory of success, there is an historical fight for economic and sociopolitical independence, which resulted in significant delay in progress.

Colombia is one of the best examples of this conjecture. The country has favorable geographic[8] elements, but, in spite of that, has to deal with sociopolitical and economical obstacles, such as inequality, drug trafficking and a historically complex and unstable energy sector. This reality brought on many difficulties to the Colombian government in establishing itself in a place of importance when it comes to sustainability. Even if the country uses hydroelectric energy in bulk (almost 70% of its matrix[9]), throughout its history the introduction of new forms of sustainable energy was very complicated. In this sense, it is firstly necessary to trace thoughts concerning the Colombian energy matrix so that it is possible to discuss a plan to improve access to energy in the country.

Given that the matrix was planned with the objective of attending to the population's necessities, any ecological concerns would come in second. However, with time, the spotlight was given to such issues, and changes could be seen in the energy sector. The country would establish itself as a significant oil and gas player in the 1990s. However, the lack of new site discoveries and geographic and climatic factors were enough for the drug trafficking and guerrilla culture - present for over 50 years in Colombia -, to take away the space and efforts and delay the growth of the energy sector in rural and isolated areas, amidst the geographically complex Colombian countryside. Accordingly, the necessity to avoid the energy sector's collapse and the special attention offered to oil and gas raised ecological concerns involved with these practices, such as the search for oil in ecologically sensible areas and the pressure of the armed guerrilla.[10]

[7] For instance, environmental abundance, great energetic potential and incomparable biodiversity present in the Latin-American continent.

[8] For example, access to the ocean, its localization close to the Amazon forest and the abundance of natural resources.

[9] XM S.A. E.S.P. **Informe de Operación del SIN y Administración del Mercado: Capacidade Efectiva Neta. 2015.** Available at: http://informesanuales.xm.com.co/2015/SitePages/operacion/2-6-Capacidad-efectiva-neta.aspx. Access: 26 June 2016.

[10] For practical reasons regarding their goals, the guerrilla groups keep camping sites amidst the forest.

It was in this context that ecological protection and energy deregulation policies became the initial step for the rebirth of the sector, starting in 1995. The Uribe Administration (2002 – 2010), with its proposals for control of the illegal armed groups, and stimuli for investments, foreign or not, aiming for the economic revitalization and ecological regulation, brought Colombia to a path towards a sustainable future after more than a decade in remission, especially in the oil sector. The solution was to adopt new environmental legislation that dealt with the cited factors – economic revitalization and protection of the environment. Special attention was given to the electric sector: after laws 142 (Law of Public Services) and 143 (Electric Law), in the 1990s, which inaugurated the restructuration process in the search for investments[11] through the regulation of the sectors to which they refer.

Observing the general scope, the Colombian energetic revitalization was a success: the energy factor unleashed 'silent' reforms all over the country, through the creation of new jobs, resource generation for social investments and, mostly, the expansion of the matrix through access to energy to a great part of the population which did not have it before (in 2009, 96% of the population had access to energy due to the National Integrated System - SIN[12]). However, all the positive results ended up revealing the real problem: the urgent need to worry about sustainable development not only in the legal field, but in more practical ways, given that the reality of energy sources wouldn't be easily improved and that no chances could be given to environmental irresponsibility to undo the progress.

Even if most of Colombia's energy production is from hydroelectric plants, another stage of reforms would be necessary to prepare the country for non-traditional sustainable energy. Given that those means of production are cheaper and more trustworthy in the long term, the significant agricultural sector could be the key, for its size and effectiveness. For instance, there is the potential for exploration of biomass from sugar cane: Colombia has a considerable number of plants and mills for sugar production, most of them located in the Cauca River region[13], whose residues could be reused

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[11] Cf. Sector Eléctrico – InviertaenColombia (ProexportColombia 2009).

[12] Cf. Sector Eléctrico – Invierta en Colombia (ProexportColombia 2009).

[13] The sugar industry is mainly located in the Vale of the Cauca River, with plantation areas in 48 towns, from the north of the Cauca state, through the center of the Valle del Cauca, to the South of Risaralda, Caldas and

though priority reassessments and reorganization, with more focus in that potential over only the ethanol production. Additionally, after analysis of the equatorial position of the nation, which incentives solar energy production; the progress (and price reduction) in the production of wind energy; and the uncertainty caused by the submission of the hydroelectric sector to natural, omnipresent factors, such as El Niño and La Niña[14], it was expected that new measures would be taken to reevaluate energy in this sense. As an example of progress, there was the approval, in 2015, during the Juan Manuel Santos Administration, of Law 1715, proposed in 2014, that again addressed the energy issue and proposes incentives for the integration of alternative forms of energy production, economic development, reduction of the emission levels for polluters and guarantee of safety for the energy sector as a whole.

Thus, when dealing with non-traditional forms of energy (from the sustainable spectrum all the way to nuclear energy), incentives and exemptions are guaranteed for investment and promotion in/of the area. Besides, by way of guaranteeing better, smarter and more efficient energy management, the public administration would have to face changes: new goals for sustainability of government-owned buildings would be set; plans and regulatory mechanisms would be created to incentive *demand response* (the modulation of energetic demand in order to avoid waste) and the continuous development and financing of the Program for Rational and Efficient Use of Energy and Non-conventional Sources – PROURE (*Programa de Uso Racional y Eficiente de Energía y Fuentes No Convencionales*). This program is the first to deal specifically with the problem of energetic inefficiency in regards to the public administration. It was implemented under the Law 1665, from 2013, which approved and adopted the Statute of the International Renewable Energy Agency – IRENA.[15]

Referring to the technical perspective of the Colombian energy matrix, firstly, it is necessary to consider that the growth of the energy demand in

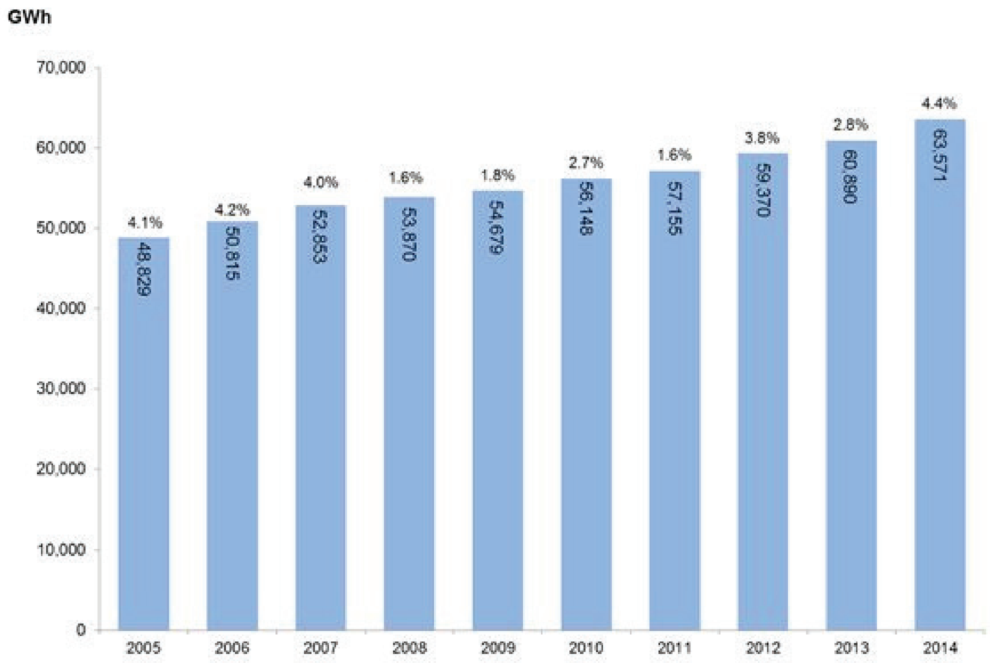
Quindio. The plantations are located among the states of Cauca, Valle Del Cauca and Risaralda. To know more: Asocaña**: Reporte de Sostenibilidad Del Sector Azucarero Colombiano 2015-2016.**

14 During the years of 2009 and 2010, the patterns of atmospheric circulation over Colombia were altered due to anomalies in the wind: in the El Niño phase, positive anomalies of zonal winds were constant; in the La Niña phase, while negative anomalies occurred on the high levels, on low levels, the anomalis' characteristics were inverted (ARISTIZÁBAL, 2011, p. 18).

15 The Statute, approved in Bonn, Germany, in 2009 and which approval is the only object of Law 1665, deals with the necessity to firm international accords in the sense of promoting sustainable development and the reduction of pollution emission levels.

the country is not only related to the development of industrial activities[16]. According to data published by XM[17], a company that operates the Interconnected System (*Sistema Interligado Nacional - SIN*) and manages the Colombian Energy Market (*Mercado de* Energía *Mayorista* - MEM), demand for power in Colombia, in 2014, reached its highest growth levels in the last 10 years (4,4%), and the only reason was the raise in 5% of the energy demand in the regulated market[18]. The chart below illustrates that growth:

Chart nº 1: Energy demand in Colombia in the past 10 years.



Source: XM (2015)

[16] Unlike the global trend in which the increasing of the demand for energy is related to the population growth, increasing technological development and changes in production processes. To know more: NOLLA, José Pinto. **Mejora de Accesso a Mercados Energéticos Fase I- Colombia: Estudio Integral de La SituacionActual y perspectivas Del Mercado Energetico de Colombia**, Bogotá: OLADE,2013. Available at: <http://www.olade.org/sites/default/files/CIDA/Colombia%20Informe%20Final%20Octubre%20V3.pdf>. Access: 26 June 2016.

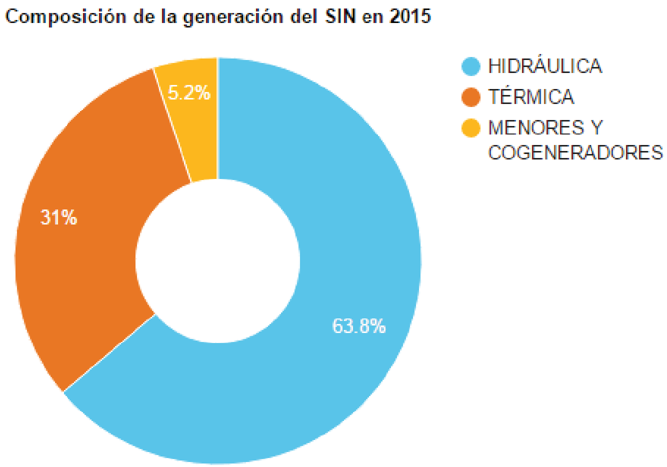
[17] XM; **Demanda de Energía 2014;** Bogotá: 2014 Available at: http://www.xm.com.co/Pages/DemandaEnergia-2014.aspx. Access: 26 June 2016.

[18] By regulated market, we mean small business and domestic energy consumption.

That growth, according to the entity PROCOLOMBIA, resulted in the country's participation in the development of many international projects regarding energy expansion[19]. Furthermore, according to the World Bank, while 97% of the Colombian population has access to electricity[20], it is estimated that 540.000 families still live without it[21].

Accordingly, in the current energy matrix, the capacity of the power grid installed and used by SIN, up until the end of 2015, was of 14.559 megawatts and 64% of the total are from hydroelectric sources, 31% from thermal sources and 5% from other sources, such as biomass and wind energy.[22] Thermal energy generation faced an expansion of 12,1% in comparison to 2014, now representing the aforementioned 31%. This expansion is a consequence of the dry in Colombia due to the El Niño in the second semester of 2015, a phenomenon which, as exposed, vastly influences the composition of the Colombian energy sector[23]. The graph below illustrates this situation:

Chart nº 2: SIN generation composition in 2015.



Source: XM (2015)

[19] For example, the inclusion of Panama in the interconnected distribution net in Central America and, for 2018, a planned new connection with Ecuador. To know more: PROCOLOMBIA; **EletricPower in Colombia- PowerGeneration;** Bogotá: Procolombia, 2015.

[20] BANCO MUNDIAL. **Accesso a la Electricidad (% Población)**, 1990-2012. Available at: http://datos.bancomundial.org/indicator/EG.ELC.ACCS.ZS. Access: 25 June 2016.

[21] Ibid.

[22] PROCOLOMBIA; **EletricPower in Colombia- PowerGeneration;** Bogotá: Procolombia, 2015.

[23] XM. **Descripcion Del Sistema Electrico Colombiano**. Available at: http://www.xm.com.co/Pages/DescripciondelSistemaElectricoColombiano.aspx. Access: 26 June 2016.

Having the elimination of regional inequalities through mining-energetic development as one of the main goals in terms of competitiveness and infrastructure, the National Plan for Development 2014 – 2018 (PND)[24], implemented by the National Department for Planning, provides a brief study regarding the current status of the access to renewable energy sources by the population, and prediction of its growth. According to PND, in 2013, public domestic natural gas services, for instance, counted with a 78% coverage of the national territory and, with government funding through the Special Fund for Development, 69,720 new clients were covered. Moreover, the goal for 2018 is to reach 1,006,935 new clients[25]. This demonstrates the current concern of the Colombian authorities with the diversification of its energy matrix, in order to guarantee the fulfillment of new demands.

2. A plan for democratic access to energy in Colombia

In Colombia, as the hydroelectric plants are the main source of power generation, the Colombian energy matrix can be considered clean. However, the search for the reduction of the dependence upon hydro resources, caused by preoccupation regarding water scarcity due to natural phenomena, and the expansion of energy demands gave rise to the incentives for the new projects of power generation using alternative sources.[26]

As in most part of its neighboring countries, Colombia has water resources in abundance: although they occupy only 15% of the global surface, Latin-American and Caribbean countries receive almost 30% of total amount of rain and generate 33% of flow, resulting in 28,000 m3 per capita for year in the region.[27] Furthermore, Colombia has a favorable weather for wind and solar energy generation and can produce power through biomass due to its sugar

24 In spanish, "Bases Del Plan Nacional de Desarrollo 2014-2018".

25 COLOMBIA. Departamento Nacional de Planeación. **Bases Dell Plan Nacional de Desarrollo 2014 - 2018**, Ibagué, 2014. Available at: https://colaboracion.dnp.gov.co/cdt/prensa/bases%20plan%20nacional%20de%20desarrollo%202014-2018.pdf. Access: 27 June 2016.

26 MANTILLA, Victor Patiño; VENTURINI, Osvaldo José; PALACIO, José Carlos Escobar. Panorama das Energias Renováveis na Colômbia: Mercado e Regulamentação **- Visão Sobre a Nova Lei de Energias Renováveis e a Influência da Proposta 077 da Comissão de Regulamentação de Energia e Gás (CREG)**; Revista Brasileira de Energias Renováveis, 2015. Available at: http://revistas.ufpr.br/rber/article/view/44157/pdf_79. Access: 16 August 2016.

27 Data from Latin-America and Caribbean Economic Comission: http://www19.iadb.org/intal/intalcdi/PE/2014/13734.pdf. Access: 28 August 2016.

production[28]. This scenario favors the research and development of renewable sources in order to fulfill the energy demand through clean and sustainable means.[29] Accordingly, it is necessary to describe the Colombian rural areas and population, because they are the first beneficiaries of the plan for the equal access to energy in the country.

The rural population of Colombia

In order to successfully implement a plan to ensure the democratic access to electricity in Colombia, fulfilling the energy demands of the rural areas, it is important to characterize the people that is going to be the target of the plan. Thus, it is worth noting the difficulty to find accurate and recent information on the population of Colombian rural areas. This observation was made Carlos Salgado Araméndez:

> The most recent studies dealing with the rural Colombia issue show that, as incredible as it may seem, it is very difficult, today, to make strong statements about the reality of the rural world. There is not enough information to say the exact dimension in terms of hectares of land in use for agriculture or pasture purposes. There are only estimations based on partial surveys conducted by DANE, referring to 22 departments and statistics of organizations.[30]

As said by the World Bank, Colombia has an amount of 24% of its population living in rural areas[31], according to the 2011 – 2015 census. This represents a reduction of 4% compared to the data of the 2000[32]. Given this, it is necessary to explain what is meant by "rural population" on the statistics. Still according to World Bank:

[28] In 2015, 24,205,089 tons of sugar cane were produced in the country. Data from: Asociación de Cultivadores de Caña de Azúcar de Colombia. Available at: http://www.asocana.com.co/modules/documentos/5528.aspx. Access: 18 August 2016

[29] Sustainable energy is different from clean energy. Clean energy is from a clean source (without harmful gas emissions) and might not be sustainable if it causes environmental damages. For example, hydroelectric plants are clean sources, but their construction often results in large flooding, changes in the local fauna and flora and, hence, they are not sustainable. Sustainable energy is generated from renewable sources which result in less or no impact, compromising the minimum of life quality and the natural resources for the next generations.

[30] ARAMÉNDEZ, Carlos Salgado; Los Conflitos rurales y los escenarios a futuro; In: **La cuestión agrária en Colombia: tierra, desarrollo y paz;** page 11, 2012.

[31] WORLD BANK. **Rural Population (% of total population).** Available at: <http://data.worldbank.org/indicator/SP.RUR.TOTL.ZS>. Access: 24 June 2016.

[32] Ibid.

> Rural population refers to people living in rural areas **as defined by national statistical offices**. It is calculated as the difference between total population and urban population. Aggregation of urban and rural population may not add up to total population because of different country coverages.[33]

Aspect of great relevance is the expression "defined by national statistical offices", especially on the Colombian legislation, since the country faces an uncertainty on what rural area and its population mean. In accordance with Edelmira Pérez Correa and Manuel Pérez Martíez[34], while the "urban" population comprehends all the municipals headquarters – *cabeceras* –, regardless of the number of inhabitants, "rural" population can be considered the "rest". The Economic Commission for Latin America and Caribbean (ECLAC) clarifies that, under the Colombian census, rural population means "[…] those people living in areas not included within the perimeter of the municipal head (populated centre where the city hall is located)."[35]

Moreover, due to the vagueness of the definition, here we share the conclusions of the UNDP (United Nations Development Program) in its study *"Colombia Rural: Razones para esperanza"* (Rural Colombia: Reasons for Hope) published in 2011, in which it demonstrates that the definition of rural population as the "remainder" is unduly simplistic. It is necessary to consider the complexity of the urban-rural reality, combing demographic density with the distance between centers more and less populated. It is important to have a unity of analyses that does not consider the city as an uniform entirety and that takes into account not only its size. Finally, one cannot consider the "rurality" as continuous[36]. In this context, the territory is not defined just as a geography space, but a space of social constructions, where different actors

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33 WORLD BANK. **Rural Population (% of total population).** Available at: <http://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?page=2>. Access: 24 June 2016.

34 CORREA, Edelmira Pérez; MARTÍNEZ, Manuel Pérez; **El sector rural en Colombia y su crisis actual,** page 38, 2002.

35 ECLAC; **Definición de población urbana y rural utilizadas en los censos de los países latinoamericanos;** Bogotá: 2012, page 5.

36 UNDP. 2011**. Colombia rural: Razones para la esperanza**. Informe Nacional de Desarrollo Humano 2011. Bogotá: INDH PNUD, 2011, page 34. Available at: <http://www.co.undp.org/content/dam/colombia/docs/DesarrolloHumano/undp-co-ic_indh2011-parte1-2011.pdf>. Access: 23 June 2016.

establish numerous relationships[37]. By this analyses, UNDP says that not only 24% of Colombians live in rural areas, as assumed by the World Bank, but 32%.[38]

Now, one needs to define who are the Colombia rural people. Following this line, we must then map out the composition of the Colombian rural population. Colombia is one of Latin America's countries[39] that also have a high percentage of rural population. Even though its territory suffered a transformation in the twentieth century, with a massive urbanization process, the country constructed a model of development that condemned the rural world to failure .Resulting in a large index of inequality in the countryside and concentration of lands.

Although the rural Colombia had an improvement in its human development indexes[40], the inequality is still very strong. The concentration of lands and violence affect dramatically the development factors. Currently, about 77% of the country's land belong to 13% of owners, but only 3.6% of these have 30% of the whole territory. The highest concentration of land is in the states of Cordoba and Caquetá. However, greater inequality can be found in Antioquia and Valle. Another relevant fact is that the informality of the land possession of small landowners exceeds 40%.[41] About 15.36% of the municipalities in the country has a *Gini*[42] of landowners concentration above 0.84, an extremely worrying number. Some municipalities stand out, like Unión Panamericana (Chocó), San Jose Del Palmar (Chocó), Puerto Nariño (Amazonas) and Sácama (Casanare). However, it's necessary to say that the

[37] For this reason, the denomination "remainder" is not correct, because it considers just the number of inhabitants and not the territorial dimension. Thus, the UNDP census will be considered here.

[38] The UNDP defines rural area as the complexity resulting from the relationship of four components: (1) The territory as a source of natural resources, a support of economic activities, scenery of exchanges and political and cultural identities; (2) The population that live its life attached to the natural resources and land sharing a cultural model; (3) The settlements that establish relations between themselves and with the outside, through the exchange of people, goods and information; (4) Public and private institutions as milestones within which runs the entire system.

[39] As well as Bolivia, Peru and Nicaragua.

[40] In accordance with UNDP, in 2010, the country featured a human development index (HDI) of 0.71. Counterpart, in 1980 the HDI was 0.55. Note that a gradual improvement occurred.

[41] REVISTA SEMANA. **Así es la Colombia Rural.** Bogota: 2012, Available at: <http://www.semana.com/especiales/pilares-tierra/asi-es-la-colombia-rural.html>. Access: 25 June 2016.

[42] Briefly, Gini is the index that shows the concentration of income, lands, etc, in a certain group. It indicates the difference by incomes (in the case concentration of lands) between the more rich and the more poor. It goes from 0 (zero) to 1 (one). Hence, the countries with a Gini near 1 (one) have more concentration. To know more: IPEA**. O que é? Índice de Gini.** Ano 1. Ed 4, 2004. Available at: http://www.ipea.gov.br/desafios/index.php?option=com_content&id=2048:catid=28&Itemid=23. Access: 20 August 2016.

cause of land concentration can also be conveyed to the purchase of these by drug lords. In 2002, 42% of the land belonged to drug trafficking. This land purchase phenomenon by drug traffickers had its most significant impact between the 1980s and 1990s.[43]

Colombia's rural population is composed of different people, arranged in a disperse way across the territory. About 75.5% of Colombian municipalities are rural, and they occupy an area of 94.4% of the country's surface, and 32% of the population live there[44]. States with the most indices of rurality in the country are: Amazonas, Arauca, Caquetá, Casanare, Chocó, Guaviare, La Guarija, Nariño, Putamayo, Vaupés and Vichada:

> The rural population in Colombia is make up of poor peasants and small, medium and some large landowners. Rural residents are also the fishermen, craftsmen and those engaged in mining activities. Also, indigenous and most of the members of the black communities are part of the rural population.[45]

However, here we will focus on the most vulnerable groups of the rural population: peasants, ethnic groups (indigenous and Afro-Colombian communities, mostly) and women. These specific groups suffer from various types of historical discrimination, given their rural housing, little economic representation and the informality of their properties. The concentration of land and violence also contribute to the aggravation of the discrimination and social segregation. It is for these reasons that the plan for the eradication of unfair energy distribution of this study target these individuals.

By didactic means, it is defined as peasant population the people that work in production facilities and family-type consumption. They differ from other farmers by the element of family production, which is essentially aimed at subsistence. Throughout history, the urban-rural development plans adopted in the country did not recognize the Colombian peasantry. Thus, due to the informality of their properties, they were excluded from rural development

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[43] CORREA, Eldemira Perez; MARTÍNEZ, Manuel Perez. El sector Rural en Colombia y su crise actual; In: **Cuardenos De Desarollo Rural**, no.48, Bogotá, 2002, p. 39. Available at: http://www.redalyc.org/articulo.oa?id=11704803. Access: 22 May 2016.

[44] Considering the methodology adopted by the UNDP, quoted in paragraph 1 of this article.

[45] CORREA, Eldemira Perez; MARTÍNEZ, Manuel Perez; El sector Rural en Colombia y su crisis actual; In: **Cuardenos Del Desarollo Rural.**Bogotá: number 48, 2002, page 39.

programs, government support and subsidies. Additionally, the ancient practice of encouraging commercial policies in the country put the peasantry only as a labor force and not as a rural stratum with market capacity. This logic reinforced the subordination of the whole class, preventing the recognition of these individuals as people with rights. All of these conditions, according to the UNDP, led these people to a situation of poor living conditions. In our times, about 80% of all peasants have less of a family farm unit of land (AUF). This scenario generates structural poverty, migration to urban centers, incorporation of illicit crops or the enlistment to illegal armed groups as alternatives for survival.[46]

Regarding rural women, they suffer three forms of discrimination which shows a disproportionate aggravation of the problem. "They suffer discrimination because they live in the countryside, because they are women and because they are victims of violence"[47]. Hence, there is a gender debt caused by the traditional inequality between men and women enhanced by the fact that these women are living in the countryside and further aggravated by the vulnerability to which they are exposed, family violence and violence outside the family. Poverty in households where women are responsible for subsistence is higher than when men are assigned to this function. Colombia is one of the few countries in Latin America that has this scenario. The average unemployment rate of family "heads" (when women has to lead the family) in 2010 was 9.6%[48]. Regarding violence, there is little information about it, since rural women face more barriers to denounce. Also in this context, there are also numerous violent acts that affect women as consequence of armed conflicts. They are exposed to physical, psychological and especially sexual violence. All these circumstances show the extreme state of vulnerability of women in the countryside.[49]

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[46] Bogotá: INDH PNUD, September 2011. Available at: http://www.co.undp.org/content/dam/colombia/docs/DesarrolloHumano/undp-co-ic_indh2011-parte1-2011.pdf. Access: 23 June 2016.

[47] Bogotá: INDH PNUD, September 2011, page 132. Available at: http://www.co.undp.org/content/dam/colombia/docs/DesarrolloHumano/undp-co-ic_indh2011-parte1-2011.pdf. Access: 23 June 2016.

[48] Data from PNUD 2011: PNUD. 2011**. Colombia rural: Razones para la esperanza**. Informe Nacional de Desarrollo Humano 2011. Bogotá: INDH PNUD, september 2011. Available at: http://www.co.undp.org/content/dam/colombia/docs/DesarrolloHumano/undp-co-ic_indh2011-parte1-2011.pdf. Access: 23 June 2016.

[49] Ibid.

As for the characterization of Colombian rural population, ethnic groups must also be addressed. These groups are composed, mostly, by indigenous and Afro-Colombian communities. When it comes to indigenous peoples, in Colombia, there are about 1.4 million natives - approximately 3.36% of its population. Most of them live (73.65%) in the states of Cauca, Cesar, Cordoba, La Guajira, Nariño, Sucre and Tolima. According to the 2005 census, 78.4% live in rural areas. About 63% of indigenous people live below the poverty line, 47.6% below the misery line and 28.6% of those older than 15 years old are illiterate[50]. This condition of life is also the result of discrimination associated with labor exploitation and shortages of scarce public goods.

The Afro-Colombians are composed by a heterogeneous and diverse population. About 10.62% of the Colombian population call themselves "African descents". They are divided into four groups: the Pacific Region; Traditional Communities of San Andrés y Providencia; Community of San Basilio de Palenque. They are concentrated in few states: Valle Del Cauca (1.1 million); Cali (542,936); Antioquia (600,000); Bolivar (500,000); Chocó, Nariño and Cauca with 300 000 inhabitants each; Atlantico (200,000). It is noteworthy also that the highest percentages of this population can be found in the following states: Chocó (82.1%), Archipelago of San Andrés, Providencia and Santa Catalina (57%); Bolivar (27.6%); Valle del Cauca (27.2%) and Cauca (22.2%), Nariño (18.8%) and Sucre (16.1%). The Afro-Colombians have historical ties to extractive activities of wood and ore, sugar cane plantations and banana. It is important to consider that the registration of this population is poor and a greater effectiveness would help get more information. They suffer historic discrimination, because of their cultural and especially religious dynamics. In the Afro-Colombian communities, even after the titling of collective territories, poverty and misery remain and it gets worse when in the rural areas. Social indicators reflect a low level of protection of rights especially regarding women, young people and children. Like the other people mentioned, there are few opportunities for access to public goods and services.[51]

From these data, it is possible to see that poverty is an incisive factor in Colombian rural populations. Accordingly, the costs of the energy projects

50 Ibid.

51 Ibid.

have to be minimal. Although the number of poor people in the country has decreased from 53.7% to 45.5% between 2002 and 2009, it is still a very high figure. The poverty reduction rate is much lower in rural areas than in the urban ones.[52] Rural poverty is mainly manifested in the lack of access to public services such as education, health and social security. Poverty is also associated with variations of income due to market policies adopted by the country over time. In 2002, 79.7% of the population did not have enough income for basic maintenance of their survival. In 2011, about 60% of the rural population had informal employments, which influences the variation of the minimum income.[53]

The United Nations Development Program did a survey on the extent of the vulnerability of rural population from six perspectives, in which the maximum score is 60.0: (1) Environmental Vulnerability - it is 54.9, i.e., it reaches almost maximum rate. This demonstrates the lack of sustainable resources in the rural areas. It is relevant to remember that, in land distribution, part of the rural population occupies areas of forest reserves[54]; (2) Vulnerability for Economic Capacity - which is 51.5; (3) Vulnerability by Demographic Characteristics – 53.7; (4) Vulnerability by Human Capital - which has an index of 51.8; (5) Vulnerability by Violence Presence - which is 51.3; and (6) Vulnerability by Institutional Capacity - with a 50.1 index. This shows extremely worrying data on the protection of the rural population and the struggle for enforcing its rights. While the vulnerability of the rural municipalities is around 52.2 points, in less rural municipalities this figure is around 46.4%. This data reveals the discrepancy of lifestyles and inequality proportionally connected to rurality[55]. It is worth quoting the definition of the Department of National Administrative Statistics of Colombia (DANE) for rural area:

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52 Ibid.

53 In accordance with a UNDP's study published in a special edition of the magazine "Revista Semana".

54 44.7% of Colombia's territory is reserved area and 25.2% of this area is for collective indigenous propriety and 5% is for the collective territories of the Afro-Colombian communities. To know more: PNUD. 2011. **Colombia rural: Razones para la esperanza**. Informe Nacional de Desarrollo Humano 2011. Bogotá: INDH PNUD, 2011. Available at: http://www.co.undp.org/content/dam/colombia/docs/DesarrolloHumano/undp-co-ic_indh2011-parte1-2011.pdf. Access: 23 June 2016.

55 PNUD. 2011. **Colombia rural: Razones para la esperanza** .Informe Nacional de Desarrollo Humano 2011. Bogotá: INDH PNUD, September 2011, page 68. Available at: http://www.co.undp.org/content/dam/colombia/docs/DesarrolloHumano/undp-co-ic_indh2011-parte1-2011.pdf. Access: 23 June 2016.

> Rural areas or municipal remainder: they are characterized by a dispersed arrangement of houses and farms existing in it. They do not have a urban grid or names on streets, roads, avenues, and others. Also, generally, there are no utilities and other urban areas facilities[56].

Thus, according to the DANE, rural areas are those that generally do not have public services or other types of facilities found in the urban area, which disclose the isolation of these regions and the inaccessibility of the population to basic services.

The problems are intensified also by the presence of violence in the countryside. The violence covers both rural conflicts over land ownership and the ones generated by the development of guerrillas, increased drug trafficking and paramilitarism. This is aggravated by the fact that few public service entities or state institutions operate in the rural area. Armed conflicts, especially after the breakdown of peace talks with FARC, negatively impact the supply of drinking water and electricity to many rural people of Colombia. The document "National Framework Development Plan 2014 - 2018", adopted in the Perez Gutierrez Administration, concludes that even in Antioquia, a department that is between the 7 ones with the highest electricity coverage, 5.5% of rural households still lack access to electricity.[57]

Thus, in light of the abovementioned conditions, it can be seen why - taking into account the SDG 7- an energy policy for the Colombian rural population is needed, in order to implement the sustainable development principle, which must be understood as the integration between the social, environmental and economic perspectives - the social development shall receive priority. Accordingly, the public policy have to be implemented in order to fulfill the rural population's social demands, taking into account the environmental sustainability and economic features. In other words, it will promote social rights for adequate life conditions and human development with energy access. This energy cannot be environmentally unsustainable[58] and economically inaccessible.

[56] DANE, **Conceptos Básicos.** Available at: www.**dane**.gov.co/files/inf_geo/4Ge_ConceptosBasicos.pdf . Access in: 23 June 2016.

[57] OCAMPO, José Antonio. **Misión para Transformacion del El Campo.** Bogotá: Departamento Nacional de Planeación, October 2014.

[58] Sustainability is very hard to define. Some authors highlight its imprecision, that is similar to the definition of justice. However, the lack of clarity of these two terms is not due to their ambiguity, but given their

2.1. The small pumped storage hydroelectric option

In order to achieve the expansion of service energy demand in rural Colombia, it is essential that this meets the basic requirements present in the ODS 7, which are: (1) safe, reliable and sustainable access to energy resources; (2) accessible prices; and (3) available to all. Accordingly, the principle of sustainable development would be respected by the plan.

Hence, it is necessary to evoke the previous observations on the Colombian rural populations, especially those about the three fragile groups[59] highlighted in this study, and the lack of access to public services and to financial resources by these groups[60]. One should also consider the large areas and dispersion of Colombian rural areas in its territory, noting the tendency to poverty of a population being directly linked to geographical isolation: more dispersed is the population, less access to resources and development it will have.[61] These two elements - poverty and geographic isolation - should be considered in the elaboration (and execution) of a plan to eradicate unfair energy distribution through the transmission of clean and sustainable power to the Colombian rural population. If these elements are not observed, the alternative proposal will not fulfill its essential assumptions to meet social demands, the duty of not harming the environment and its affordability, wherein the economic framework is an instrument for the execution of the two first contexts (social and environmental). In other words, if the project does not take into account the conditions of poverty and geographic isolation, it will not be able respect and carry out the principle of sustainable development through its conceptual elements.[62]

complexity. For this reason, unsustainable is used here, because - in the same way as injustice - it is easier to realize. To now more: VEIGA, José Eli da.**Sustentabilidade: a legitimação de um novo valor.**São Paulo: Editora Senac, 2010.

59 These groups are: the small peasantry, women and ethnic groups (indigenous and Afro-Colombians).

60 In addition to the challenges previously mentioned, it can be said that in general analysis, the average income of a farmer in 2009 was 220,000 pesos, while in the city the average income is 668,000 pesos. To know more: REVISTA SEMANA. **Así es la Colombia Rural.** semana.com, 2012. Available at: http://www.semana.com/especiales/pilares-tierra/asi-es-la-colombia-rural.html. Access: 19 August 2016.

61 Scattered populations: very low densities, below ten people per km². OCAMPO, José Antonio. **Saldar la DeudaHistórica con el Campo Colombiano**. Available at: http://fear.javeriana.edu.co/documents/2781897/5711404/Jos%C3%A9%20Antonio+Ocampo-Saldar+la+Deuda+Hist%C3%B3rica+con+el+Campo.pdf/2a606631-cce1-4a84-b6ee-a668a90c2582. Access: 19 August 2016.

62 Again we emphasize that the conceptual elements of the principle of sustainable development highlighted here are the social, environmental and economic spheres. This principle relates to the integration of these

Given the above, at first, it appears that the use of water sources, abundant in most of the territory[63], reveals to be the main part of the set of solutions for the diversification of the energy matrix and the care of rural population demand for energy. However, considering the geography and the demographic density[64] of the rural areas above cited, the environmental impact and the high costs, the construction of hydroelectric plants for power distribution to rural areas is not a viable option. However, relying on the institutional structure of the country (that will still be studied here), specially the Decree 1623 of 2015 which deals with the expansion of the coverage of electricity service in isolated areas - more precisely its Article 7, which says that the expansion of electricity service must be performed by centralized isolated solutions or individual microgrids,[65] we propose here a solution to be individually implemented and that involve micro grids. Hence, we suggest the adoption of individual measures for each rural village and that do not require major transmission networks for distribution. Therefore, based on the principle of sustainable development, interpreted from the perspective of the goal of Sustainable Development[66] and the Training Program in Renewable Energy, developed by the United Nations Industrial Development Organization (UNIDO)[67], it is proposed as alternative to the problem of energy inaccessibility by the Colombian rural population, an individual feasibility study of each region and the construction of Small Pumped-Storage Hydroelectrics 68 (PSH) in places where conventional energy supply is absent for any reason whatsoever.

three spheres. This can be seen, especially since 2002 in the Declaration of the World Summit on Sustainable Development, known as the Johannesburg Declaration on Sustainable Development. To learn more visit: UN DOCUMENTS**. Johannesburg Declaration on Sustainable Developmet**. Available at: http://www.un-documents.net/jburgdec.htm. Access: 21 August 2016.

63 The hydrographic map of Colombia and its rivers can be found here: http://atlasgeografico.net/mapa-hidrogrfico-de-colombia-con-sus-ros.html

64 In general, Colombian relief is formed by three regions: (1) mountainous area; (2) the flat relief and (3) peripheral relief. It is worth remembering that the rural population is dispersed throughout the territory of the country, which contributes to its isolation. To learn more visit: TODA COLOMBIA. **Relieve Colombiano.** Available at: http://www.todacolombia.com/geografia-colombia/relieve-colombia.html. Access: 22 August 2016.

65 Cf. Decree 1623 of 2015: MINISTERIO DE MINAS Y ENERGÍA. **DECRETO 1623, 11 de agosto de 2015.** Available at: <http://www.siel.gov.co/Portals/0/Normatividad/Decreto_1623_2015.pdf>. Access: 19 August 2016.

66 United Nations Development Programme. **The objectives of sustainable development.** 2015. Available at: http://www.pnud.org.br/ods.aspx. Access:19 August 2016.

67 Observatory of Renewable Energy for Latin America and Caribbean. Training Program in Renewable Energy, 2016. Available at: https://pt.scribd.com/document/276824432/Pequenas-Centrais-Hidreletricas. Access: 12 August 2016.

68 Also known as storage by pumping water or storage for hydraulic accumulation.

Thus, it is considered that PSH are composed of two reservoirs built on different levels, pipes, pump and turbines. The system consists of pumping the stored water in the lower reservoir to the upper reservoir through the energy supply of another source[69] in periods of lower energy demand and, at a later time, in the kinetic energy[70] collection during the fall of the upper reservoir water to the lower one. Thus, hydraulic power is generated[71] through the level difference between the two reservoirs by the fall of the same water stored[72]. In this scheme, diameter, length and pipe material comprising the forced conduct[73] are factors that impact the loss of load[74] and consequently the total energy generated by the system. Therefore, the PSH project should be calculated separately, for each individual case.

Nevertheless, in view of the high cost of hydro-electrical-mechanical equipment, one proposes the replacement of the conventional turbine by a pump running as a turbine (BFT)[75], which, besides providing lower cost,

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69 It is suggested that one installs solar panels to collect energy for pumping and keeping the system in the sustainable concept.

70 The transformation of kinetic energy (which is related to the state of motion of a body - in this case with the water flow) into electricity, is made through hydraulic turbine coupled to an electric generator connected to the power network. However they can also be used for small-scale power generation in isolated communities. To know more: <http://www.portalpch.com.br/93-informacoes-portal-pch/turbinas-hidraulicas.html> Access:19 August 2016.

71 The installed hydraulic power will be determined by the equation: $P = 9.81.\ Q.\ (Hb - Hp).\ \eta = 9{,}81.Q.H\iota.\eta$ [κW]
Where:
Hι - Net loss (m);
η - total yield of the plant (dimensionless).

72 CANELES, Fausto Alfredo; BELUCO, Alexandre; MENDES, Carlos André Bulhões. R**eversible hydroelectric plants in Brazil and the world: applications and perspectives.** Available at: http://periodicos.ufsm.br/reget/article/viewFile/16002/pdf. Access: 19 August 2016.

73 One calls "penstock" the pipe through which the liquid flows forcibly through a pump, for example, in a pressure different than the atmospheric one. To know more: EVANGELISTA, Adão Wagner Pêgo. **Water conduction(Cont.)** Escola de Agronomia e Engenharia de Alimentos, setor de engenharia rural. Universidade Federal de Goiás. Available at: <https://www.agro.ufg.br/up/68/o/3.2__Condutos_For_ados.pdf> Access: 20 August 2016.

74 The flow of water in long, straight and cylindrical tube cause pressure loss varying (approximately) directly with the kinetic load (), Using a proportionality coefficient (f) called friction factor Darcy, Weisback and others have proposed the following equation for calculating the pressure dropwhere:
hf = head loss (m);
f = head loss factor (admensional);
L = length of pipe (m);
D = diameter of pipe (m);
g = acceleration of gravity (m s²).

75 As stated, the turbines are machines designed to transform kinetic energy into electrical and the pumps have the goal to boost a fluid, helping to transport this. By reversing a pump and using it in the energy harvesting generated by a fluid in the gravitational flow, gain a working pump as turbine (BFT), which can reduce the cost of the system considerably, since pumps are manufactured in series, and easily found in non

completes the system, pumping the water back to the upper tank in order to start the new cycle of power generation. Furthermore, the system maintenance as a whole does not demand specialized labor: its installation is simple and its components and parts are easily found.

Capturing energy in PSH by using waterfalls between two reservoirs preserves the main advantages of the generation of hydraulic power minimizing considerably the environmental impact. It is also worth considering that one extends the enforceability of the PSH in isolated areas where there are no natural water falls since once the water is stored, there will be no need for other water resources. In the economic perspective, it is possible to reduce the cost of the system implementation by replacing turbines with BFTS because they present lower costs in the market, as already said.

As to corroborate the low cost of this alternative, it is emphasized that in a case study in a farm called Boa Esperança in Brazil (2006)[76], a micro hydroelectric plant reached the power production of 43kiloWatts with a fall of 20 meters and flow rate[77] of 0,250m³/s (cubic meters per second). Through the replacement of the turbine with BFT, it were obtained savings over 65% with the gen set. This shows that the easy and democratic access to clean and cheap energy is possible, even without employing additional methods of fund raising for generation of electricity.

Despite the geographical challenge of building and linking two reservoirs vertically, separated by tens or hundreds of meters, but horizontally next to each other, one has to conclude that such a proposal would achieve the

skilled trades, also dispensing hand specific skilled labor expensive (VIANA, Augusto Nelson Carvalho; LIMA, Gustavo Meireles. **BombasFuncionando Como Turbina: Uma Alternativa De BaixoCusto Para GeraçãoIsolada-Estudo De Caso No ParqueEstadual Da IlhaAnchieta**. UNICAMP: Campinas, 14 December 2010).

76 Data of the study cited are available on: VIANA, Augusto Nelson Carvalho; REZEK, Ângelo José Junqueira; MEDEIROS, Daniel de Macedo. **The use of induction generators driven by BFTS in generating electricity.** AGRENER GD 2004- 19 A 21 DE OUTUBRO. Available at: http://seeds.usp.br/pir/arquivos/congressos/AGRENER2004/Fscommand/PDF/Agrener/Trabalho%20133.pdf. Access: 20 August 2016.

77 Hydraulic flow is defined as the ratio between the volume of fluid and time, i.e., representing the speed of flow of a particular fluid. I is obtained such value using the formula: Qv =
Where:
Qv = volume flow (m³ / s);
V = volume (m³);
T = time interval for filling the reservoir (s).
(INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA. **Fluid Mechanics, class 8 introduction to kinematics of fluids.** São Paulo. Available at: <http://www.engbrasil.eng.br/pp/mf/aula8.pdf> Access: 21 August 2016)

power distribution expansion goals, development of alternative sources in the Colombian energy matrix and raising the quality of life of rural populations, ensuring the principle of Sustainable Development proposed in Goal 7 of Agenda 2030. However, one cannot rule out the importance of a social-economic study with the aim of measuring the impact on communities, availability of lands, labor, maintenance, among other conditions of analysis. It is also important to say that the PSH does not end up the alternatives to eradicate inappropriate energy distribution in the Colombian countryside. They are just the mean considered as the most feasible in this study. Meanwhile, it is noteworthy that when it comes to response to energy demands of isolated populations it is "crucial that the model provides a structure able to deploy autonomous power generation projects, meeting the proposed development that the company intends to deploy in the region[78]." This is stipulated in the Article 7 of Decree 1623 of August 11, 2015, and it will be consolidated with the construction of the PSH.

In this line, one then will expose other institutional means to support the plans for distribution of sustainable and low energy cost to the Colombian rural communities. Exposing also strategies with the creation of new public policies that support alternatives to meet the demands for energy.

3. Institucional support and a proposal of public policy for more effectiveness of the plans to democratic access to energy

As previously said, it is necessary to describe the institutional framework that supports the plan in favor of the universal, sustainable and affordable access to energy resources, mainly in the rural communities of Colombia.

Regarding the hydroelectric sector (which comprehends most of the Colombian matrix), there is a historical issue concerning energy production. Hydroelectric plants are sold as having less environmental impact through the use of a "raw material" available in abundance (the water). Although they

[78] FERREIRA, Maria Julita Guerra; ANDRADE, AdneiMelges de. **Modelagem de políticas públicas para o atendimento energético a comunidades isoladas**. Encontro de Energia do Meio Rural, ano 4, 2002. Available at: http://www.proceedings.scielo.br/scielo.php?pid=MSC0000000022002000200026&script=sci_arttext. Access: 22 August 2016.

are in fact productive, their environmental and social costs are very serious.[79] Even so, it would be imprudent to ignore the water resources availability, which makes Colombia dependent on this type of energy. In order to avoid the many problems caused by the industry and to supply the energy demand that the latter cannot generate, a proposal was necessary to unite the hydroelectric availability, economic advancement, sustainable development and, especially, the possibility of energy decentralization for democratization of access, especially for rural populations. Also, given the hegemony of the hydroelectric sector, such a proposal would only become a reality if it is appropriate to the eco-political-economic status quo in Colombia.

Accordingly, since 2001, with the Law 697 dealing with the promotion of the rational and effective use of non-conventional technologies, the path began to be traced. Under that law, the State became responsible to create the norms and the infrastructure necessary to establish such factors, by creating the Program for the Rational and Efficient Use of Energy and Other Forms of Non-conventional Energy - PROURE (In Spanish: *Programa de Uso Racional y efeciente de la energía y demás formas de energía no convencionales*):

> Article 5. Creating PROURE.
>
> The Program for the Rational and Efficient Use of Energy and Other Forms of Non-conventional Energy "PROURE", which will design the **Ministry of Mines and Energy**, aims to gradually implement programs for the entire energy chain in order to permanently **fulfill the minimum levels of energy efficiency and provisions of the current regulations on environment and renewable natural resources** (our emphasis, free translation).

After the adoption of this law, a bigger concern with the area was established in Colombia, with waves of provisions that provided incentives and exemptions to those promoting clean and non-traditional energy, always under state auspices. In this context, the various efforts would culminate in the aforementioned Law 1715 of 2014, adopted under the aegis that the country could not bear to continue to support traditional methods with their costs and

[79] These costs go from the flooding caused (necessarily) by the installation - which affect forests and agricultural lands, resulting in serious loss of biodiversity causing damage to local populations - to the incredible waste of energy indexes produced with maintenance and operation. Hence, it can't be called clean energy.

pains, and from the objective of promoting the sustainable and non-traditional development. By establishing this legal framework, one proposes greater attention to scientific research that is fundamental to the sector, creating new technologies and plans of action to implement them. In its article 2, Law 1715 extensively lists its purposes:

> Article 2. Purpose of the Law.
>
> The purpose of this law is to establish legal framework and instruments for the promotion of the use of non-conventional energy sources, especially those from renewable sources, as well as the promotion of investment, research and development of clean technologies for the production of energy, energy efficiency and demand supply in the context of national energy policy. It also aims to establish lines of action for the fulfillment of commitments made by Colombia in renewable energy, efficient energy management and reduction of emissions of greenhouse gases, such as those acquired through the approval of the Statute of the International Renewable Energy Agency (Irena) by Law 1665 of 2013 [...] (free translation).

It is important to note, on the final part, the reference to Law 1665 of 2013, which had internalized in Colombia the Statute of the International Renewable Energy Agency (IRENA). This latter aims to support countries in their transition to sustainable energy development. It's interesting for the suggestion in this paper to mention that the above law, in its Article 5, among the definitions of terms used by law, expressly refers to small hydroelectric plants:

> Article 5. DEFINITIONS.
>
> For purposes of interpreting and applying this law:
>
> [...]
>
> 17. Non conventional sources of renewable energy (FNCER): The renewable energy resources available worldwide that are environmentally sustainable, but that are not employed in the country or that are marginally used and not widely commercialized. It can be considered FNCER: biomass**, small hydroelectric,** wind, geothermal, solar and seas. Other sources may be considered FNCER according to UPME. [...] (our emphasis, free translation).

Article 22 deals specifically with this form of production:

> Article 22. Development of Small Hydro Power Plants.
>
> 1. The power of small hydroelectric plants will be considered as FNCER.

> 2. The Ministry of Mines and Energy, through the competent member institutions, **will continue promoting its development as an energy solution**.
>
> 3. The Ministry of Environment and sustainable development will **promote integrated and sustainable management of water resources of river basins in the country** (our emphasis, free translation).

Therefore, there is expressed support and forecasting of government incentives for the creation of small hydroelectric power plants. These latter can be implemented using pumps working as turbines, resulting in benefits from their reasonable production and installation price, which can represent what is aimed here, i.e., to have democratization of energy and sustainability, particularly with regard to rural populations. What is seen, at first, as an disadvantage (its lower yield in relation to the traditional plants) would not be a problem on the small communities that have problematic or more expensive access, or that do not have access at all. Colombian normative framework make it clear: it is necessary to promote sustainable culture in the country as a whole. This gives rise to equitable access to energy, covering the poorest population in the rural areas.

There is also the Decree 1623 of 2015 dealing with the expansion of the energy coverage in the National Interconnected System and Non Interconnected Zones. This legal approach takes into account the article 365 of Colombia's politic Constitution - which states that public services are inherent of the social purpose of the State -, as the constitutional ground for establish and secure efficient energy services for all people in the national territory. The Laws 142 and 143 of 1994 - both refers to the supply of energy to houses and its complementary activities, such as essentials services - determinates the obligation of the State to guarantee the energy supply in various regions and sectors of the country. Therefore, public policies should be created allowing the Public Administration to promote the equal access to sustainable and affordable energy.

The Colombia's National Development Plan, mainly through their goals for the rural zone - "Missions for the Camp"[80] -, also supports projects to ensure energy access to rural areas. Thus, through the State's central goal to

[80] OCAMPO, José Antonio. **Misión para Transformacion del El Campo.** Bogotá: Departamento Nacional de Planeación, 2014.

promote policies for the development of the countryside, in order to accomplish what is presented in the Colombian Constitution and to guarantee economic opportunities and economic, social and cultural development to the rural population, the present paper proposes a public policy for the eradication of the non-access to energy, in accordance to the sustainable development principle. Thus, as in the National Development Plan, policies for a equal access of energy in the country aim for: (1) to reduce inequalities in rural areas; (2) to help promoting environmentally sustainable rural development; (3) to ensure a development that allow the progress of small, medium and large enterprises, including cooperatives and other forms of association of producers; (4) to have social rights services, by adopting an affordable energy distribution policy that implement basic rights to the survival of families, helping, among others, the social shortcomings of the countryside and promoting poverty eradication. Hence, the access to energy by the Colombian rural population is one of the main ways to perform the aims contained in the National Plan for the country's development, having a key-role guaranteeing the sustainable and inclusive economic development. Promoting more access to energy resources is explicitly linked to the need to ensure a "green" growth of the country, highlighting sustainable and affordable energy sources with reduced or no environmental impact. This perspective is very similar to ODS 7, another theoretical apparatus for the purpose of this study.

In summary, there is a new trend in the country in pursuit of equitable development, embracing not only the economic fields, but the social and environmental areas. This can seen in the Colombian National Development Plan, which reveals itself as an avant-garde framework to be compared with other plans in the country that do not trace prospects for rural areas, leaving those at the mercy of their problems. For this reason, we use this as a theoretical apparatus for the proposal for greater access to energy in the Colombia. We intend to create mechanisms for the execution of all the principles laid down in the National Development Plan, as well as to implement the goal of Sustainable Development 7 in the country. Firstly, when we consider the isolation of the Colombian rural population and its dispersion in all territory it is necessary to propose an approximation of the municipal and state instances in the solution of energy demand issues. Accordingly, it should be created an integrate model of energy resources in the regional level, i.e., a specialized organ in which civil organizations, State and Municipal authorities could participate:

> In the case of the regional resources exploration or optimization of the conventional energetic offers, the participation of members of the community and of public authorities is a necessary condition for the success and should happen since initial steps of the planning and data collection.[81]

Therefore, it is necessary to mention the Decree 1623/2015 whose article 18 regulates the Commission of Energy and Gas Regulation (CEGR) and its responsibility to establish special conditions of provision of energy services to the people living in zones with difficult access to the interconnected system. Thus, the Public Administration itself created a commission do deal with the universal access to energy, specializing the decision-making authorities of this area. In the present work, we do not intend to abolish the CEGR, but to regionalize its activities.

The choice for regionalization discloses vantages mainly concerning the demand analyses and measurement of impacts caused by CHRs or other means aimed at sustainable and democratic distribution of the energetic resources. It should also be considerate the creation of regional sub-organs in the regions (or State). In general lines, as said by Maria Julita G. Ferreira and Adnei M. de Andrade [82], the integrated models of planning of the energy resources should have tree basic stages: <u>(1) Determination of the energy demand of a region</u>, through an analyses of the necessary energy that each development areas needs, such as education, entertainment, health, work, infrastructure, and others; <u>(2) Planning of the energy offer;</u> (3) <u>Structure for implementation of autonomic energetic projects:</u> analyses of the projects which, as the CHRs, can propose a structure that promotes the distribution of energy in a sustainable way and continuing their actions by low costs.

Furthermore, in accordance with the same authors, those structures should have a institutional flexible format in order to: (1) acquire resources of

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81 Free translation. FERREIRA, Maria Julita Guerra e ANDRADE, Adnei Melges de**. Modelagem de políticas públicas para o atendimento energético a comunidades isoladas**. Encontro de Energia do Meio Rural, year 4, 2002. Available at: http://www.proceedings.scielo.br/scielo.php?pid=MSC0000000022002000200026&script=sci_arttext. Access: 22 August 2016.

82 Ibid.

international organisms or private actors; (2) hire services and provide technical support to the projects; (3) have financial independence to guarantee the continuity of their activities, regardless of politic and administrative changes; and, (4) give continuity to the activities performed by the State.

Another important point concerning the access to energy by the Colombian rural population relates to the informality of land ownership by peasants. Thus, an effective rural cadastre is necessary. The Development Plan in force in Colombia, in general lines, foresees the creation of that cadastre and the registration of the Colombian rural properties. The formalization of rural land ownership permits a better municipal and state planning for the rural development, through the improvement of the public programs and actions in the relevant areas. With the rural cadastre, the financial institutions have a highest security in the concessions of credit to small farmers, and public authorities can map the forests and other green areas that cannot face interferences from the constructions of plants.[83] Accordingly, the rural cadastre is necessary for the promotion of the integrated planning models of the energy resources, enabling the mapping of the local communities and, consequently, the identification of power demands. After that, the selection process of the best areas to implement the energy autonomous solutions, which are responsible to promote the access to energy by the people living in isolated areas, and the obtaining of financial resources become possible and/or easier. Also, it ensures safety to the most vulnerable groups.

Conclusion

There are attempts within the Colombian State to promote sustainable forms of energy. These are different from the forms of clean energy that are already being used in the country from the hydroelectric plants. Since the 1990s, the Colombian government attempts to promote the democratic access to sustainable energy resources through the incorporation of new laws in the national legal order. This process was intensified from 2013 to 2015. In 2014, Colombia adopted the National Development Plan 2014-2018, that establish,

83 THE NATURE CONSERVANCY. Car: eu apoio. Cadastro rural ambiental. Available at: http://www.tnc.org.br/tnc-no-mundo/americas/brasil/projetos/car-cadastro-ambiental-rural.xml. Access: 22 August 2016.

for the first, goals especially adopted for the rural population. It recognizes the vulnerability of these people and the necessity to guarantee their basics rights, as the access to energy.

In light of this context, the present paper described a plan to guarantee the democratic distribution of energy to the most vulnerable groups of the Colombian rural population (peasants, rural women and ethnic groups). Thus, with the support of institutional means and the SDG 7, the proposal has as fundamental principle - beyond democratic, sustainable and low cost energy distribution - the autonomous energy supply to the Colombian rural population. It suggests the construction of Small Pumped Storage Hydroelectric Plants (PSHs) using BFT rather than traditional turbines. The PSHs are viable in Colombia due to its geographic features and, mainly, due to its hydro potential that cannot be ignored. However, different from ordinary hydroelectric plants, PSHs generate clean sustainable energy, because they do not demand large dams to work. Also, the use of BFT makes the energy production affordable given its low cost. Affordability is an element that cannot be neglected in Colombia since poverty is the one of the most present issues in its rural areas. Another factor to be considerate is the isolation of these people. Accordingly, autonomous systems - which do not need large transmission grids - should be chosen, as for example the PSHs.

In order to achieve the most efficient access to energy, the paper also proposes the regionalization of the Power and Gas Regulation Commission (PGRC), which already exists under Colombian legislation, and a rural cadastre project in order to analyze issues caused by the lack of energy following a regional method of work. Hence, this process of analysis will have a higher precision in identifying energy demands and ensuring the necessary resources to supply this demands. Finally, it is necessary to ensure respect for the sustainable development principle though the SDG 7, under which the integration of social, environmental and economic perspectives are achieved by the access to sustainable and low cost energy to every single Colombian citizen.

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PERU

THE ENVIRONMENTAL ENERGY INSTITUTIONS AND THE EFFICIENCY OF THE RIGHT TO ACCESS TO RENEWABLE ENERGY IN RURAL AREAS OF PERU

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Abstract: This paper aims to analyze the performance of the environmental energy institutions related to the generation of energy based on non-conventional renewable sources in the rural areas of Peru. The research is based on the socioeconomic impacts of the relationship between climate change, energy security and the promotion of public policies on the use of renewable energy to combat global, regional and local environmental pollution, specifically focusing on the dependence of fossil fuels in the country, through the various national and international technical-scientific studies. Accordingly, the paper analyzes the collection of data on the environmental energy potential and on the efficiency of public policies in this area, based on the constitutional and legal provisions that support the right to access to renewable energy. Therefore, the paper suggests a preliminary proposal of agenda as a public policy to reinforce the transcendence of innovation and new technologies that safeguard environmental protection, as well as the harmonization of strategic legal-economic interests based on a system of incentives between State, Market and Society, in order to boost the generation, promotion and investment in non-conventional renewable energy in rural and / or isolated areas. Thus, it contributes to the formation of a Socio-Environmental and Democratic State of Law in Peru.

Keywords: Peru – Environmental Energy Institutions – Non-Conventional Renewable Energies – Rural Areas – Strategic Legal-economic Interests – Incentives – Socio-Environmental State of Law.

Introduction

Throughout history, the South American country that perhaps stands out for its ancient past due to the enrichment of the formation of various cultures, as well as the origin of the continent's civilization in its territory[2], for its great potential in biodiversity and genetic resources, as well as the display of an outstanding geological volume along its coast in the Pacific Ocean, the

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[2] PERU. **Ministério de Cultura. Caral, patrimônio mundial.** Lima, MC, 2016. Available at: http://www.zonacaral.gob.pe/gestion-y-proteccion-de-sitios-arqueologicos/patrimonio-mundial/ Access: 10 July 2016.

mountains of the Andes and the Amazon rainforest, is Peru, as one of the most attractive destinations not only for its archaeological, ecological and gastronomic tourism, but also given its incentives for the reception of foreign investments, which also contributes to the development of State policies.

> Peru is the third country with the largest extension in South America, with an area of 1,285,215.6 km2, located in the eastern region and south of the Equator. It has 7,062 kilometers of land borders and limits in the north with Colombia and Ecuador (with border 1494 km and 1529 km, respectively), to the east with Brazil (2659 km) southeast with the Plurinational State of Bolivia (1212 km) and south with Chile (168 km). To the west, it is adjacent to the Pacific Ocean, with 2414 km of coast.[3]
>
> In half of the year 2015, the population reached 31 million 151 thousand 643 people, of which 15 million 605 thousand 814 are men and 15 million 545 thousand 829 are women. The five departments with greater territory, Loreto, Ucayali, Madre de Dios, Puno and Cusco, cover most of the country, 55% of the total area of the country. The three most extensive are located in the jungle, where the territory is so inhospitable that there is low population concentration.[4]

Peru is considered an emerging country, with its economic development model based on dependence on natural resources, specifically the diversification of metallic minerals and renewable energy sources. Nevertheless, the energy matrix of the State is based on the main traditional fossil fuels, such as carbon, oil and oil products, and even gas. These sources are highly damaging to the welfare and growth of environmental state institutions. Despite the fact that Peru's environmental state institutions have been strengthened in the last ten years, they have been suffering various instabilities.

Thus, when we speak of environmental institutional performance of the State, this

> should be analyzed from the point of view of a middle-income country, which has an important economic growth from the exploitation of natural renewable and nonrenewable resources, such as fishing, the polymetallic mining and hydrocarbons. Along with the great wealth in mineral resources, we highlight the abundant water

3 ECLAC. **Evaluaciones del desempeño ambiental del Perú. Aspectos destacados y recomendaciones.** Santiago of Chile, OECD/CEPAL, 2016. p. 45.

4 PERU. **Instituto Nacional de Estadística e Informática.** Available at: https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1251/Libro.pdf Access: 10 July 2016.

resources (but heterogeneous distribution) and the great biodiversity of the country, which place it among the main diverse countries of the world.[5]

However, specifically on the relationship between the potential of environmental goods and the energy matrix, we wonder: Is the magnitude of natural resources being effectively protected, controlled and suited for the generation of new renewable energy sources that seek to achieve development with sustainability in the Country?

Therefore, the purpose of this article is to analyze the energy performance of environmental institutions relating to electricity generation from renewable unconventional energy resources in rural areas of Peru. The problem goes aroundresearch on the socio-economic impacts of the relationship between climate change, energy security and promotion of public policies for the use of renewable energy to fight environmental pollution in the global, regional and local levels, focusing specifically on the dependence of fossil fuels in the country through the various national and international technical and scientific studies. In this sense, the present paper describes the data on the Peru's environmental energy potential and the efficiency of public policies in this area based on constitutional and legal provisions that support the right to access to renewable energy. Thus, the result of this study generates a proposed agenda as public policy to strengthen the transcendence of innovation and new technologies for environmental protection, and the harmonization of legal and economic strategic interests based on an incentive system between State, Market and Society, seeking to further diversify the generation, promotion and investment in non-conventional renewable energy in rural and / or isolated areas. Hence, it will contribute to the formation of an Environmental and Democratic Rule of Law in Peru.

1. Energy crisis, climate change and incentives to renewable energies

Global warming is not only a problem in developing or developed countries. It is configured as a problem common to all members of the planet.

[5] ECLAC. **Evaluaciones del desempeño ambiental del Perú. Aspectos destacados y recomendaciones.** Santiago of Chile, OECD/ECLAC, 2016.

Hence, it is a global interest to try to control, prevent and collectively remedy the negative externalities of environmental pollution generated by the society itself. "Pollution and climate change are the greatest market failure of all time"[6].

> No issue is more global than global warming: all inhabitants of the planet share the same atmosphere. There are seven indisputable rights with respect to global warming: (1) the world is heating - at about 0.6 degrees Celsius in the last century; (2) even small temperature changes can cause large effects; (3) this rate of warming is unprecedented, even in millions of years; (4) the sea level is rising - about ten to twenty centimeters in the last century; (5) even small changes in sea levels could cause major effects - for example, one-meter rise would flood low-lying areas of the world, from Florida to Bangladesh; (6) there was a huge increase in the amount of greenhouse gases in our atmosphere, at an estimated level as the highest in the last 20 million years at least, and that is growing at the fastest pace of the last 20,000 years at least; and (7) it is possible that the rate of temperature change can accelerate because small increases in the concentration of greenhouse gases can lead to even greater climate changes than those that occurred recently[7]. Practically all scientists agree that greenhouse gases contribute to global warming and rising sea levels and believe that most of it is a result of human activity (80% of fossil fuels, 20% of deforestation). Most also agree that there will be a significantly greater warming - between 1.4 and 5.8 degrees Celsius - by the end of the century, and a rise eighty centimeters to one meter above the sea level. Experts say we can expect more droughts and floods, cyclones and hurricanes.[8]
>
> Global carbon dioxide emissions from the energy sector remained at 32.1 billion tons in 2015 for the second consecutive year, suggesting that contamination by greenhouse gases reached its peak.[9]

In this context, the current situation is no different, because the environmental crisis has worsened as a result of massive global emissions of carbon dioxide by the constant commitment of the countries in the use of fossil fuels as a primary energy source to give greater dynamism to economic

6 STERN, Nicholas. **The Economics of Climate Change.** Nueva York: Cambrigde University Press, 2006. p. 25.

7 "The broader scientific research on global warming is done by the Intergovernmental Panel on Climate Change (IPCC) in its regular reports. Cf. IPCC, IPCC Third Assessment: Climate Change 2001 (Cambridge University Press, 2011). The two previous reviews:– IPCC, IPCC First Assessment Report, 1990 (Cambridge, GB: Cambrigde University Press, 1990); e IPCC, IPCC Second Assessment: Climate Change 1995 (Cambridge, GB: Cambridge University Press, 1995) – they can be found here www.ipcc.ch/pub/reports.htm".

8 STIGLITZ, Joseph E. **Globalização: como dar certo.** São Paulo: Companhia das Letras, 2007. p. 250.

9 IEA. **Energy Technology Perspectives 2016**. For, International Energy Agency. Paris. Available at: http://www.iea.org/Textbase/npsum/ETP2016SUM.pdf Access: 05 August 2016.

development and energy security. There is no doubt that the effects of climate change directly interfere in the formation of a State with sustainable development, which grants sufficient mechanisms to consolidate public policies that lead to human development with freedom.

Nonetheless,

> the effects of climate change open up new spaces for public policy. The latest crisis has generated a strong demand for expansionary tax policies to consolidate the economic recovery, as opposed to behaviors such as "beggar-thy-neighbor" in relations between the countries. The expansion of fiscal spending can support the emerging consensus around the need for major investments to change the energy matrix and the standard of production. In other words, the global Keynesianism to sustain effective demand can be based (as suggested in the literature) an environmental Keynesianism, where full employment and environmental care goals harmonize in a block of investments in track low growth carbon.[10]

Strengthening the position of the global environmental Keynesianism, its idealization of low growth in carbon will have a greater effect as a state policy to seek for equal opportunities for the development of individuals through access to sustainable energy sources, which result in the reduction of poverty, and by structuring incentive mechanisms that have focus in a dynamic socio-economic development.

Regarding the last point,

> the set of National Plans for Development and the National Strategies for Poverty Reduction and Energy National Strategies[11] found two dominant approaches in relation to poverty - energy nexus. The first stresses the key role of energy for economic development, which in turn is the basic condition to stimulate production, create jobs and thus fight poverty.[12]

10 ECLAC. **Horizontes 2030: La igualdad en el centro del desarrollo sostenible.** Santiago of Chile, 2016.p. 22.

11 UNEP. **Informe regional sobre Desarrollo Humano para América Latina y el Caribe. Progreso multidimensional: bienestar más allá del ingreso.** New York: UN, 2016.

12 ECLAC. **Contribución de los servicios energéticos a los objetivos de Desarrollo del Milenio y a la mitigación de la pobreza en América Latina y el Caribe.** Santiago of Chile: UN, 2009. p. 19.

But what is the relevance of useful energy for humanity?

> Energy is like any other economic good. You need a decent administration, functioning institutions and efficient markets, so that electrons can be taken from the producer to the consumer on a sustainable basis. Without a reliable source of energy, every aspect of life, practically, is negatively affected. After all, energy is at least the ability to work.[13]
>
> Today, more than ever, economic growth comes with the switch. Energy, nowadays, releases much more knowledge, stimulates much more potential, provides much more protection and, as a consequence, creates much more stability than before. Therefore, energy poverty not only keeps the most vulnerable people behind, but also deprives all of their potential contributions.[14]

Regarding this conglomerate, it is very clear that the transcendence of energy sources is vital to ensure the continued economic development and quality of life for society. Thus, safeguard energy security is the central objective of any State through promoting mega energy projects, whether or not sustainable, green. Currently, not all countries have large capacities in their primary matrix to efficiently generate electricity, either because of the lack of natural resources as a result of climate change, or the failure of governments in promoting incentive policies to attract the interest of private agents in betting on investments in the energy sector.

> Why is there still so much energy poverty in the world? The reasons vary from region to region. In some places, the combined economic growth and the population explosion overwhelmed the supply. In others, the high prices of oil and natural gas have forced poor countries to ration consumption. In others, still prolonged droughts impair the operation of hydroelectric plants. Nevertheless, there is a common denominator that affects the energy capabilities of all poor countries: the simple fact of not having public companies able to finance, build and properly operate power plants and power transmission networks.[15]

[13] FRIEDMAN, Thomas. **Quente, Plano e Lotado. Os desafios e oportunidades de um novo mundo.** Translation, Paulo Afonso. Rio de Janeiro: Editora Objetiva, 2010. p. 251.

[14] FRIEDMAN, Thomas. **Quente, Plano e Lotado. Os desafios e oportunidades de um novo mundo.** Translation, Paulo Afonso. Rio de Janeiro: Editora Objetiva, 2010. p. 253.

[15] FRIEDMAN, Thomas. **Quente, Plano e Lotado. Os desafios e oportunidades de um novo mundo.** Translation, Paulo Afonso. Rio de Janeiro: Editora Objetiva, 2010. p. 250.

However, to ensure energy security, States should not focus on any particular kind of energy to meet their development policies. They must act taking into account the sustainability of the appropriate use of non-conventional renewable energy, because the use of fossil fuels such as oil, coal, natural gas and liquefied petroleum gas and all their derivatives continue to contribute to greater environmental pollution, further expanding the negative externalities of global warming[16].

Today, there is an urgent need to exchange fossil fuels by unconventional, clean and / or green renewable energy sources, in order to control the energy crisis and global warming. Thus, natural resources such as sun light, wind, waves, water, and also urban solid waste, among others, are sources of opportunities that could neutralize the impacts of environmental pollution emissions through the appropriate use of renewable energy resources. In this sense and referring to the sustainable use of natural resources, as the alternatives that has the technology to generate electricity through non-conventional renewable energy, we have the wind (parks windmills), solar (solar panels), biomass, tidal and geothermal. Thus, it is considered that the promotion of clean, green and / or alternative renewable energy will safeguard the individual and collective interests of the society, despite the fact that each source of energy responds differently according to generation, the State and the production in which the energy matrix will be implemented. Hence, the use of solar energy, wind energy, hydropower, geothermal energy, biomass and biodiesel constitute the ideal model of natural renewable energy sources that will contribute to social well-being, while respecting the rights of present and future generations.

As for the environmental protection movement,

> to increase the generation of renewable energy in order to achieve the global climate goals could produce savings of up to US $ 4.2 billion per year by 2030, according to a new report published by the International Renewable Energy Agency - INRENA,

[16] "Sustainability is, at same time, both simple and complex. Like the idea of justice. Most of us know intuitively when something is not "fair." Likewise, most of us are fully aware of unsustainable things: trash, fossil fuels, polluting automobiles, unhealthy foods and so on. We can also assume that many people have a clear sense of justice and sustainability. For example, they feel that a just and sustainable world is very necessary, no matter how far from the ideal it may be." Cf.: BOSSELMANN. Klaus. **O princípio da sustentabilidade. Transformando direito y governança.** Translation, Phillip Gil França. São Paulo: Revista dos Editores, 2015. p. 25.

> which calls on legislators from several countries to strengthen clean energy policies. Doubling the percentage of renewable energy in the energy matrix worldwide to 36% by 2030 would cost $ 290 billion a year and limit global warming to less than two degrees Celsius. Much of the savings would be achieved by mitigating the harmful effects of global warming.[17]

Facing the relationship between energy security, poverty and the use of renewable energy,

> the need to protect the environment, another key aspect of the 2030 Agenda for Sustainable Development, transforms the perspective with which one looks the economic dynamics, whose negative effects can no longer be ignored. Every effort to restore global growth and to reduce income differences between developed and developing countries should be mediated and accompanied by an even greater effort to decouple growth from environmental impact.[18]

In the specific case of Peru, we ask: What is the current state of the energy institutions of the country? What are the impacts and negative externalities for the environment, arising from the emission of greenhouse gases as a result of Peru's economic development? How are the public policies on generation of non-conventional renewable energy being implemented throughout the national territory?

Over its economic history, especially since the early twentieth century, Peruvian energy matrix has been dependent on massive importation of petroleum and its derivatives, such as fossils and / or traditional fuels. Today, Peru is a surplus hydrothermal country, i.e., with a high potential for hydro and thermal sources, maintaining an energy dependence on water and diesel and disregarding the use of other not-conventional renewable energy sources throughout its history.

Currently, the most important means of electricity generation in the Andean country is the hydroelectric and thermoelectric power plants. While hydroelectric plants are considered a conventional renewable source, the thermoelectric plants are considered non-renewable sources. Thus, Peru's

[17] BLOOMBERG. **Una razón de US$4,2 billones para duplicar la energía renovable.** Available at: http://www.bloomberg.com/latam/2016/03/18/una-razon-de-us42-billones-para-duplicar-la-energia-renovable/ Access: 06 August 2016.

[18] ECLAC. **Horizontes 2030: La igualdad en el centro del desarrollo sostenible.** Santiago of Chile, 2016. p. 21.

energy matrix relies on natural resources (water) and fossil fuels (oil and oil products), the latter contributing to the increase in emissions of greenhouse gases.

> According to data from the World Resources Institute (WRI), total emissions of greenhouse gases in Peru (including the change in land use) represented 0.34% of global emissions and 3.5% of America's emissions in Latin America and the Caribbean. By excluding the change in land use and deforestation, such emissions would correspond to 0.2% of the global emissions and 2.5% of the emissions in the region. During 2012, emissions by changing land use and deforestation accounted for 46% of the total emissions of greenhouse gases in the country, and in the period of 2003-2012, they increased by 60%. The International Energy Agency (IEA) reported that in 2012, Peruvian CO2 emissions associated with fossil fuel combustion (not including changes in land use) accounted for 0.14% of global emissions, and since 2003, they increased by 82%. To disaggregate emissions from burning fossil fuels in terms of sectors, it appears that 39% of these emissions come from transportation and 25% from power generation and heat. This ratio is different from the OECD average, under which 28% of emissions are associated with the transportation and 40% with the generation of power and heat (IEA / OECD, 2014). The smallest proportion of emissions by generating power and heat is due to the fact that the energy matrix is composed of a high percentage of natural gas and hydropower. IEA also reported that, between 2003 and 2012, Peru has increased CO2 emissions per capita by 65% and its emissions per unit of GDP remained stable. The intensity of emissions in 2012 is 1.53 tons of CO2 per capita, equivalent to 16% of the OECD average. Currently, Peru emits 0.15 tons of CO2 per $ 1,000 of GDP (in terms of purchasing power parity in 2005), which places this country below the OECD average (0.31 tons) and Latin America and Caribbean's average (0.23 tons). The relationship between CO2 emissions and primary energy supply has been decreasing over time. In the period of 2003-2013, this indicator experienced a reduction of 1.6%, according to the OECD trend to reduce this indicator by 3.5%. However, the relationship between CO2 emissions and the final energy consumption increased by 14%, instead of the reduction in OECD countries, 3.6%.[19]

In light of the data of CO2 emissions and the energy matrix of Peru, it is important to note that the largest enterprise in the field of gas in the country is called "Camisea gas,"[20] administered by the Camisea Consortium and led by

[19] ECLAC. **Evaluaciones del desempeño ambiental del Perú. Aspectos destacados y recomendaciones.** Santiago of Chile, OECD/ECLAC., 2016. p. 50.

[20] "The reserve is in the Amazon jungle, in Southern Peru, Echarate district, La Convención province, Cuzco region, more than 400 km southeast of the city of Lima." Cf. ZAVALA, Abel. GUADALUPE, Enrique.

Argentine company Pluspetrol and the Peruvian Perupetro. In aggregate terms, it is estimated that the mitigation of CO2 emissions in the three sectors linked to the Camisea gas (power generation, industry and vehicular transportation) reached a volume close to 54 million tons of CO2. Thus, it generated a financial value equivalent to US $ 1.306 billion in the between 2004 and 2013.[21] However, according to some technical studies, environmental negative externalities of the "Camisea gas" are only less harmful than the use of other fossil fuels such as diesel, gas or coal, since for each kilogram of burned methane that is produced, a significant proportion of greenhouse gases is generated, thereby contributing to the maximization of CO2 emissions at the expense of the right to the human development of the society.

Accordingly, as for the current evaluation of the institutional framework of the energy matrix and energy use in the Andean country, the Environmental Performance Assessment, carried out by the United Nations Economic Commission for Latin America and the Caribbean - ECLAC and the OECD, in 2013, notes that:

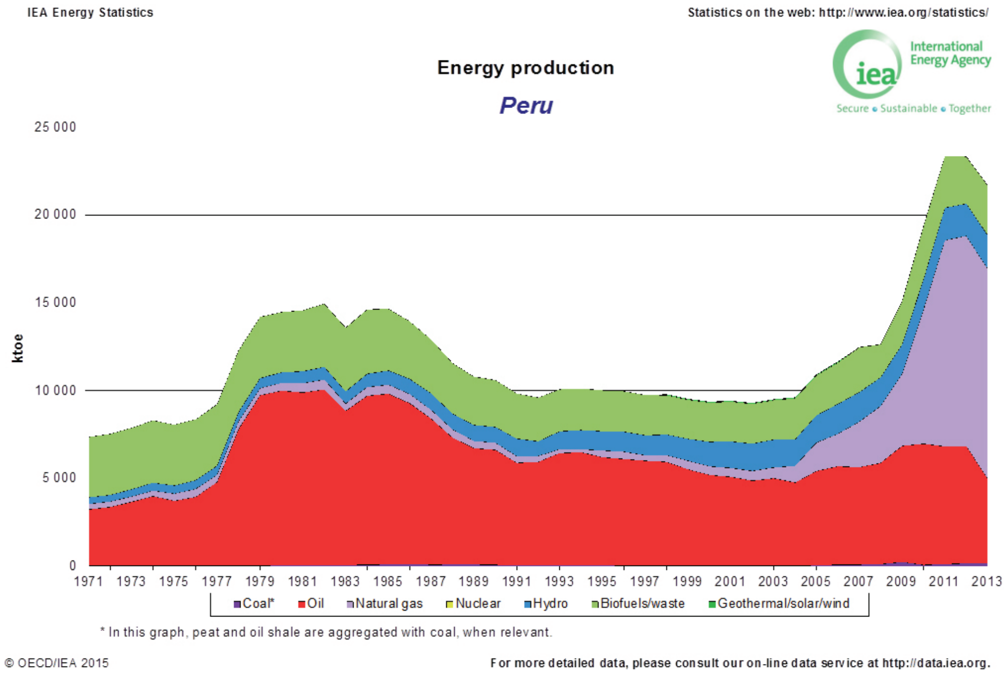
> The National Energy Balance of the Ministry of Energy and Mines of Peru shows that the domestic supply of primary energy doubled in the period 2003-2013. In addition, the energy matrix has changed substantially with an increasing share of natural gas, which enlarged from 10% of the national supply in 2004 to 57% in 2013. In the period 2003-2013, the domestic supply of natural gas had a growth of 98%. This contrasts with the decline in oil supply by 9% during the same period, whose participation in domestic supply of primary energy reached 13% in 2013. While the supply of hydropower and coal has increased, its share in the domestic supply of primary energy decreased, respectively, 8% and 3% in 2013. The biofuels and sun energy decreased their share in the domestic supply, and, combined, they accounted for 9%. Note that in 2013 the supply of natural gas, liquefied natural gas and hydroelectricity came from domestic sources. In contrast, 52% of crude oil and 84% of coal came from abroad. In comparison, the IEA shows that the proportion of renewable energy that makes up the total supply of primary energy in Peru is higher than 2.6 times that of the OECD, mainly due to the use of hydroelectricity and biofuels. At the same time, Peru has a lower relative consumption of coal, but a greater proportion of oil and natural gas (including LNG). The sector with the largest final energy consumption

CARRILLO, Norma. **El gas de Camisea: geología, economía y usos.** Vol. 10, Nº 19, 113-119. UNMSM. Lima: Revista del Instituto de Investigaciones FIGMMG, 2007.

[21] OSINERGMIN. **Gas natural en el Perú. A diez años del proyecto Camisea.** Lima: November, 2014.

in 2013 was shipping, with 41%, followed by residential, commercial and public sectors, and industry and mining, both with 27%. The growth of the transportation sector followed the fluctuations in GDP and, since 2008, it has been continuous.[22]

In the following table, drawn up by the IEA, we can see the evolution of the energy matrix process of the country from 1971 to 2013, with emphasis on production and mass consumption of non-renewable energy, but also the use of hydroelectricity and gas:



Source: Agencia Internacional de Energía (IEA), 2013.

In light of the data above, it can be confirmed that one of the reasons for the weakness of environmental energy institutionality of the country is closely connected to the continuous investment in the use of fossil fuels - consumption of coal, oil and all its derivatives, and even gas -, and subsidies

22 ECLAC. **Evaluaciones del desempeño ambiental del Perú. Aspectos destacados y recomendaciones.** Santiago of Chile, OECD/ECLAC, 2016. p. 16.

for hydroelectric power. All these elements are harmful for the quality of life and access to renewable and / or clean energy by the society.

Moreover, in addition to the problem of generation and use of non-renewable energy, another problem to consider when analyzing the environmental energy institutions in the country is: the failure of the State in promoting access to energy and the eradication of poverty, especially in remote areas and rural populations or located at border points - which are threatened once again by the inefficiency of public policies to consolidate the right to human development with freedom.

Regarding access to electricity in poor populations, such as those living in rural areas, "the percentage of the population below the national poverty line decreased significantly, from 52.5% in 2003 to 23.9% in 2013. Currently, poverty rises to rural and urban areas do 48% to 16%, respectively"[23].

According to the data on the role of electricity coverage in the relationship between rural housing, common welfare and economic growth, ECLAC indicates that:

> According to the National Census of 2007, the coverage of electricity service reaches about 74.1% of households. In 2009, coverage increased to 81.6% and reached 97.2% of urban households, while only 51.2% of rural households. Since the early 1990s, when the reform of the electricity sector began and the service coverage was slightly higher than 50%, the progress has been significant, even though a very large deficit remains, especially in rural areas, which hinders economic development and the quality of life of their populations.[24]

From this perspective, unfortunately, today there are people who are not served by the National Interconnected Electric System (SEIN), and find themselves excluded by the urban radius, specifically with rural areas most affected by the lack of energy, renewable or not. Thus, according to the INEI Summary Statistics 2015, "6% of households in Peru still do not have access to electric power"[25], which creates greater difficulties to achieve the human development of the inhabitants of these homes.

[23] ECLAC. **Evaluaciones del desempeño ambiental del Perú. Aspectos destacados y recomendaciones.** Santiago of Chile, OECD/ECLAC, 2016. p. 20.

[24] PERU. **Plan Bicentenario. El Perú hacia el 2021.** Approved by National Accord. Lima: CEPLAN, 2011. p. 19.

[25] PERU. **Síntesis Estadística 2015.** National Institute of Statistics and Informatics - INEI/Peru. Lima.

In addition, regarding the lack of access and inadequate provision of public energy services in excluded areas, it is considered that the social costs of externalities will increase by the inefficiency of the consolidation of fundamental human rights, such as the right to health, education, work, housing, food, social security, and even the economic freedoms, among others, at the expense of the general welfare[26]. Faced with such impacts to the human development, schools, hospitals (and health posts), leisure centers and rural community centers will be negatively affected by the State failure in the provision of public services. Thus, in light of such problems, to ensure access to sustainable renewable energy to the society will be one of the main tasks to be performed by the State, based on a long-term public agenda to safeguard the fundamental rights of the person, as the Sustainable Development Goal 7 (SDG 7) of the United Nations Agenda 2030 commands.[27]

Of course, the asymmetry of conflicts of interest in the generation and supply of electricity derives from the relationship between State, Market and isolated and / or vulnerable populations: the first, by the failure in the development policy and even social; the second, the lack of incentives for economic agents to invest in new sustainable markets; and third, the lower purchasing power of individuals to pay for the continued provision of such public service.

Therefore, after preliminarily analyzing the problem of the environmental energy institutional framework in Peru, there are three key questions to define the present article: How is the Peruvian government controlling, through the Energy Policy, CO2 emissions from the use of fossil fuels? How is the State expanding its sectoral policies in order to promote the use of green renewable energy sources in the country? And what is the current state of the right to access to non-conventional renewable energy in Peru? Let’s see.

[26] See articles 4 to 29 of the regime of the Social and Economic Rights of the Political Constitution of Peru.

[27] SDG no. 7 states the following: “By 2030, ensure universal access to affordable, reliable and modern energy services; By 2030, increase substantially the share of renewable energy in the global energy mix; By 2030, double the global rate of improvement in energy efficiency; By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology; By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support”.

2. Environmental and energy legal institutions of Peru

The current financial crisis joins with the various global crises[28]. All the factors that led to the crisis in question have a close relationship with the impacts of the energy crisis on the global economy and the difficulty of States to invest more in renewable energy generation.

The energy consumption for the production processes and the Gross Domestic Product (GDP), reflected in economic development policies, maintain a close relationship. In the case of the Peruvian economic development, the need for energy demanded greater intensity of their production cycles in recent decades.

On the prospects of the Peruvian economic development in recent years, ECLAC noted that:

> The Peruvian economy is the seventh in size in Latin America and the Caribbean and its high dynamism ranks Peru as the second largest growth in the region. GDP grew at a rate of 6.4% per year between 2003 and 2013, more than the OECD average and Latin America and the Caribbean. The GDP per capita grew had an average of 5% per year over the same period. The per capita income was equivalent to a quarter of the OECD's income during the period 2003-2013. The income gap has decreased due to higher labor productivity and higher employment rates of a growing labor force (World Bank, 2011). Peru has a permanent growth, with a slight slowdown in 2009 due to the global economic crisis. During the period analyzed, GDP has almost doubled.[29]

Accordingly, "in 2015, the Peruvian economy had a growth of 3.3%. Currently, according to the ECLAC's 2016 Economic Report of the Second Annual, the growth of the Peruvian GDP is projected at 3.9%, with a better result of the economic balance, unlike their Latin American peers."[30]

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[28] "Seven years after the begging of the economic and financial crisis of 2008 and 2009, world trade has not yet recovered the dynamism it exhibited during most of the post-war period. This chapter analyzes the factors that determine this phenomenon and its effects on Latin American and Caribbean foreign trade. " ECLAC. **Panorama de la Inserción Internacional de América Latina y el Caribe. La crisis del comercio regional: diagnóstico y perspectivas.** Santiago: UN, 2015.

[29] ECLAC. **Evaluaciones del desempeño ambiental del Perú. Aspectos destacados y recomendaciones.** Santiago of Chile, OECD/ECLAC, 2016. p. 60.

[30] ECLAC**. Estudio Económico de América Latina y el Caribe. La Agenda 2030 para el Desarrollo Sostenible y los desafíos del financiamiento para el desarrollo.** Santiago of Chile: UN, 2016. p. 51.

Concerning the link between economic development, energy and environmental protection, we ask: How does the Peruvian legal system regulate the right to a balanced environment and the use of renewable energy resources in their constitutional, legal and administrative sectors? What is the legal framework and / or provisions that promote the generation of these renewable energy in the country?

> The process of incorporating, in the Latin American countries, the environmental dimension of the structures began in the mid-1970s, with the incorporation of certain environmental functions in sectors related to management of natural resources, such as agriculture, fishing, mining, and, in some cases, social sectors, such as health or infrastructure, housing and sanitation. That is, the environmental dimension was incorporated into the State in a divided approach.[31]

However, the promulgation of the Constitution of 1979 marks the partial beginning of the implementation of a public agenda for greater and legal protection of environmental goods, as well as the institutional framework, management and administration of environmental goods. After this, Peru adopted a major environmental concern as a state policy in the 1990s. However, the system had a number of legal gaps in its civil, criminal and administrative branches.

About this timeline of environmental institutions in the country, "as a result of the effects of the UNCED (United Nations Conference on Environment and Development) in Rio in 1992, Peru had to incorporate a set of international environmental standards, which it began to do from 1993, when the constitutional reforms resulted in the formation of a new Constituent Assembly, which gave rise to the Constitution of Peru of 1993.

The value-principle of human dignity, which governs the 1993 Constitution and all public policies aimed at strengthening environmental institutions in Peru, is the foundation and the supreme goal of the society and of the state to its structure, formation and execution.

However, how is the right to access to energy constitutionally regulated in Peru? Article 2, paragraph 1, of the 1993 Constitution provides that everyone has the right to life and to his or her free development and well-being, i.e, the

[31] VALDEZ, Walter Muñoz. **Marco institucional para la gestión ambiental en el Perú.** Revista de la Facultad de Derecho de la PUCP. Nro. 70. p. 45-62. Lima: PUCP, 2013.

goal of the State is to support, promote and ensure the human development of individuals who are part of the nation guided by the free exercise of his or her will and the common welfare. In light of the guarantee of respect for fundamental human rights, in addition to recognizing the right to life, the Constitution gives priority to the development with freedom.

Regarding fundamental rights, the Constitution of 1993, in its paragraph 22, states that everyone has the right to a balanced and appropriate environment for the development of life. Thus, the relationship between the right to environment and the right to development, the first has to be exercised by the people in a balanced and appropriate way, to strengthen once again the full exercise of their human development. Thus, the fundamental right to an ecologically balanced environment transcends all laws and the implementation of the agendas of the State Development Policies.

However, it is considered that the constitutional provision in question must emphasize that the right to environment entitle the people to an environment which is "ecologically" balanced and appropriate, better delimiting the full development of people in a healthy environment and according to ecological parameters of well-being and quality of life and the rights of both present and future generations[32]. Thus, the right to access to renewable energy is guaranteed by the Peruvian Political Constitution, as well as the right of access to renewable energy in rural populations.

On the other hand, a legal and constitutional analysis of the environmental institutions in Peru reveals that Article 67 indicates that the State must determine the National Environmental Policy, not only in its administrative structure or its structure for the protection of the environment, but State policies should also promote the sustainable use of natural resources. This last

[32] The Political Constitution does not explicitly refer to mechanisms for environmental protection, unlike other countries. However, since Article 2, paragraph 22, regulates the right of every citizen to enjoy a balanced and adequate environment for the development of life, the constitutional guarantee of such right is pertinent (Support Procedding). The environmental relationship with the other actions - Habeas Data, Compliance, Unconstitutionality and Popular Action - becomes applicable, but not due to the right to the environment, but due to the legal nature of the values that protect such actions. In a discursive or qualifying sense, non-technical, it is alluded to Habeas Environmental Data or to Environmental Compliance Procedure. The very mention of "environmental protection", although it is the closest to the theme, is not procedurally correct either. The Constitutional Procedural Code (Law No. 28237) restructures this whole legal theme and explicitly states that the support proceedings are the means to protect the right to the environment, not excluding - we add - the possibility of using other constitutional procedures, according to their nature from an environmental perspective" Cf. MINAM. **Compendio de la legislación ambiental peruana.** Volumen I. Dirección General de Políticas, Normas e Instrumentos de Gestión Ambiental del Ministerio del Ambiente. Lima: MINAM, 2011.

constitutional provision deals with the performance of efficient public policies on the environment in the country, ensuring the exercise of the protection of environment promoted by the State in order to strengthen the right to an ecologically balanced environment and a better sustainable use of natural resources located in the national territory.

However, even with the constitutional support to social and environmental rights, it is considered that there is no direct connection of such rights with the sustainable right, seen as a principle-value that enhance the full exercise and enjoyment of the various environmental regulatory provisions. Article 69 stresses the obligation of the State to promote the sustainable development of the Amazon, and, following a hermeneutic interpretation of this provision, it does not have a connection with all the axiological values of the constitutional text. Hence, one cannot say that environmental sustainability should cover only the Amazon, but that sustainable development must be immersed as value-principle throughout the national territory, as a guideline to the full exercise of environmental rights, such as the right to an ecologically balanced environment, access to information, participation and environmental justice.

> The weight that the 1993 Constitution gives the environment is qualitatively superior to that given in 1979, not just because the 1993 Constitution includes the right to a balanced and appropriate environment for the development of human life, listed as a fundamental human right and as a means to promoting sustainable development in the Amazon; but also due to the constitutional requirement of sustainable use of natural resources.[33]
>
> Over the past decade, the environmental institutionality of the country was strengthened by the approval of the 2005 General Law of the Environment and the subsequent creation of the Ministry of the Environment (MINAM), the National Service of Protected Natural Areas by the State (SERNANP) and the Environmental Control and Assessment Agency (OEFA), in 2008. It also worth mentioning, the creation of the National Environmental Certification Service for Sustainable Investments (SENACE), in 2012.[34]

Law no. 28611/2005 - General Environment Law (LGA) - aims to order the legal framework for environmental management in Peru. However, in 2008,

[33] LAMADRID, Alejandro Ubillús. **Derecho Ambiental contemporáneo. Crisis y desafíos.** 1 ed. Lima: Ediciones Legales, 2011. p. 186.

[34] ECLAC. **Evaluaciones del desempeño ambiental del Perú. Aspectos destacados y recomendaciones.** Santiago of Chile, OEDC/ECLAC, 2016. p. 50.

the Law of creation, organization and functions of the Ministry of Environment was approved, and the Law no. 28611 was modified by the Legislative Decree No. 1055. These legislative changes have, as a common feature, the role of establishing, defining and overseeing the National Environmental Policy. Thus, the LGA is the main environmental management tool that, among the various existing guidelines, principles and provisions that it governs, closely relates to its application in the field of protection of natural resources throughout the national territory and seeks, at the same time, to strengthen the institutionality of the National Environmental Policy.

Given the progress of the environmental institutions in Peru, in 2008, the Legislative Decree No. 1013 was promulgated, which establishes the *Law of Creation, Organization and Functions of the Ministry of the Environment*[35], whose overall function is to design, establish, implement and monitor the National Policy of the environmental sector. Its activity comprises the technical regulatory actions nationwide on environmental regulation, defined as the establishment of the policy, the specific regulations, the supervision and the control. After these developments, the Peruvian government institutionalized the "*National System of Environmental Impact Assessment - SEIA*", a single and coordinated system for identifying, preventing, monitoring and early correction of significant negative environmental impacts[36]. Moreover, also by Law No. 29325, it was created the *Office of Evaluation and Environmental Inspection (OEFA)*[37], which aims to contribute, support and strengthen, among other administrative functions, environmental management in Peru[38].

35 "The Ministry of the Environment (MINAM) is the competent authority to formulate the National Environmental Policy, which applicable to all levels of the government, in accordance with the provisions of its creation norm, the Legislative Decree No. 1013, article 6. However, this policy is mandatory to the public authorities in light of Articles 4 and 5 of the Framework Law of the National Environmental Management System - Law No. 28245 and Article 4 of the Organic Law of the Public Sector No. 29158 (LOPE)." Cf. LAMADRID, Alejandro Ubillús. **Derecho Ambiental contemporáneo. Crisis y desafíos.** 1 ed. Lima: Ediciones Legales, 2011. p. 72.

36 Through the Ministerial Resolution No. 052.2012, the directive for the agreement between SEIA and the National Public Investment System (SNIP) was approved.

37 "The Environmental Assessment and Inspection Body - OEFA is a public and technical institution under the Ministry of the Environment. OEFA is the lead entity of the National Environmental Assessment and Inspection System (SINEFA). It has the responsibility to verify compliance with environmental legislation by all natural and legal persons. In addition, it ensures that the functions of evaluation, supervision, control, sanctioning power and application of environmental incentives, carried out by the various State entities, occur in an independent, impartial, agile and efficient manner, in accordance with the legal provisions in National Policy of the Environment". Available at: http://www.minam.gob.pe/el-ministerio/organismos-adscritos/oefa/ Access: 15/07/2016.

38 VALDEZ, Walter Muñoz. **Marco institucional para la gestión ambiental en el Perú.** Revista de la Facultad de Derecho de la PUCP. Nro. 70. p. 45-62. Lima: PUCP, 2013. p. 45-62.

The National Environmental Policy, approved in 2009, expressed, in its structure and material, the enormous complexity of the environmental challenges. To provide resources in a rational and comprehensive manner, preserving or restoring environmental quality, promote the potential offered by the environment in order to improve the competitiveness of our economy are goals whose achievement requires a multi-sectoral, systemic and complex approach; essential and characteristic elements for environmental management. However, for a given sector, "unfortunately, it is considered that this National Policy is not extremely right, which makes it difficult to determine the extent of its protection, but is focused on defining, minimally, what are the bases and the institution or authority they have on their own definition and implementation." Within the complexity that exists in the organization, promotion and implementation of the National Environmental Policy, the set of provisions aims to know the instruments, mechanisms and / or programs that can respect, fulfill and carry out the scope and objectives outlined in the government agenda.

Therefore, it is through the Law 2681- *Organic Law for the Sustainable Use of Natural Resources* - that the State seeks to promote and to regulate the sustainable use of natural, renewable and non-renewable resources by establishing an appropriate framework for the promotion of investments, seeking to establish a dynamic balance between economic growth, conservation of natural resources and the environment and the integral development of the human person[39].

Concerning the link between environmental protection, sustainable use of natural resources and generation of electricity in the country, it was through the Power Concessions Law No. 25844 and its Regulations DS. (1993/1994), that the institutional framework of the electricity market was created, by setting up everything that is related to the generation, transmission, distribution and sale of electricity in the country[40]. As stated in the first provision of the Electrical Concessions Law, activities of generation, transmission and distribution can be

[39] ALVARADO, Omar Escobar; VENTURA, Alberto Rivas Plata. **A tajo abierto: explorando la intervención estatal en la actividad minera.** Trabajo de investigación del grupo Ius Et veritas. Nro 35. Lima: IUS, La revista, p. 486-521, 2009.

[40] "The Ministry of Energy and Mines, through the SINERGMIN (Supervisory Body for Energy and Mining Investments), representing the State, is in charge of ensuring compliance with the Law." "The concessions and authorizations will be granted by the Ministry of Energy and Mines, which will establish for this purpose a Register of Electric Concessions (Article 4)."

developed by individuals or corporations, national or foreign. Thus, this law defines points on energy tariffs, concessions and permits, and the electricity pricing system, which is about the maximum transmission and distribution tariffs, as well as its audit, assurance and measures to promote investment in this sector.

In line of the strengthening of the Peruvian energy market, the Law No. 26848, Organic Law on Geothermal Resources (1997), was promulgated for the use of the mineral resources and the subsoil of the national territory. Geothermal resources were promoted in order to ensure the energy supply necessary for economic growth, people's well-being and efficient diversification of the country's energy sources. Similarly, the Law No. 28832 was passed, which ensures the Efficient Development of Electric Generation, promoting procurement and long-term contracts as mechanisms to stimulate and support investments on power generation in large-scale, specifically the development of large hydropower dams and other major projects.

In light of this conglomeration of rights, policies and the legal framework of the electricity market in the country, the Legislative Decree No. 1002 promotes investment for the generation of electricity from renewable energy in Peru[41]; the Supreme Decree No. 012-2011-EM regulates the production of electricity from renewable energy[42]; and the Supreme Decree No. 020-2013-EM (2013) adopted a regulation to promote investments on electricity in areas not connected to the network (autonomous facilities using renewable resources).

The Legislative Decree No. 1002 underscores the Declaration of national interest and participation of Renewable Energy Resources - RER in the matrix of electricity generation, the competent authorities, the marketing power and power generated with RER, the determination of regulated rates applicable to generation with RER[43], the access to electrical transmission and distribution networks as well as the drafting of the National Plan for Renewable Energy in Peru[44].

41 PERU. Legislative Decree no. 1002. **Sobre la promoción de la inversión para la generación de electricidad con el uso de energías renovables.** Lima, El Peruano, 2008.

42 The Supreme Decree no. 012-2011-EM was modified by the D.S. No. 24-2013-EM.

43 "In order to fix the tariffs and premiums, the OSINERGMIN will make the corresponding calculations considering the classification of the installations by categories and groups according to the characteristics of the different RERs".

44 According to the general guidelines of the Legislative Decree No. 1002, "this normative initiative will bring additional benefits such as the implementation of a framework for promoting private investment,

Keeping the connection between the National Environmental Policy, the sustainable use of natural resources and the promotion of investment in electricity generation using renewable energy in Peru, the Peru's Bicentenary Plan 2021, prepared in 2011, stands out among its main guidelines policy public environmental objectives:

> 1. To promote the analysis and evaluation of natural heritage and integrate them into development planning. 2. To promote the integrated management of natural resources, the integrated management of water resources and land use planning. 3. Promote the conservation and sustainable use of the natural heritage of the country with efficiency, equity and social welfare, taking action to protect biodiversity, control the loss of forests and ecosystems, ensuring sustainable fisheries, conserving the native genetic heritage and valuing traditional knowledge (...).[45]

Moreover, the Bicentenary Plan highlights the guidelines for air quality in Peru by 2021, seeking to promote the use of renewable energy as a new source of green energy, with the aim of:

> 1. Protecting the environment and its components, following a preventive approach and restore environmental quality, ensuring the conservation and sustainable use of natural resources and biodiversity in a responsible manner, consistent with respect for fundamental rights of individuals; 7. Promote and encourage clean production, bio-trade, the use of renewable energy and new energy sources and the use of economic and environmental opportunities for national and international markets for competitive development and eco-efficient of the country's potential (...)[46].

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eliminating barriers to this energy activity, preserving the environment through the production of clean energy, contributing to positive effects at the global level and, at the same time, achieving a minimum development condition of the Peruvian economy, which requires greater security in the availability of energy". In addition, the mentioned norm emphasizes that, "it is necessary to grant incentives to promote the investment in the generation of electricity with the use of renewable energy sources, to encourage scientific research and technological innovation, besides the realization of projects that qualify as Development Mechanisms Clean and obtain their registration, the respective Emission Reduction Certificates (CERs), which can be negotiated with companies from industrialized countries that will account for these GHG reductions as part of the quantitative targets they have committed to under the Kyoto Protocol." PERU. Legislative Decree no. 1002. **Sobre la promoción de la inversión para la generación de electricidad con el uso de energías renovables.** Lima, El Peruano, 2010.

[45] PERU. **Plan Bicentenario. El Perú hacia el 2021.** Approved by the National Agreement. Lima: CEPLAN, 2011. p. 245.

[46] PERU. **Plan Bicentenario. El Perú hacia el 2021.** Approved by the National Agreement. Lima: CEPLAN, 2011. p. 249.

Taking into account the Peru's Bicentenary Plan and the Legislative Decree No. 1002, the latter's Article 1 indicates that the Decree aims to promote the use of Renewable Energy Resources (RER) to improve the population's quality of life and to protect the environment through the promotion of investment in electricity production. For purposes of this Decree, it is understood as RER energy resources such as biomass, wind, sun light, geothermal and tides. The hydropower is considered RER when the installed capacity of the plant does not exceed 20 MW (Art. 3). As regards the administrative capacity to generate electricity through the RER, the Ministry of Mines and Energy is the competent national authority responsible for promoting projects using RER. Regional governments can promote the use of RER within their territorial areas under the National Renewable Energy Plan (Art. 4).

With regard to the accreditation of a company as generator of RER, the Decree indicates that "it will benefit from the provisions of this Legislative Decree the new operations of companies using RER as primary energy, as long as they have an accreditation before the Ministry of Mines and Energy." Furthermore, Article 2, paragraph 2.1, states that "the Ministry of Mines and Energy will establish every five (5) years, a target percentage of electricity generated from RER that should participate in national electricity consumption, not considering in this percentage target the hydroelectric plants."

Regarding the legal framework for renewable energy generation in the countryside, it is through the Supreme Decree No. 020-2013-EM[47] that the Regulation for Investment Promotion in Electricity in Areas not-Connected to the Network was approved, which regulates the supply, installation, operation, maintenance and transfer of photovoltaic systems in rural, isolated or border areas.

However, the Peruvian State, in 2010, approved the National Policy for the Energy of Peru from 2010 to 2040[48], and, in 2013, through the MEM issued the Universal Access Plan for Energy from 2013 to 2022[49]. Both documents have as one of its main objectives to improve energy efficiency and dynamism of

47 PERU. **Reglamento para la Promoción de la Inversión Eléctrica en Áreas No Conectadas a la Red.** Supreme Decree no. 020-2013-EM. Lima: El Peruano, 2013.

48 This Energy Policy was approved through the Supreme Decree no. 064-2010-EM.

49 This Energy Plan was approved through the Ministerial Resolution no. 203-2013-MEM-DM.

universal access to energy supply for all populations located mainly in rural, isolated and border areas. Referring to the measures under the auspicious of the Universal Access Plan for Energy,

> it is expected to expand the universal access to energy and the electrification of the rural zones through four general mechanisms: a) Massification Promotion Programs of the Use of Natural Gas; b) Promotion and / or compensation for access to LPG; c) development programs of new energy supplies in border areas; and d.) programs and improvement of rural energy use (...).
>
> Within the resources for the implementation of this Plan are the Social Energy Inclusion Fund (FISE), created by the Law No. 29,852, as well as the resources allocated to the National Plan for Rural Electrification 2013-2022.[50]

Therefore, the Legislative Decree No. 1002, the Supreme Decree No. 012-2011-EM 1002 and Supreme Decree No. 020-2013-EM[51] make up the legal framework for the generation of electricity via RER in rural, isolated and border areas, and in conjunction with the Public Policy embraced by the Universal Access Plan for Energy 2013-2022.[52]

3. The potential of renewable energy and its relationship with access to sustainable sources in rural areas

Peru is one of the countries in the region that are strongly promoting the integration of renewable energy in their energy matrix. In fact, the government announced in December 2014 that the objectives of the National Energy Plan 2014-2025 were "double production of hydroelectric power plants by 2022, to reach a participation of 5% of renewable energy by 2018 and reach 100% renewable electricity in national coverage by 2025"[53].

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50 Cf. http://www.minem.gob.pe/descripcion.php?idSector=6&idTitular=5474 Access: 08 August 2016.

51 PERU. **Reglamento para la Promoción de la Inversión Eléctrica en Áreas No Conectadas a la Red.** Supreme Decree no. 020-2013-EM. Lima: El Peruano, 2013.

52 PERU. **Reglamento para la Promoción de la Inversión Eléctrica en Áreas No Conectadas a la Red.** Supreme Decree no. 020-2013-EM. Lima: El Peruano, 2013.

53 PERU. **Plan Energético Nacional 2014-2025**. Working Document. Executive Summary. Lima: Ministry of Energy and Mines, November 2014.

This Andean country has very attractive scenarios to invest in renewable energy, because "it has important sources of renewable energy and very few of them have been used. There are abundant solar resources in the Southern part of its territory, there is the sea and the plateau and wind resources in the central, northern and southern coastlines. Areas with geothermal potential were identified in the highlands and in the volcanic area of the South. Likewise, Peru has large quantities of water that could be used in the future to generate electricity"[54].

The energy potential of natural resources available for electricity generation along the Peruvian national territory is highlighted by the international community and private actors awaiting new economic measures to encourage their incursion in this market. Among Peru's natural resources useful for the production of renewable energy, its water potential from the basins of Atlantic, the Pacific, Lake Titicaca, among others is remarkable. These resources are exploited by hydroelectric plants, such as the Gallito Ciego and Mantaro, both located in the Departments of Lambayeque and Junin, with a capacity of over 1 GW, which provides about 20% of the National Interconnected System (SEIN) 55. However, the potential for solar energy is also partially relevant, given the high radiation records in certain areas and in certain months. As for the wind power, in its entire coastline, coupled with the dynamism of the anticyclones in the Pacific Ocean and the Andes, there are strong winds from the southeast, in the regions of Arequipa and Ica. Another natural energy potential that stands out is the geothermal source, due to the volcanic activities in its southern regions, especially in Cusco, Puno and Arequipa, and in the northeast from Cajamarca. Moreover, despite the fact that the potential of biomass do not have practical results for renewable power generation at present, it could be an interesting option given the waste of agroindustrial plans processing sugarcane, cotton, asparagus, rice husk, forestry waste, among others.

According to several studies on renewable energy production, one can say that Peru is a hydrothermal country, i.e., its main source of electricity comes

[54] IRENA. **Evaluación del Estado de preparación de las energías renovables 2014. Perú.** Internacional Renewable Energy Agency. Abu Dhabi, 2014.

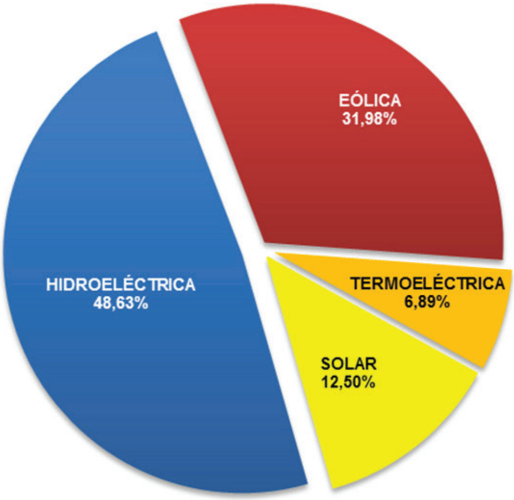
[55] COES. **Producción hidroeléctrica y recursos hídricos.** Prepared by the Operations Committee of the National Interconnected System. Lima: MEM, 2015. Available at: http://www.coes.org.pe/Portal/Publicaciones/Estadisticas/. Access: 6 August 2016.

from its hydraulic system[56]. Nevertheless, in recent years, Peru has giving attention to other energy sources.

In 2015, electricity production capacity with RER in the country generated a total COES of 1,847.2 GW.h, giving an overall margin by COES of 44,540.0 GW.h on the RER-COES figure of 4.15%, adding up 100% of the companies operating these energy sources. The most important of them are: Wind Power (24.15%), EGEJUNÍN (11.83%), Santa Cruz (9.61%), PE Marcona (7.60%), etc. Referring to the type of power generation by RER, 48.63% originated from hydroelectric (898.2 GW.h), 31.98% from wind power (590.7 GW.h), 12.50% from solar panels (231.0 GW.h) and 6.89% from thermal plants (127.3 GW.h).[57]

The following table discloses the statistics presented by OSINERGMIN on the electrical production capacity with RER in the 2015, as indicated in the previous paragraph:

Chart nº 1: Energy production with RER, 2015.



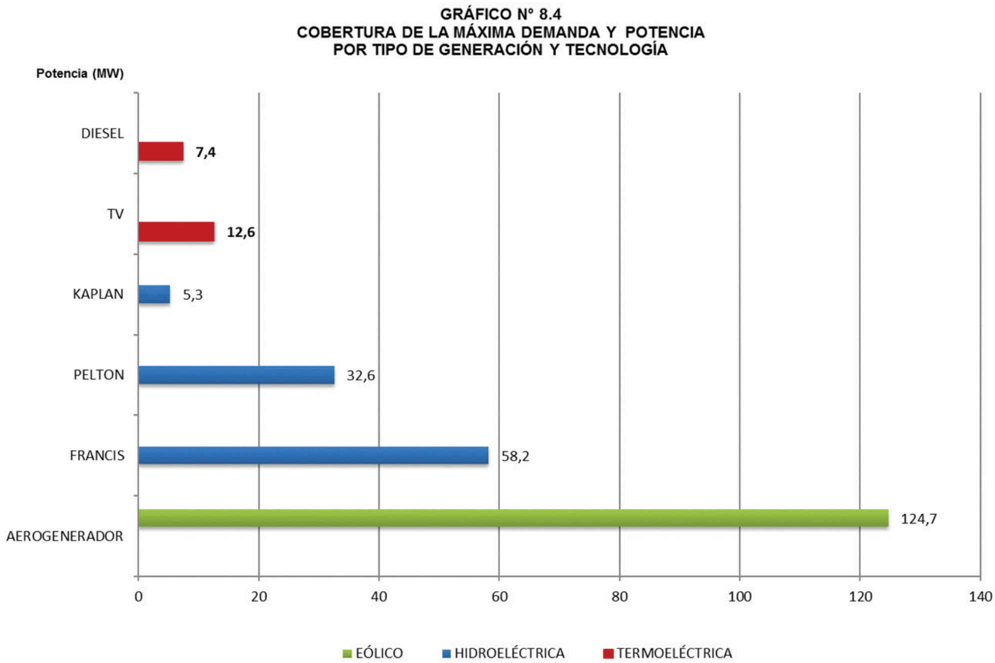
Source: COES

[56] "As for the energy use of water, hydroelectric power is one of the main sources of power generation in the national interconnected system (more than 50%)." Cf. PERU. **Plan Bicentenario. El Perú hacia el 2021.** Approved by the National Agreement. Lima: CEPLAN, 2011. p. 231.

[57] MEM. **Producción con recursos renovables del SEIN.** Prepared by the Operations Committee of the National Interconnected System. Lima: MEM, 2015. Available at: http://www.coes.org.pe/Portal/Publicaciones/Estadisticas/ . Access: 6 August 2016.

Regarding the types of technology for the production of electricity from renewable energy resources, according to the following table for the year 2015, we can highlight the technologies of wind turbines (590.7 GW.h), Francis (510, 8 GW.h), Pelton (298.3 GW.h), Photovoltaic Solar Cells (231.0 GW.h), TV (90.5 GW.h), KAPLAN (89.1 GW.h) and Diesel (36.7 GW.h), giving a total amount of 1,847.2 GW.h.

Chart nº 2: Energy production with RER, 2015.



Source: COES

From 2009 to 2016, Peru held four auction processes for the generation of non-conventional renewable energy, generating a total of 3% of renewable energy based on the implementation of the RER projects of the first three public auctions. Currently, there are several renewable energy projects being implemented as a result of the fourth renewable energy auction (2015)[58],

[58] In September 2015, the OSINERGMIN published the basis for a new auction for non-traditional renewable energy facilities with an annual output of up to 1,300 GWh. On February 16, 2016, the results of the fourth renewable energy auction were published. The hydroelectric part participated with 79.66MW, distributed

obtaining the lower selling prices of renewable energy in the continent's history and continuing with the drastic drop in energy prices offered by these technologies. This price is very low in comparison with the price of conventional fossil energy. With this last auction of renewable energy supply, it is expected an increase in non-traditional renewable energy reaching about 5%, in 2018, of the total production of electricity nationwide. However, compared to other countries such as Uruguay[59], Chile or Brazil, this percentage - as a goal for future clean energy production - is insignificant, abstract and minimal[60], but at least it is a major breakthrough for the formation of a Social and Environmental State of Law in Peru.

In the fourth auction in question, it were presented 111 projects in total, which is one of the most competitive auctions held in the region. Furthermore, contracts were held for period of 20 years and with December 2018 as the scheduled date for the beginning of commercial operation[61]. In total, two waste biomass plants with a total capacity of 2 MW c/u, three wind farms with a capacity of 162 MW, two solar plants[62] with a capacity of 184 MWp and six hydroelectric plants with 79.7 MWp of capacity were agreed.

among 6 power plants. The photovoltaic energy participated with an expected annual production of 415GWh, the wind with 573GWh and the biomass with 312GWh. A round of 450GWh of hydroelectric power is planned.

59 "According to the consultaing company SEG Engenharia, a company specialized in reducing energy costs, of the total energy consumed in the last 24 hours in Uruguay, 70.53% has its origin in hydroelectric plants, 21.13% was generated in wind, 7, 96% came from biomass and 0.39% from solar energy". Available at: http://www.efe.com/efe/america/cono-sur/el-100-del-consumo-electrico-uruguayo-provino-hoy-de-energias-renovables/50000553-2921176 Access: 06 August 2016.

60 "In our region, the countries that invested more than one billion dollars - excluding Brazil - were Mexico, Chile and Uruguay. Despite not reaching one billion, Honduras is the fourth largest Latin American country to invest in renewable energy, with more than $ 500 million. Countries with important economies such as Argentina, Colombia and Venezuela still have little investment in clean energy. Other countries that have invested heavily in previous years, such as Peru, Costa Rica, Panama and Guatemala, have reduced their investment a little in 2015 (...). Places like Chile and Uruguay are seen as more stable markets, where it is possible to have profits and to get good conditions from the banks ". Cf. BBC. **Los países de América Latina que más y menos invierten en energías renovables**. April 2016. Available at: http://www.bbc.com/mundo/noticias/2016/04/160329_ciencia_energia_renovable_inversion_america_gtg Access: 04 August 2016.

61 The winning projects are located throughout the national territory, in the departments of Cajamarca, Áncash, Ica, Lima, Moquegua and San Martín.

62 The prices awarded, especially for photovoltaic plants, represented a world record.

Chart nº 3: Fourth RER Auction in Peru.

Tecnología	N° de Proyectos Adjudicados	Potencia Total (MW)	Energía Total Adjudicada (GWh/año)	Precio Promedio de Adjudicación (USD/MWh)
Biomasa Residuos Sólidos Urbanos Biogás	2	4,0	29,0	77,00
Eólica	3	162,0	738.6	37,79
Solar Fotovoltaica	2	184,5	523.4	48,09
Hidroeléctrica	6	79,7	448,2	43,86

Source: OSINERGMIN, 2016.

Under the auspicious of the auction promoted by the Peruvian government and the main renewable energy projects under implementation, the companies awarded with the major public procurements were the Italian Enel Green Power (a wind farm, a solar park and a hydroelectric plant with an installed capacity of 326 MWh[63]) and the Spanish Renewable Grenergy[64] (responsible for the construction of two wind farms out of the 13 projects selected through the auction process in question). These wind farms have a capacity of 18 MW each and are located in Cajamarca. It is important to note that currently there are four wind farms in operation: Marcona (Ica, 2014), Cupisnique (La Libertad, 2014), Talara (Piura, 2015)[65] and Tres Hermanas (Ica, 2016). Regarding the generation of photovoltaic solar energy, the company Enel Green Power and GDF Suez were the only winners, presenting historical selling prices.

63 "*Enel Green Power*, through its power generation subsidiaries Edgel and Eepsa, manages the control and operation of seven hydroelectric plants and three thermal power stations along the Peruvian territory, between the coast and the center of the country, with an installed capacity of approximately 1,976 MW". Available at: https://www.enelgreenpower.com/peru_newcountries/en-gb . Access: 6 August 2016.

64 Available at: http://grenergy.eu/es/contacto/ Access: 6 August 2016.

65 The US company *CountourGlobal* is responsible for the largest wind farm in Peru (Cupisnique and Talara), made up of 62 wind turbines, with an investment of US $ 250 million, whose production is connected with the SEIN.

Until July 2016, there were five solar parks connected to the regular power grid with a nominal installed capacity of 96 MWp, all connected to the *Sistema Elétrico Interligado Nacional* - SEIN. However, for the "RER auction for power supply to the areas that are not connected to the grid," the OSINERGMIN awarded two offers of Ergon Perú company for the execution of 500,000 solar systems in rural areas, generating approximately 85Wp each installation. Concerning solar energy in rural areas, the criticism relates to accessibility, insufficiency and inefficiency of energy for each household and the risks to be taken by the State regarding the marginal costs of production, installation and execution[66].

The Energy National Plan - PNE[67] points out that "the commitment to renewable energy definitely continues in the country. In the electric field, apart from the conventional renewable energy generation (hydroelectric plants) that have been operating in the country for many years, the promotion to unconventional renewable energy, including wind, solar, small hydroelectric plants, etc, will continue"[68].

On the other hand, the main institutional challenge to current RER energy projects and to the protection of Peru's energy security, is the generation and distribution of renewable energy through new technologies in rural and/or isolated areas, where the regular power grid does not reach or worse, where the rural exodus is increasing[69], creating an asymmetry between investments and the benefits for rural users, as shown in the following table on the evolution of migration rural in Peru:

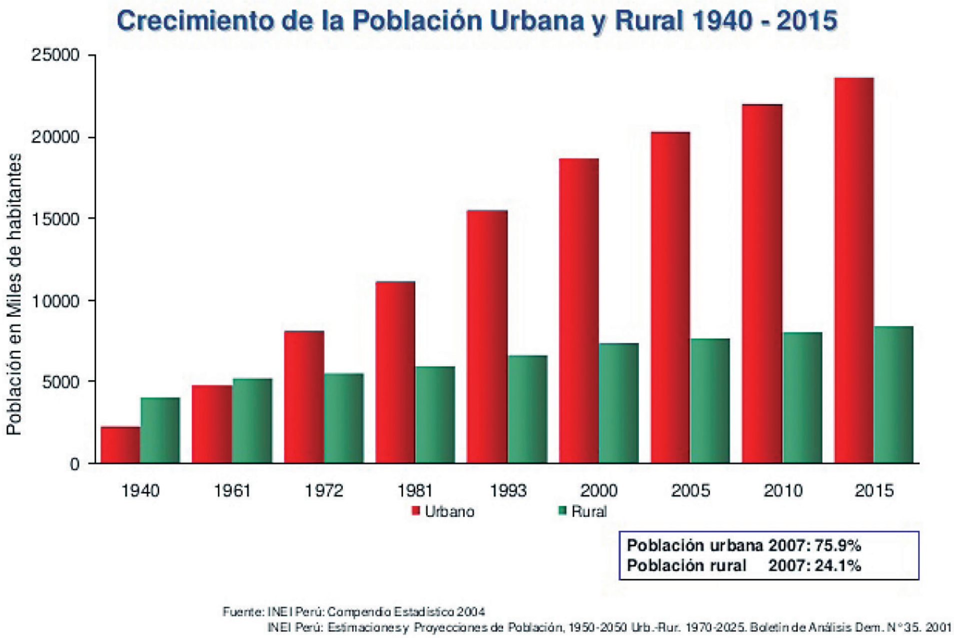
[66] IRENA.

[67] PERU. **Plan Energético Nacional 2014-2025**. Approved by Ministerial Resolution No. 185-2014-MEM-DM. Ministry of Energy and Mines. Lima: March 2016.

[68] PERU. **Plan Energético Nacional 2014-2025**. Working Document. Executive Summary. Ministry of Energy and Mines, November 2014.

[69] According to the UNFPA/UN Annual Report 2015, more than 50% of people in the world live in cities, and by 2050, this number will increase by approximately 65%. Cf. UNFPA. **Annual Report 2015. For people, planet & prosperity.** New York: UN, 2015.

Chart nº 4: Projection of rural migration 1940-2015.



Source: INEI.

Thus, the major institutional challenge that Peru currently faces regarding the rural migration to urban areas is how to fulfill the needs of these great centers of consumption if no appropriate measures are taken in order to safeguard the local population's rights and to ensure generation of electricity at low cost and with competitive prices in rural areas sparsely populated, because of the massive migration to the cities. This is the main current problem of the installation of RERs in rural areas of Peru: the shortage of rural population, which do not have access to the right to development and renewable energy sources due to their high costs of installation, control and maintenance and that should be covered by the State, under the principle of subsidiarity. Moreover, other relevant aspect is the lack of interest of private investors to finance projects in isolated green markets.

However, assuming the risk of rural migration, since 2012, the Peruvian government initiated a remarkable policy for the generation, promotion and incentives to supply the electricity demand in rural, isolated or border areas, as the legal system indicates.

Accordingly, in order to contribute to a better quality of life for the inhabitants of rural areas of Peru, improving their socioeconomic development and discouraging rural exodus, the MEM, through the General Directorate of Rural Electrification - DGER[70], is subsidizing and promoting the use of non-conventional renewable energy in rural areas, having the "*Plano Nacional de Eletrificação Rural 2016-2024*" as the main public instrument[71]. The latter describes the framework of investments (costs) by departments, provinces and districts, which reflects the current projects and the state of their implementation in 2015 and the rural populations and households benefited as electricity users. It is worth mentioning the nationwide massive programs of solar renewable energy through photovoltaic panels[72]. "Currently there is the auction of 500,000 *offgrid* photovoltaic systems equivalent to 50 MW of capacity to be installed in rural areas of the country."[73] These projects promote the rural areas that are not connected to the SEIN through public auctions[74], i.e., these locations are not connected to the national electricity distribution grids, which is the central point in the State promotion to the access to electricity and to the interest of economic players.

In the table below we can see the evolution of the process of rural electrification in Peru from 1993 to 2015, highlighting the demographic rate of beneficiaries:

70 The DGER is currently the public authority with the responsibility for rural electrification in the country and, therefore, carries out all projects in rural, isolated and border areas, according to the "*National Rural Electrification Plan 2016-2024*". Cf.: http://dger.minem.gob.pe/default.aspx Access: 8 August 2016.

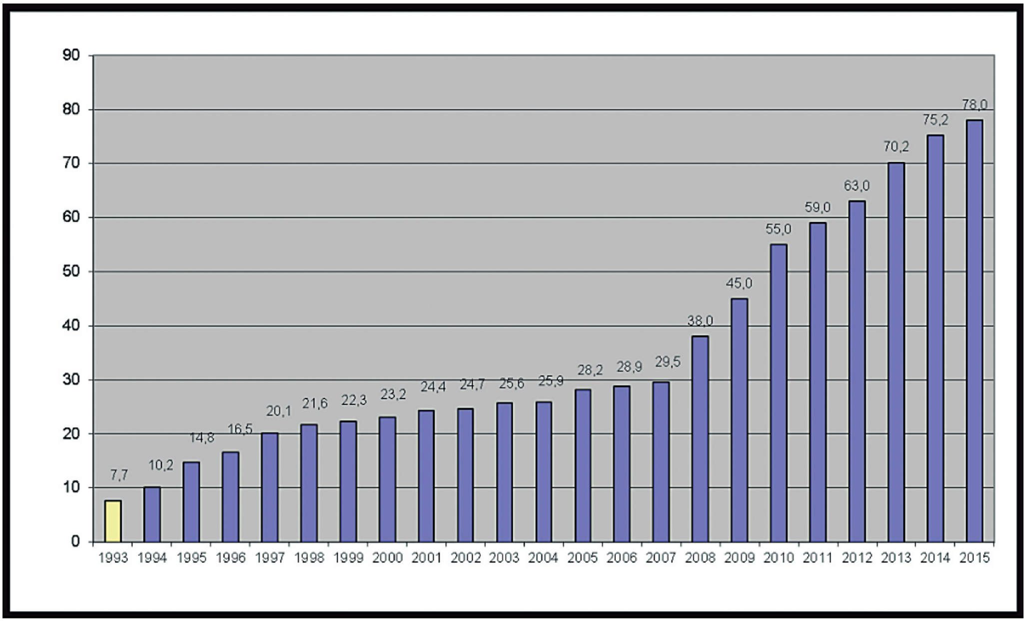
71 PERU. **National Rural Electrification Plan (PNER) Period 2016-2024.** Ministerial Resolution No. 579-2015-MEM / DM. Ministry of Energy and Mines. Lima, MEM, 2016. Available at: http://dger.minem.gob.pe/ArchivosDger/PNER_2015-2024/F4-PNER-Dptos-2015-24.pdf Access: 8 August 2016.

72 "To promote the productive uses of electricity, the project used a business and services development approach. It focused on the promotion to small businesses through non-governmental organizations (NGOs) and developed a market strategy for the electricity provider, which addressed the lack of information, tariff barriers and quality of service." Available at: http://www.bancomundial.org/es/results/2014/09/24/peru-brings-electricity-to-rural-communities Access: 8 August 2016.

73 PERU. **National Energy Plan 2014-2025.** Working Document. Executive Summary. Lima: Ministry of Energy and Mines, November 2014.

74 In September 2013, the first auction for the supply of energy from areas not connected to the SEIN was carried out through international public bidding, with the contract being signed in mid-2015.

Chart nº 5: Evolution of the rural electrification rate in Peru (1993 - 2015).



Source: DE/POWER 2016-2015 (MEM).

This table indicates that, from August 2011 to December 2015, it was possible to electrify at national level, 9,659 localities, benefiting about 1,400,000 people. At the end of 2015, MEM was able to complete 55 works of rural electrification, which allowed to provide energy for more than 1,400 locations, benefiting 166,000 people from all over the country. The regions benefited from these projects are: Cajamarca, La Libertad, San Martin, Ayacucho, Puno, Ancash, Huanuco, among others. It is worth mentioning that the coefficient of rural electrification in 2015 was 78% and at the end of 2016, the DGER expects to reach 89.2%. According to the latter, in Cajamarca - one of the most important regions of the North - it was possible to bring electricity to more than 1,300 places in the last four years, benefiting about 200,000 inhabitants of the various provinces of this department. Among the most important projects during this period we can highlight the Rural Electrical Systems (SER) Santa Cruz - Chota - Bambamarca IV Stage; La Encañada-Sucre-Miguel Iglesias-La

Libertad de Pallán, Santa Cruz - Chota - Bambamarca V Stag;e and the project of rural electrification in the province of Celendín"[75].

Conclusion

Despite the fact that Peru has structured a set of public policies to safeguard environmental protection, helping to improve the control, supervision and accountability over natural resources, its environmental legal institutional framework is a new system and still lacks strong institutions able to protect the environmental rights of present and future generations. The efficient performance of legal institutions will strengthen the socio-environmental rule of law in Peru, resulting in harmony and benefits in the relations between the State, economic players and society[76].

The diversification of Peru's energy matrix must remain aimed at renewable energies strictly in view of the benefits to local geography and appropriate natural conditions. This dynamism should be further strengthened if the State wishes to be a member of the OECD. Peru has very attractive scenarios for investment in renewable energy sources and therefore it is necessary to continue to promote public policies on clean, sustainable and renewable energy. By setting a regulatory framework in this sense, one must seek to reconcile both individual and collective interests of the agents involved, stimulating the generation of electricity from unconventional sources, mainly based on innovation and new technologies. Although it is true that four public auctions were successfully conducted to generate unconventional RERs, perhaps the greatest challenge for the future is the opening of the green market for power generation from biomass (promoting greater support for solid waste management in cities), geothermal energy (an adequate exploitation of the energy emitted by the Earth and the Southern volcanic chains) and tidal energy

[75] Available at: http://www.minem.gob.pe/_detallenoticia.php?idSector=8&idTitular=7170 Access: 8 August 2016.

[76] A very important point to note is that Peru hosted the 20th Conference of the United Nations Framework Convention on Climate Change (COP 20), which underlines its commitment to strengthen its environmental institutions based on the implementation and efficient results of its public policies, in accordance with the international normative provisions in environmental matters. In this regard, Peru has, as its main guide, the Principle 10 of the Rio Declaration, with emphasis on the commitment to boost the right to information, public participation and access to environmental justice.

(extracting energy from the force of movement of the tides or waves alongside the Pacific coastline).

Even with the 34 renewable energy projects currently in operation and predicting that in 2019, 60 public concessions projects are going to be under implementation, in addition to maximizing the objectives all of these projects, we recommend a further strengthening of the framework of incentives for renewable energy generation individually or privately on a small scale or at the national level. Currently, the Peruvian government does not have adequate structural mechanisms to facilitate the access to non-conventional renewable energy by individual investors, except those that are promoted through international cooperation seeking to encourage the individual and private access of microenterprises[77]. Institutionally, the Development Bank of Peru, represented by COFIDE, maintains a loan fund for the implementation of renewable energy; such funding is not provided by private banks, perhaps because they believe that there is no future market for non-conventional renewable energy.

It is necessary to create a public agenda on the research of new technologies under the coordination of CONCYTEC, led by the MEM, with regional and even local governments in order to structure a series of legal and economic mechanisms through tax incentives to encourage the legal and economic strategic interests in the relationship between State, Market and Society. It is fundamental to take into account the economic criteria of incentives for private agents who want to invest in power generation based on renewable energy sources in the moment of subsequent State regulation of this market, for the benefit of users of such energy. Thus, as it is clear that individuals respond to incentives, the Peruvian State must take into account the extrafiscal taxation that promotes an increase in supply in the green energy market. In this sense, the use of sustainable energy for all is guaranteed, in order to accomplish universal access to energy services with the latest technology, which are intended to improve both performance and the flow and energy efficiency of the country.

Therefore, froming an evaluation of the State policies on energy security and the encouragement of sustainable power generation in Peru, it can be

[77] PERU. **Cooperación Alemana al Desarrollo GIZ.** Available at: https://www.giz.de/en/worldwide/26019.html Access: 6 August 2016.

noted that there are substantial advances that are beginning to facilitate the efficiency of the right of access to renewable energy in rural, isolated and border areas, in conformity with the various projects of public investment and the participation of private agents across the country. This is reinforced by the set of Public Policies, National Plans and legal frameworks that guarantee the dynamism of this energy goal, resulting in the formation and consolidation of the pillars of Environmental and Democratic Rule of Law in the country.

According to ECLAC, in order to strengthen the energy paradigm transformation from the use of fossil fuels to the power generation through non-conventional renewable sources, in view of the contraction of the development, "the region needs a progressive structural change, with a major environmental stimulus, to promote development based on equality and sustainability"[78], as highlighted in the institutional document "*Horizons 2030: Equality at the Heart of Sustainable Development*". Similarly, the 2030 Agenda for Sustainable Development recommends that a major effort to mobilize funding for development is needed, involving both the public and the private sectors[79]. On the use of renewable energy in rural areas of Peru, the core of the development should rely on the guarantee of equality and freedom of local communities in order to strengthen the Socio-Environmental Rule of Law by obtaining a more diversified, efficient and competitive (regarding both supply and demand) energy matrix, with emphasis on the use of renewable energy resources.

Finally, we suggest that the next meeting of the Forum of Latin American and Caribbean Countries on Sustainable Development - although these meetings are held to monitor and review the implementation of the entire 2030 Agenda for Sustainable Development, including the Sustainable Development Goals (SDGs) - gives greater attention to discussions on ODS 7, regarding the construction and implementation of public policies for renewable energy by the States (their central, regional and local parts) based on the connection between poverty, energy and climate change. Accordingly, it is possible to ensure a more significant promotion, use and efficiency in power generation through non-conventional energy sources. This framework can contribute to

[78] ECLAC. **Horizontes 2030: La igualdad en el centro del desarrollo sostenible.** Santiago of Chile: UN, 2016.

[79] ECLAC. **Estudio Económico de América Latina y el Caribe. La Agenda 2030 para el Desarrollo Sostenible y los desafíos del financiamiento para el desarrollo.** Santiago of Chile: UN, 2016. p. 51.

the further strengthening of environmental institutions and the dynamism not only of economic development but also of all spheres that compose sustainable development with freedom, which guarantee the right to clean and/or green energy respecting social and environmental rights of both the present and future generations in Latin American countries.

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BRAZIL

THE ENERGY ACCESS IN RURAL OR ISOLATED AREAS IN BRAZIL: A VIABILITY REVIEW

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Abstract: This work aims to analyze the renewable energy access in rural areas in Brazil. Regarding its energy matrix, it is observed that the country uses mainly renewable resources; however, they remain underexploited, especially wind and solar energy. In recent years, the Brazilian government has implemented an energy access public policy with some success, the Light for All Program (*Programa Luz Para Todos*). However, the need to expand accessibility remains and can be implemented through renewable energy equipments. The main current challenge is expanding reach to the Brazilian Amazon region. The proposal is to achieve full energy access for Brazilian rural or isolated population by exploring different resources, such as small-scale water resources, biomass and through a dedicated and residual form and exploitation of both wind and solar energy.

Keywords: Brazil – Energy Access – Rural Areas – Renewable Energy – Isolated Areas – Amazon.

Introduction

With a territory of continental dimensions (8.500.000 Km²) and the biggest population among Latin American countries (about 200 million), Brazil has a high demand for energy generation and distribution. Despite the expansion and universal power supply attempts, it is estimated that about two million families, corresponding to 1% of the Brazilian population, still have a precarious access to energy. In this scenario it is a real challenge to plan the energy generation and distribution to the communities located at isolated places, far from urban centers.

This challenge proves to be even greater considering that the expansion of Brazilian energy must be inserted into a sustainable development context.

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The gradual shortage of fossil fuel reserves in the world and the climate change (largely caused by the use of these fuels) lead to the need for investment in renewable energy matrixes, broadly available and with low impact on the environment and climate. The international community, especially given the leadership position the country holds not only in Latin America, but also among the emerging developing countries, will closely observe the choices Brazil outlined in its energy planning for the future.

Therefore, this work aims to investigate the possible measures to promote renewable energy access in Brazilian isolated areas. At first, it is necessary to analyze the current state of the Brazilian energy matrix, with emphasis in renewable energy, including the legal and political context. The next step is to identify and analyze the main obstacles in providing energy access to rural communities in Brazil, the public policies implemented on the issue and renewable energy supply alternatives in this specific context.

1. The current scenario of the Brazilian energy matrix

Official data shows that Brazil produces about 144.9 million kilowatts (kW), distributed by 4,539 projects in operation. It draws attention the fact that 64.58% of installed capacity comes from hydropower. Also, the thermopower plants account for 27.69%, wind power for 6.34%, nuclear power for 1.37% and solar power for only 0.02%[3]. A curious fact is that Brazil has more than 70% of its power generation based on renewable sources, while in the rest of the world fossil fuels generate, on average, 80% of the power[4]. Currently, Brazil is the ninth country on the largest energy consumers list[5]. Tracing this panorama, we proceed to the analysis of the current situation of the Brazilian energy matrix, with emphasis on renewable energy (hydro, biomass, wind, solar and tidal).

3 AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA (ANEEL). **BIG – Banco de Informações de Geração.** Avaliable at: <http://www2.aneel.gov.br/aplicacoes/capacidadebrasil/capacidadebrasil.cfm>. Access: 1 July 2016.

4 INTERNATIONAL ENERGY AGENCY. **Key World Energy Statistics.** Avaliable at: <https://www.iea.org/publications/freepublications/publication/KeyWorld_Statistics_2015.pdf>. Access: 1 July 2016.

5 According to data from the USA Central Intelligence Agency (CIA), Brazil is behind China's energy consumption, the United States, European Union, Russia, Japan, India, Germany and Canada. UNITED STATES CENTRAL INTELLIGENCE AGENCY. Country Comparison (CIA): Electricity Consumption. **The World Factbook.** Avaliable at: <https://www.cia.gov/library/publications/the-world-factbook/rankorder/2233rank.html>. Access: 15 July 2016.

According to the presented data, the most used power source in Brazil is hydropower generated (64.58%). The hydropower dependence had been much higher in the past (over 80%). The emergence of the energy crisis in the early twenty-first century caused by the increase of energy demand and the diminishment of water containers due to drought, led the Brazilian government to invest in other sources. Studies classify the country as the holder of the greatest hydropower potential in the world, but only about 30% has been explored[6].

Nowadays the country has 555 hydropower plants (CHP), 450 small hydropower plants (SHC) and 219 medium sized hydropower plants. The overwhelming majority of the generated hydropower comes from these last plants (93%)[7]. The power plants in the rivers Paraná (South), Tocantins (North) and San Francisco (Northeast) are substantial.

The Itaipu hydropower plant, located on the Paraná River, is the second largest in the world[8]. Built on a river at the border between Brazil and Paraguay as a result of the binational relationship, it has been producing 15% of total electricity consumed in Brazil and 75% in Paraguay[9]. Tucuruí, the second largest plant, is based in the Tocantins River. The third largest, Ilha Solteira hydropower, is also based on the Paraná River. Both hydropower plants Xingó and Paulo Afonso IV are located in the basin of the São Francisco River.

According to Brazilian Electricity Agency (ANEEL), the Northeast, the South and the Southeast hydropower potentials are already almost fully exploited[10]. Therefore, an expansion of the use of this source in the near future includes the construction of new large hydropower plants in the North region.

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[6] AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA (ANEEL). **Atlas de Energia Elétrica do Brasil**. 3 ed. Brasília: ANEEL, 2008, p.57.

[7] They are classified as hydroelectric power plants projects with installed capacity of up to 3 MW; as small hydroelectric plants, those with capacity to produce between 3 MW and 30 MW; and as power hydroelectric plants, the installed capacity exceeding 30 MW. MAKISHI, André et al. Hidrelétrica. In: TOLMASQUIM, Maurício T. (Org.). **Energia Renovável:** Hidráulica, Biomassa, Eólica, Solar e Oceânica. Rio de Janeiro: EPE, 2016, p. 85.

[8] The Power Plant Three Gorges Damin China is the first in installed capacity, with 22,400 MW of generating power. Itaipu has an installed capacity of 14,000 MW. However, in the face of seasonal hydrology of the Chinese plant, the record of annual generation is very similar: 98.8 and 98.6 billion kWh / year, respectively. ITAIPU BINACIONAL. **Comparisions.** Available at: <https://www.itaipu.gov.br/en/energy/comparisons>. Access: 8 July 2016.

[9] ITAIPU BINACIONAL. **Geração.** Available at: <https://www.itaipu.gov.br/energia/geracao>. Access: 17 July 2016.

[10] AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA (ANEEL). **Atlas de Energia Elétrica do Brasil**, p. 57.

As a result, Brazil recently started the construction of Belo Monte hydropower (in Xingu River), São Luiz do Tapajós (in Tapajós River), Jirau and San Antonio (both in Madeira River). Such projects are suffering hard criticism due to possible environmental damage and violation of the rights of indigenous peoples living in the region[11].

To obtain heat-generated power (corresponding to 27.69% of the Brazilian energy matrix), thermal power plants burn fossil fuels and biomass, the latter being classified as a renewable resource. The main fossil fuels used in Brazil are oil and its derivatives - natural gas and coal. Currently, 92.52% of the oil fields in Brazil are in the marine coast, while 7.48% are on land[12]. Comparing the regions where the largest quantities of oil are concentrated, the state of Rio de Janeiro accounts for 68.4%, followed the states of Espírito Santo and São Paulo[13]. Recently, the pre-salt layer oil discovery (rocks formed of petrified salt present in the bottom of the ocean) in the Brazilian exclusive economic zone has raised the upstream potential of this energy matrix. In general, the natural gas is extracted jointly with oil directly from the well. Coal is not often used in Brazil, since what's found is poor in energy potential point of with high levels of impurities. A large part of the deposits is located in the state of Rio Grande do Sul[14].

In Brazil, biomass is generally derived from sugarcane, elephant grass (type of grass), rice husk, vegetable oils, charcoal, blast furnace gas, wood, black liquor, forest residues and biogas from agricultural, animal or urban solid residues. Biomass can be dedicated, when economic activity is geared exclusively for its production, or residual, from agro-industrial activity wasting - the latter is most used in Brazil. In this case, the biomass is used for the energy generation unit itself with the possibility to sell the surplus. However, a significant portion of these industrial units is only able to produce

[11] See FLEURY, Lorena Cândido; ALMEIDA, Jalcione. A Construção da Usina Hidrelétrica de Belo Monte: Conflito Ambiental e o Dilema do Desenvolvimento. **Ambiente & Sociedade**, São Paulo, v. XVI, n. 4, p. 141-148, out.-dez. 2013. BRATMAN, Eve Z. Contradictions of Green Development: Human Rights and Environmental Norms in Light of Belo Monte Dam Activism. **Journal of Latin American Studies**, New York, v. 46, n. 02, p. 261-289, abr. 2014. SQUEFF, Tatiana de A. F. R. Cardoso. **Estado Plurinacional: a proteção do indígena em torno da construção da Hidrelétrica de Belo Monte**. Curitiba: Juruá, 2016.

[12] AGÊNCIA NACIONAL DE PETRÓLEO, GÁS E BIOCOMBUSTÍVEIS (ANP). **Anuário Estatístico Brasileiro do Petróleo, Gás Natural e Biocombustíveis.** Rio de Janeiro: ANP, 2015, p. 69.

[13] INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE). **Logística de Energia 2015**. Rio de Janeiro: IBGE, 2016, p. 23.

[14] Ibid., p. 31; 136.

low efficiency energy for self-consumption, with little or no surplus. Due to Brazilian governmental efforts, biomass use has grown in the latest years, currently accounting for 8% of all power generated[15].

The sugarcane has been considered as the most important source of Brazilian biomass, accounting for nearly 7% of the total power generated (more than 10 million kW and over 392 power plants)[16]. The reason behind such expressive data is the pioneering Brazilian biofuel extracted from sugarcane called ethanol, started by the "National Program of Alcohol" (Proálcool), established in 1975, as a result of the need to diversify the energy matrix due to strong oil crisis in the beginning of the 1970s[17]. Research conducted in Brazil helped identify sugarcane species with greater energy potential[18]. The bagasse (remaining fibrous matter after sugarcane juice extraction), the tip, straw and stillage from the sugarcane[19] are used or power generation. Despite the predominance of sugarcane, there are other good prospects for increasing the use of straw soybeans and corn in the future.

The sugarcane cultivation [20] is concentrated in the Southeast (the state of São Paulo is responsible for almost half of the total produced in the country), the Midwest and parts of the Northeast regions[21]. An important aspect is that the harvest of sugarcane coincides with the Southeast region dry season, where the largest installed capacity of hydropower plants in the country is concentrated. The electricity supplied by biomass in this period helps preserve the reservoir levels of these power plants[22].

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15 COELHO, Daniel Kuhner et al. Biomassa. In: TOLMASQUIM, Maurício T (Org.). **Energia Renovável***:* Hidráulica, Biomassa, Eólica, Solar, Oceânica. Rio de Janeiro: EPE, 2016, p. 138-139.

16 AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA (ANEEL). **BIG – Banco de Informações de Geração.** op. cit.

17 COELHO, Daniel Kuhner et al. op. cit., p. 137.

18 Traditionally, the species used in the planting of sugarcane was the *saccharum officiarum*, with high levels of sugar and low fiber content. Recently, researches are looking for sugarcanes with high level of fiber (as*saccharum spontaneum*), know as "sugacane-energy".Ibid., p. 163.

19 Each of sugarcane ton is possible to extract 270 kg of bagasse and 155 kg tip and straw. The stillage can be fermented and transformed into a kind of biogas, yielding 150 cubic meters of biogas per ton. COELHO, Daniel Kuhner et al. op. cit., p. 166-168.

20 Since the beginning of Proálcool Programme in 1975, the production of sugarcane in Brazil increased nine times. In 2015, the area devoted to its cultivation was approximately 9 million hectares, resulting in a production of 658.4 million tons. This amount were extracted 177.8 million tons of pulp and 102.1 million tons of tip and straw, raw materials for biomass. COELHO, Daniel Kuhner et al. op. cit., p. 139-140.

21 INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE). op. cit., p. 139.

22 GOLDEMBERG, José. O Estado Atual do Setor Elétrico Brasileiro. **Revista USP,** São Paulo, n. 104, p. 37-44, jan. / mar. 2015, p. 40.

Regarding using vegetable oil as biomass, Brazil has great potential to be explored. About 90% of the oil is extracted from soybeans, but also from peanuts, sunflower seeds, palm and castor, the latter with high drought resistance. Besides these traditional crops, a wide range of oil coming from the Brazilian fauna, such as *pinhão manso, nabo forrageiro, pequi, buriti* and *macaúba* can be explored. Although the native plants have showed good laboratory results, great production levels are achieved through the extraction of such plants from the forest. There is no full dominance of botanical and agronomic cycles able to encourage commercial planting and biomass processing of these species in large-scale[23].

In the least developed regions, the most frequently used biomasses are firewood, charcoal and other forest residues. However, it is important to say that forest biomass usually has low efficiency because it requires a large volume of raw materials for a small amount of energy generation[24]. Concerning the economic exploitation potential, we highlight the black liquor processing, a by-product originated from turning wood into pulp in paper production, as traditional industrial segment in Brazil that has generated approximately 2 million kW in 16 power plants.

Brazil is privileged in wind potential receiving twice the world´s wind average and a volatility of only 5%, allowing more predictability of power generation. Then, the region in Brazil with the greatest wind potential is the Northeast (data indicates 75 GW of power generation potential), followed by the Southeast (29.7 GW), South (22.8 GW), North (12.8 GW) and Midwest (3.1 GW). Wind power can be used as a hydropower complement in drought periods to preserve the hydro basins[25]. Because of its great potential, wind power generation in Brazil is still underexploited (corresponding to 6.39% of the total power generated in Brazil). Despite being one of the fastest growing sector in recent years (only in the year 2015, the growth was 56.9%), the country is tenth in the overall rank of wind power generation[26].

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23 GENOVESE, Alex Leão; UDAETA, Miguel Edgar Morales; GALVÃO, Luiz Cláudio Ribeiro. Aspectos Energéticos da Biomassa como Recurso Energético no Brasil e no Mundo. *Anais do 6º Encontro Energia Meio Rural*. 2006. Available at: <http://www.proceedings.scielo.br/scielo.php pid=MSC0000000022006000100021&script=sci_arttext>. Access: 3 July 2016, p.5.

24 AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA (ANEEL). **Atlas de Energia Elétrica do Brasil**, p. 67.

25 Ibid., p. 81.

26 First is China, with 31%, the USA with 18% and Germany with 10%. SOUZA, Gustavo Brandão Haydt et

The first wind turbine was implemented as an experiment in Brazil in 1992[27]. After the 2001 energy crisis, the Wind Power Emergency Programme (*Programa Emergencial de Energia Eólica*- PROEÓLICA) was created with few results. Nonetheless, the 2002 Alternative Power Sources Programme Incentive (*Programa de Incentivo às Fontes Alternativas de Energia Elétrica* - PROINFA) has been crucial for establishing the reduction of tariffs on wind power generation. Several projects began after the completion of an exclusive bid (Reserve Energy Bid in 2009), which granted a number of benefits for the sector, including tax exemption and credit lines. Other following auctions consolidated the use of this energy matrix[28].Over the past few years, an infrastructure installation costs reduction has been observed, thanks to the national companies that are presently able to produce most of the components needed.

Currently, there are 376 operating wind power plants in Brazil, most of them concentrated in Northeast, in the states of Rio Grande do Norte, Bahia, Ceará, Piauí, Pernambuco, Paraíba and Sergipe. In the South, we highlight the large wind farms located in Rio Grande do Sul and new wind projects in Santa Catarina and Paraná. Low wind power is generated in the state of Rio de Janeiro, in the Southeast region. Despite their wind power potential, as previously mentioned, the remaining areas have no operating enterprises[29].

Classified as non-renewable, nuclear power,[30] is part of the Brazilian energy matrix (1.37% of the granted power). Brazil has considerable reserves of uranium, the raw material of nuclear energy, which allows the country to exercise this power generation for decades, without ore imports needing[31].

al. Eólica. In: TOLMASQUIM, Maurício T. (Org.). **Energia Renovável:** Hidráulica, Biomassa, Eólica, Solar e Oceânica. Rio de Janeiro: EPE, 2016, p. 239.

27 This was a partnership between the *Grupo de Energia Eólica da Universidade Federal de Pernambuco* (UFPE) and the *Companhia Energética de Pernambuco* (CELPE) and the Folkecenter Institute from Denmark.

28 SOUZA, Gustavo Brandão Haydt et al. op. cit., p. 242.

29 ASSOCIAÇÃO BRASILEIRA DE ENERGIA EÓLICA. **Boletim de Dados – Julho de 2016.** Avaliable at: <http://www.portalabeeolica.org.br/images/pdf/Boletim-de-Dados-ABEEolica-Julho-2016-Publico.pdf>. Access: 1 July 2016, p. 05.

30 Despite being regarded as a clean energy due to the low carbon and greenhouse gas effect, nuclear energy cannot be classified as renewable because of the use of mineral uranium, a finite resource. UNITED KINGDOM PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY. **Carbon Footprint of Eletricity Generation.** Avaliable at: <http://www.parliament.uk/documents/post/postpn268.pdf>. Access: 1 July 2016. U.S. ENERGY INFORMATION ADMINISTRATION. **Renewable Energy Explained.** Available at: <http://www.eia.gov/energyexplained/index.cfm?page=renewable_home>. Access: 15 July 2016.

31 In Brazil, only 25% of the territory was prospected for uranium. The deposits are located in Bahia, Ceará, Paraná and Minas Gerais. BRASIL. AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA (ANEEL). **Atlas de Energia Elétrica do Brasil**, p. 448.

Brazil has two nuclear power plants located in the municipality of Angra dos Reis, in Rio de Janeiro state (the third plant was not finished), generating electricity mainly used for supply complementation[32].

Similarly to the wind power situation, Brazil is also favored by high solar radiation levels present throughout the national territory, including during winter, mostly due to its tropical location. The Brazilian Northeast region is classified as one of the areas with the highest solar radiation in the world[33], with special emphasis in the West of Bahia state. Other areas are the São Francisco Valley, Piauí, Mato Grosso do Sul, East of Goiás and West of São Paulo[34].

Solar energy can be exploited through photovoltaic and solar thermal modes. By the photovoltaic method, energy is obtained by direct conversion of light into electricity using a semiconductor material (the most used is silicon). In the heliothermic process, power is converted firstly into thermal energy, and then into electricity, using a heated fluid[35].

Since the 1950s, Brazil has been doing research in solar energy technological development. However, only in 1990, with the public policies implementation by federal government, solar energy matrix was considered a viable alternative to isolated places, far from centers, mainly rural areas. In 2012, solar power generation had been target of regulation[36], establishing general conditions for access to the electricity distribution systems. Only in 2014 bids were launched for solar power exploitation in Brazil[37].

Despite the great potential, the solar power exploitation represents a very small fraction of the Brazilian energy matrix (corresponds to only 0.02% of the granted power), composed by only 39 small capacity power plants[38]. All of them are photovoltaic; in Brazil there are no heliothermic power plants.

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[32] Ibid., loc. cit.

[33] Ibid., p. 85.

[34] KONZEN, Gabriel et al. Solar. In: TOLMASQUIM, Maurício T. (Org.). **Energia Renovável:** Hidráulica, Biomassa, Eólica, Solar e Oceânica. Rio de Janeiro: EPE, 2016, p. 331.

[35] Ibid., p. 332-333.

[36] Resolução Normativa nº 482/2012 da ANEEL. AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA (ANEEL). **Resolução Normativa nº 482, de 17 de abril de 2012.** It establishes the general conditions for access and microgeneration to power distribution systems, power compensation system, and other measures. Available at: <http://www2.aneel.gov.br/cedoc/ren2012482.pdf>. Access: 1 July 2016.

[37] KONZEN, Gabriel et al. op. cit., p. 318.

[38] AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA (ANEEL). **BIG – Banco de Informações de Geração.** op. cit.

According to recent studies, Brazil has also good potential for ocean or tidal power exploitation, particularly in the Southeast region. However, this kind of power plant still has poorly developed technology, high costs and is not yet part of the Brazilian energy matrix. A few pilot projects related to academic research were issued, most developed in the municipalities of Pecém (Ceará), Rio de Janeiro (Rio de Janeiro) and São Luís (Maranhão)[39].

Brazil has a complete institutional environment able to plan and conduct the national energy policy. Within the federal government, the actions are carried out by the Ministry of Mines and Energy (MME), which is part of the executive branch[40]. There is also the National Energy Policy Council, an organ presided by the Minister of Mines and Energy and responsible for directly advising the President on these issues.

Other organs are linked to the federal government as autonomous entities that play specific roles in the Brazilian energy system. The National Power Agency (*Agência Nacional de Energia Elétrica* - ANEEL) has the role to regulate and supervene the generation, transmission and sale of electricity in the country, according to the domestic policies and guidelines. Its purpose is to provide favorable conditions for energy provisions and to the market in order to develop a balance between the agents and welfare. The National Petroleum Agency (*Agência Nacional do Petróleo, Gás Natural e Biocombustíveis* - ANP) exerts the same function within the oil and gas fields. Also, the Energy Research Company (*Empresa de Pesquisa Energética* - EPE) is a public company aiming to produce data on the energy sector. Finally, the National Nuclear Energy Commission (*Comissão Nacional de Energia Nuclear*) is a federal agency responsible for regulating the use of nuclear energy in Brazil, and the National Department of Mineral Production (*Departamento Nacional de Produção Mineral*) plays a role in the coal exploitation[41].

The National Interconnected System (*Sistema Interligado Nacional* - SIN) is the link between the generation and transmission/distribution systems of

39 MATTOS, Ana Dantas de et al. Oceânica. In: TOLMASQUIM, Maurício T. (Org.). **Energia Renovável:** Hidráulica, Biomassa, Eólica, Solar e Oceânica. Rio de Janeiro: EPE, 2016, p. 411.

40 The Ministry of Mines and Energy was created in the Brazilian government structure in the 1960s, and was absorbed by the Ministry of Infrastructure temporarily in the 1990s. As the ministerial structure is not part of the Brazilian Federal Constitution content, there is always the possibility of having its functions absorbed by another ministry in the future.

41 ALCOFORADO, Fernando. Política Energética Sustentável Requerida para o Brasil. **Nexos Econômicos – CME – UFBA**, Salvador, v. 6, n. 02, p. 121-143, dez. 2012, p. 123.

electricity in Brazil, composed by several companies (both public and private) acting in the sector. The multiple Brazilian electrical interconnections allow the power surplus exchange, ensuring continuous supply throughout the country. This system is coordinated by the National Electric System Operator (*Operador Nacional do Sistema Elétrico* - ONS), a private non-profit legal entity, presenting itself as a place for managing power stocks by Brazilian electric stakeholders. Only 1.7% of the total power consumed is outside the system (SIN), and it is concentrated in the North region[42].

Despite the mitigation of the State monopoly over the energy sector after the reforms carried out in the 1990s, the Brazilian government still holds a substantial share in economic activity. Eletrobras is a mixed capital company under Federal Government control that runs a large portion of the generation system and power transmission in Brazil. Considered the largest energy sector in Latin America and one of the world leaders in renewable energy, Eletrobras manages power plants accounting for 33% of the total installed capacity in the country and an extensive transmission network, corresponding to 48% of the Brazilian grid[43]. In the gas and oil sectors, Petrobras is also under Federal Government control as a mixed capital company, being one of the largest oil companies in the world with a dominant position in the Brazilian market. Recently, the Pre-salt Oil Company (*Pré-Sal Petróleo*) was created with similar legal status, but with the specific goal to explore fields located in the pre-salt layer zone.

To implement this entirely discriminated context, legal rules needed to be issued to regulate energy related economic activity and to establish public policies. Besides the general provisions on public service concession and permission[44], there is also a specific legislation on energy[45], created during the privatization regime and expansion of the private sector share in the electricity sector established the 1990's.

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42 OPERADOR NACIONAL DO SISTEMA ELÉTRICO (ONS). **Institucional.** Available at: <http://www.ons.org.br/home/>. Access: 25 July 2016.

43 ELETROBRAS. **O Papel da Eletrobrás.** Available at:<http://www.eletrobras.com/elb/data/Pages/LUMIS641DB632PTBRIE.htm> . Access: 16 July 2016.

44 See **Lei Federal nº 8.987, de 13 de Fevereiro de 1995.** Available at: <http://www.planalto.gov.br/ccivil_03/leis/L8987cons.htm>. Access: 1 July 2016. BRASIL. **Lei Federal nº 9.074, de 7 de Julho de 1995.** BRASIL. **Lei Federal nº 9.074, de 7 de Julho de 1995.** Available at: <http://www.planalto.gov.br/ccivil_03/leis/L9074cons.htm>. Access: 1 July 2016.

45 BRASIL. **Lei Federal nº 9.247, de 26 de Dezembro de 1996.** Available at: <http://www.planalto.gov.br/ccivil_03/leis/L9427cons.htm>. Access: 26 July 2016.

Facing an energy infrastructure crisis in the early 21st century that led to a series of blackouts in Brazil, the government promoted a legal reform in the power sector establishing a set of policies prioritizing the expansion of renewable energy, universal access and the development of a competitive market with the introduction of power bids mainly for electric distribution companies, with lower rate standard[46].

An important policy is the aforementioned Alternative Power Source Incentive Programme (*Programa de Incentivo às Fontes Alternativas de Energia Elétrica* - PROINFA), aiming to promote the diversification of the Brazilian energy matrix, energy security, appreciation of the regional and local potential, employment creation, manpower training and the reduction of greenhouse gases emissions. Another very important initiative is the Light for All Programme (*Programa Luz Para Todos*), concerning the universal energy access. It is imperative to mention another initiative called Social Tariff (*Tarifa Social*)[47], aiming to provide discounts on electricity tariffs for the low-income population consuming up to 220 kW/h per month[48]. The entire Brazilian energy legislation is complemented by regulations issued by regulatory agency in the sector.

2. Energy access and the "Light for All" programme (*Programa Luz para Todos*)

Initially, it is crucial to define "energy access." Pachauri points out that lack of access would be "a restriction on people's choices in terms of their inability to access certain goods, services, assets, capabilities, freedoms and opportunities."[49].

[46] BRASIL. **Lei Federal nº 10.438, de 26 de Abril de 2002.** Available at: <http://www.planalto.gov.br/ccivil_03/leis/2002/L10438.htm>. Access: 1 July 2016. BRASIL. **Lei Federal nº 10.848, de 15 de Março de 2004**. Available at: <http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2004/lei/l10.848.htm>. Access: 1 July 2016.

[47] BRASIL. **Lei Federal nº 12.212, de 20 de Janeiro de 2010.** Available at: <https://www.planalto.gov.br/ccivil_03/_Ato2007-2010/2010/Lei/L12212.HTM>. Access: 1 July 2016.

[48] Families that consume up to 30 kW / h per month receive 65% discount; more than 30 kW / h up to 100 kW / h, 40%; more than 100 kW / h up to 220 kW / h, 10%. Indigenous and Maroons who consume up to 50 kW / h receive 100% discount.

[49] PACHAURI, Shonali. Researching an International Consensus on Defending Modern Energy Access. **Current Opinion in Environmental Sustainability**, v. 3, n. 4, p. 235-240, 2011, p. 236.

Studies show the energy access difficulties are related to health problems, human welfare, efficiency and productivity[50]. Bhattacharyya believes there is a relationship between access to electricity and development, since high access rates are generally related to increased income[51]. The problem has gained attention in the international scene, as seen in the Sustainable Development Goals approved by the United Nations (UN) in 2015[52], which affirm that access to energy should be reliable, sustainable, modern, based on renewable matrixes and universal (Goal 7). The importance of the "right to access to energy" today has led to discussions defending its inclusion as a human right[53].

The great challenge is to promote energy access in remote areas, far from major centers, generally located in the countryside and of difficult access. Conceptually, a remote area suffers from three symptoms. The first symptom is the lack of connection to a central grid of energy infrastructure, such as pipelines or power transmission/distribution cables (in Brazil represented by the National Interconnected System - SIN). Unless local exploitable energy resources can be found, this situation leads to higher community dependence on liquid fuels (usually fossil as diesel or gasoline) transported from other locations to supply the energy consumption. The second symptom is the reduced quality of energy supply such as lack of sufficient power output and frequent supply interruption. The third symptom is the higher tariffs charged in comparison to those applied in the interconnected market, due to a number of factors such as inefficient generation and the cost of fuels transit for isolated generation[54]. In 2003, the Geographic and Statistics Brazilian Institute (IBGE) reported that Brazil has a power supply deficit equivalent to 2 million families in Brazilian rural areas. About 90% of these families have an income below three times the minimum wage, below the poverty line.

50 Ibid., loc. cit.

51 BHATTACHARYYA, Subhes C. (Org.)**. Rural Electrification Through Decentralized Off-Grid Systems in Developing Countries**. London: Springer, 2013, p. 6.

52 UNITED NATIONS. **Transforming Our World: The 2030 Agenda For Sustainable Development**. Available at: <https://sustainabledevelopment.un.org/post2015/transformingourworld>. Access: 26 April 2016.

53 The base would be Art. XXV (2) of the Universal Declaration of Human Rights of 1948, which states that "every human being has the right of equal access to public service in his country." COSTA, Maria D'Assunção. **O direito de acesso à energia: meio e pré-condição para o exercício do direito ao desenvolvimento e dos direitos humanos**. Tese (Doutorado - Programa de Pós-Graduação em Energia). EP/FEA/IEE/IF da Universidade de São Paulo. 2009.

54 INTERNATIONAL ENERGY AGENCY – RENEWABLE ENERGY TECHNOLOGY DEPLOYMENT (IEA-RETD). **Renewable Energies for Remote Areas and Islands.** 2012. Available at: <http://iea-retd.org/wp-content/uploads/2012/06/IEA-RETD-REMOTE.pdf>. Access: 10 July 2016, p.18.

The Brazilian experience in energy access started with a subsidizing policy for the production of liquefied petroleum gas through gas cylinders, during the military regime back in the 1970s. It leads to a substantial drop in biomass used for cooking, including in remote regions such as the Amazon and Northeastern backwoods, which contributed to discourage deforestation[55].

In 1994, the Energy Development Programme was created for States and Municipalities (*Programa de Desenvolvimento Energético de Estados e Municípios* - PRODEEM), one of the first rural electrification public policy experiences in the country. In 2000, the Brazilian government (during the Fernando Henrique Cardoso Administration) launched the Rural Light Programme (*Programa Luz no Campo*) in order to increase energy access in rural areas. In 2003, the program was reissued during the Lula Administration, called Light For All, consolidating itself as a State policy.[56] Initially planned to end in 2008 after successive renewals[57], it has been extended to last until 2018[58]. Currently, the Programme's beneficiaries are families located in high tariff impact areas; extreme poverty regions; rural settlements; indigenous communities; *quilombo*[59] communities; communities located in extractive reserves; communities affected by hydropower dams and places with schools, health centers or community water wells.

The Programme is coordinated by the Ministry of Mines and Energy, operated by Eletrobras and executed by power utility companies (also called concessionaires) and rural electrification cooperatives, in partnership with state governments. The program does not have the goal to expand energy access taking into account exclusively economic nature (many companies have not granted sufficient investment payback). The goal is eminently social, whose

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55 COELHO, Suani T; GOLDEMBERG, José. Energy access: Lessons learned in Brazil and perspectives for replication in other developing countries. **Energy Policy**, v.61, n.0, p.1088 –1096, 2013, p. 1092.

56 BRASIL. **Decreto Federal nº 4.873, 11 de Novembro de 2003.** Available at: <http://www.planalto.gov.br/ccivil_03/decreto/2003/d4873.htm>. Access: 10 July 2016.

57 BRASIL. **Decreto Federal nº 7.520, de 8 de Julho de 2011.** Institui o Programa Nacional de Universalização do Acesso e Uso da Energia Elétrica-"LUZ PARA TODOS", para o período de 2011 a 2014, e dá outras providências. Available at: <http://www.planalto.gov.br/ccivil_03/_Ato2011-2014/2011/Decreto/D7520.htm. Access: 10 July 2016.

58 BRASIL. **Decreto Federal nº 8.387, de 30 de Dezembro de 2014.** Available at: <http://www.planalto.gov.br/ccivil_03/_Ato2011-2014/2014/Decreto/D8387.htm>. Access: 10 July 2016.

59 Up to one hundred years after the signing of the "Áurea" Law that freed the slaves in Brazil, quilombos were considered places with large concentrations of African-Brazilians who rebelled against the colonial regime. With the Federal Constitution of 1988, the term "quilombo" had expanded its concept so that today is considered the entire area occupied by the remaining communities of ancient quilombos.

responsibility for its implementation is shared between public and private sectors. By 2015, R$ 22.7 billion (US$ 6.88 billion – rate used US$ 1.00 = R$ 3.30) was invested in crafting and developing of the Programme, considering that R$ 16.8 billion (US$ 5.09 billion – same rate) was originated from the Federal Government.

There are three alternatives to achieve the universalization of energy access: (i) investment in power grid extension, connecting the countryside to the National Interconnected System (SIN); (ii) the creation of isolated generation systems with isolated networks which may contemplate small hydropower sources, diesel thermal power plants, biomass thermal power plants, wind farms, photovoltaic or hybrid systems combining more than one technology, or individual generation systems for individual consumption without network.

This means that, if the power utility companies are not able to extend the power network (either due the unfeasibility or inaccessibility); they are compelled to make energy access available through isolated or individual systems to the inhabitants of rural areas. Given that, we′re faced with a possibility to use clean and renewable energy matrixes. The quality in providing public services and the sustainability of the implementation of these systems by ensuring economic and energy efficiency must be observed[60]. Part of the maintenance costs of these systems in remote areas (which is usually more expensive than the interconnected system) is transferred to the regulated market, reaching the entirety of energy consumers. The legislation allows isolated systems to connect with the SIN in the future[61]. For informational purposes, the communities located in border regions can connect with the power network system from other border countries if it is more feasible. This possibility has been fulfilled mainly in the Amazon region.

The Light for All Programme has successfully contributed to the energy access in Brazil. According to the Geographic and Statistics Brazilian Institute (IBGE), in 2010, Brazil reached the level of 98.73% of households with access to electricity in urban and rural areas (in the interconnected system), a great evolution when compared to 74.90%, in 1981 and 94.54%, in 2000[62]. The federal

[60] BRASIL. **Decreto Federal nº 7.246, de 28 de Julho de 2010.** Available at: <http://www.planalto.gov.br/ccivil_03/_Ato2007-2010/2010/Decreto/D7246.htm>. Access: 25 July 2016.

[61] BRASIL. **Decreto Federal nº 7.246, de 28 de Julho de 2010.**

[62] COELHO; GOLDEMBERG, op. cit., p. 1092.

government announced that, since its launching, the Programme has helped approximately 3.2 million families, representing more than 15 million rural residents. More than 35.000 indigenous families and 29.000 *quilombolas* left darkness behind. A satisfaction survey applied in 2013 among the beneficiaries showed 92.9% had improved in quality of life. The great benefits were mainly the possibility of improving school activities at night and facilitating access to health centers, installed due to the program. It is estimated that over 400.000 jobs were created. The electrical appliances purchases would have injected more than R$ 7.2 billion in the Brazilian economy. The forecast for the next years is to provide the service for over 207.000 families, about 1 million inhabitants[63].

The Social Tariff Programme framework is an aspect that needs to be highlighted. As the overwhelming majority of inhabitants of isolated rural areas are low-income families, they will also be offered discounts on the tariffs, which reinforce the social character of the energy policies implemented in Brazil.

The Light for All Programme also promoted technological innovations. To reach the river islands in the Amazonas state, underwater cables were developed. Traditional concrete poles have been replaced by others made from polyester resin and glass fiber, reducing 90% of its weight to facilitate transportation to inaccessible locations. In the Amazon riverside communities, they were transported by canoe and in a helicopter in Serra do Cafundó, Ceará state.[64]

3. Viabilities for increasing energy access in Brazilian rural areas

Brazil still has great renewable energy potential to be exploited and extended to rural areas. Considering that hydropower has been the most important source in the past decades, the Brazilian government continues to invest heavily in this sector especially in the North region, facing energy security risks.

[63] MINISTÉRIO DE MINAS E ENERGIA. **Programa Luz Para Todos. Resultados.** Available at: <https://www.mme.gov.br/luzparatodos/Asp/o_programa.asp>. Access: 25 July 2016. MINISTÉRIO DE MINAS E ENERGIA. **Luz para Todos completa 12 anos com 15,6 milhões de brasileiros beneficiados.** Available at: <http://www.mme.gov.br/web/guest/pagina-inicial/outras-noticas/-/asset_publisher/32hLrOzMKwWb/content/luz-para-todos-completa-12-anos-com-15-6-milhoes-de-brasileiros-beneficiados. Access: 15 July 2016.

[64] Ibid.

However, hydropower cannot be seen as the only alternative. First, even being an important renewable energy source, environmental and social impacts such as ecosystem damages and forced displacement (mainly indigenous and *quilombola*), need to be measured better, especially when involving the construction of large hydropower plants. Article 231, paragraph 3, of the Brazilian Federal Constitution[65] provides that the "use of water resources, including energy potential" in indigenous lands can only be carried out after Congress approval and after a community hearing. Nevertheless, the Brazilian government hasn't complied with this constitutional provision. Another important aspect is the construction of power plants in environmental conservation units, creating technical and bureaucratic difficulties with the environmental licensing, given that the area delimitation of these units must be reformulated[66] by a specific law[67].

Second, in a climate change context with unpredictable rainfall variations which could harm the continuous energy supply, it is reckless to focus power generation only in the potential of the rivers. Third, there is no guarantee that isolated rural areas with difficult access will be connected to the regular power grid in order to benefit from such dams. Nonetheless, an interesting output involves a small-scale hydropower plant with reduced impact[68]. It is then necessary to take many possibilities into account simultaneously, considering the real scenario.

One alternative is to expand the use of biomass. This energy source is traditionally associated with the past (when wood was mainly used); it is only appearing in the background in developed countries. However, technological

65 BRASIL. **Constituição da República Federativa do Brasil de 1988.** Available at: <http://www.planalto.gov.br/ccivil_03/Constituicao/Constituicao.htm>. Access: 1 July 2016.

66 BRASIL. **Lei Federal nº 9.985, de 18 de julho de 2000.** Avaliable at: <http://www.planalto.gov.br/ccivil_03/leis/L9985.htm>. Access: 1 July 2016.

67 MAKISHI, André et al. op. cit., p. 124.

68 In July 2014, in the department of Quiché, Guatemala, the Latin American Energy Organization (OLADE) participated in the implementation of the initiative of the Community hydroelectric plant in Batzchocolá, municipality of Nabaj. The event was organized by the National Institute of Electrification (INDE) and the *Asociación Hidroelectrica de Desarrollo Integral Norte del Quiché* (ASHDINQUI), the last built by men and women in three communities: Batzchocolá, Laguna Batzchocolá the municipality of Nebaj and community Visiquichum the municipality of Chajul. The project is a microrede electrification system isolated and supplied by a micro-station hydroelectric power 90 kW, which will serve 160 users in three rural communities. ORGANIZACIÓN LATINOAMERICANA DE ENERGIA (OLADE). **Inauguración de Central Hidroeléctrica Comunitaria en Guatemala**. Available at: <http://www.olade.org/noticias/inauguracion-de-central-hidroelectrica-comunitaria-en-guatemala/?lang=pt-br>. Access: 13 July 2016.

advances allow biomass to be explored in an economically efficient way. Carbon dioxide emissions, which contribute to the greenhouse effect, are considered null in the biomass burning, since the plant absorbs the emissions by during its growth[69].

In rural areas, the forests maintenance and farm energy fields dedicated exclusively for growing biomass resources are considered possible. The proper management of forestry techniques, aiming at planned removal of mature trees and their seedling replacement, is important to avoid predatory deforestation and to ensure the greatest amount of carbon sequestration[70]. As an example, the sugarcane use has been promising. It is estimated that the production will grow up to 65% by 2050 in Brazil[71]. In this field, technology investment is necessary, since the mechanical harvesting of sugarcane avoids burning the field due to manual harvesting (an extremely harmful practice to the environment) and enables greater use of its components (such as straw)[72]. Thanks to state legislations, in the South-Central region, currently 90% of the sugarcane is harvested mechanically[73].

Increasing the extraction of vegetable oil from the flora available in rural areas in multiple regions of the country is also beneficial. In this case, investment in agricultural research will allow economic viable cultivation and management of biomass large-scale production. Finally, the use of plant and animal residues produced in the Brazilian agribusiness as biomass is presented as a compulsory alternative to the expansion of power generation in the country, especially in high energy activity regions. It is necessary to minimize the waste of the residual biomass, focusing on logistical and technological solutions enabling the collection of the residues disposed in the rural properties to be used by power plants. A solution to small properties is to develop cooperatives to jointly exploit the energy potential of residual biomass[74].

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69 GENOVESE; UDAETA; GALVÃO. op. cit., p. 01-02.

70 BRASIL. AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA (ANEEL). **Atlas de Energia Elétrica do Brasil**, p. 73.

71 COELHO, Daniel Kuhner et al. op. cit., p. 165.

72 The idea is to invest in techniques and processes which increase the productivity of the biomass reducing the need for growth planted areas. Currently, Brazil has the capacity to produce 6,800 liters of ethanol per hectare planted, while in the US, the ratio is 3,100 liters per hectare for the production of ethanol from corn. AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA (ANEEL). **Atlas de Energia Elétrica do Brasil**, p. 74.

73 COELHO, Daniel Kuhner et al. op. cit., p. 140.

74 COELHO, Daniel Kuhner et al., p. 220.

As seen in the first chapter, Brazil has great potential regarding the use of wind and solar energy, due to the high incidence of winds and solar radiation. These energy forms can clearly be used in the rural environment. An interesting feature of wind power which deserves to be highlighted is its operation. It can be performed simultaneously with other land uses such as agriculture and livestock. The wind power investors also offer an economic and social benefit to the region. The negative aspects of wind power for rural areas is based on the fact the great wind potential is concentrated along the Brazilian coast, away from consuming centers and other rural areas, needing network transmission. The logistics for transporting wind turbines and their components is also a challenge for isolated locations[75].

Regarding solar energy, almost all Brazilian territory is eligible for great use of this resource, consisting in an annual global horizontal irradiation between 1,500 and 2,200 kWh/m². In Germany, for comparison, one of the countries with largest photovoltaic installed capacity, irradiation features between 900 and 1,250 kWh/m²[76].

The Amazon region is considered the last frontier (the last mile) for universal energy access in Brazil. The challenges to reaching potential users of electricity not connected to the power grid (off-grid) are physical and financial. Today, multiple isolated communities use inefficient, expensive and polluting diesel generators. The power utility companies don´t have such a significant role in the Amazon, providing electricity to about 62% (2.4 million people) of rural consumers; 14% (550,000 people) of the rural population is supplied by other forms and 24% (930,000 people) have no access at all. This led to the creation of new organizations in order to provide power for at least 4 to 5 hours a day in remote and isolated regions. However, local supply standards are far below the national minimum standards[77].

Most off-grid systems are based on fossil fuels, creating high dependence on fuel import, and are vulnerable to fuel cost volatility and freight cost, besides harming the environment. Modern solutions in this kind of small-scale generation are currently more viable through energy generating technologies

75 SOUZA, Gustavo Brandão Haydt et al. op. cit., p. 289.

76 KONZEN, Gabriel et al. op. cit., p. 331.

77 GÓMEZ, Maria F; SILVEIRA, Semida. The Last Mile in the Brazilian Amazon – A Potential Pathway for Universal Electricity Access. **Energy Policy**, v. 82, p. 23-37, 2015, p. 26-27.

from renewable sources and hybrid systems, which offer advantages in application in isolated areas. Factors such as reliability, flexibility, simplicity, environmental benefits and low maintenance costs are the main attractions in the use of these solutions. A mix of different kinds of power generators could be the first step towards ensuring energy security to these remote areas[78].

Another possibility is to check (diligence) local resources to be used for power generation in the remote region. The Amazon has a potential feature set, such as hydropower plants, wind, biomass and solar radiation. Except for hydropower plants, no other alternative has been widely used in the Brazilian Amazon[79]. The use of hydropower on a large scale in the region entails, however, the problems mentioned above.

The proposal to reach the last mile of universal energy access in Brazil is establishing an institutional and technical framework, to create the foundations of a new environment where cooperation could lead to develop the isolated regions with a more integrated power generation and consumption and improving the Light for All Programme. It should be noted that the participation of the local community is essential to the successful implementation of isolated systems, acting as a catalyst for building a local scenario to carry and operate off-grid[80] solutions. Facing operational difficulties, the use of wind energy and biomass in the Amazon region might not be a good option due to obstacles in transporting the wind turbines to remote areas and the deforestation risk as the result of the biomass acquisition. One highly recommended solution is the investment in photovoltaic generation in the Amazon. This source may be sufficient for basic needs such as lightning and water pumping, since there are no intensive productive activities in the region needing power generation of great capacity[81].

In general, the Light for All Programme should be perceived positively because it was able to expand energy access in Brazilian rural areas. However, there are barriers to be overcome. Maria Cristina Fedrizzi points out the difficulty in providing energy access in Brazil, highlighting that "regardless of the technology employed, one of the major problems of rural electrification,

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78 GÓMEZ; SILVEIRA. op. cit., p. 27.

79 Ibid., loc. cit.

80 GÓMEZ; SILVEIRA, op. cit., p. 34-35.

81 COELHO; GOLDEMBERG, op. cit., p. 1094.

if not the largest, is the dispersion of the population; therefore, the difficulties are greater when the isolated places are more remote and inaccessible with low population density." The means most used today for power generation in remote areas are generators using oil derivatives such as diesel, even with difficulties for transportation and the high cost of the product. Interestingly, in these cases, much of the power generated is used for pumping water[82].

Ribeiro *et al*. claims that, since public services such as electricity are made available to the community, "those who left and live in precarious situations in cities tend to come back because they realize the place where they lived is better."[83] In fact, the program Light for All provided the return to rural areas a large number of families. On the other hand, the authors enumerate elements resulting from practical case studies which obstruct the isolated systems implementation, such as "barriers created by the community", such as (i) cultural and social, (ii) psychological (perception of the novelty and expectations), (iii) economic (social inclusion and income generation), (iv) demand and expectation (power supplied should be similar to the conventional network, generating the same level of satisfaction among consumers). "Barriers experienced by the community" were identified as (i) geographical or natural, (ii) hard access areas as located in Environmental Conservation Units; "institutional barriers" were also identified, when due to the lack of political will or economic infeasibility it wasn't possible to provide access to essential services to isolated populations[84].

Fedrizzi highlights difficulties in implementing systems in rural areas, like the use of low-quality equipment; in other words, there is no point in investing in high quality and efficient photovoltaic panels if other components such as tanks, pipes, wiring, wells and even equipment installation aren't durable and/or suitable, which often discredits to the photovoltaic system[85].

Another difficulty approaching the local culture when implementing systems in isolated communities, like mentioned above. Regardless of the

[82] FEDRIZZI, Maria Cristina. Sistemas fotovoltaicos de abastecimento de água para uso comunitário: lições apreendidas e procedimentos para potencializar sua difusão. 2003. 174p. Programa Interunidades de Pós-Graduação em Energia da Universidade de São Paulo, São Paulo, 2003. p. 43.

[83] RIBEIRO, Tina Bimestre Selles; ZILLES, Roberto, RIBEIRO, Rosaura de Menezes Selles; RIBEIRO, Fernando Selles, implementação de sistemas fotovoltaicos em comunidades isoladas: reflexões sobre entraves encontrados, **Revista Brasileira de Energia**, v. 19, n. 1, 1º Sem. 2013, pp. 269-283.

[84] RIBEIRO, op. cit., pp. 269-283.

[85] FEDRIZZI, op. cit., p. 43-44.

technology used, intrinsic issues of population dynamics should be considered, and the local culture must be respected in the multiple phases of the projects like design, implementation and maintenance, even when not very advanced. The equipment maintenance and assistance in a continent-sized country is costly, time consuming and complex, making it crucial to adopt robust equipment and local structure able to manage and provide basic technical assistance, or risk turning the system ineffective[86].

Multiple benefits were identified: the increase in electrical and mechanical industrial equipment (as home appliance industry), tax income, migration to modern energy sources (wood x electricity), increase of agricultural productivity, job creation, rural income increase, reduction of social inequality, improved education, reduction of rural exodus, reduction of oil imports, among others. The negative impacts emerge when strategies for energy access do not consider local aspects, such as social diversity, ecosystem, sources and local resources availability and harmful practices to the environment, whether arising from the poor implementation of the projects, inefficient generation systems with high emission levels or even in the inefficient power use to irrigation, broadening the range of pesticides, among others.[87]

An interesting example was the experiment conducted in the rural area of Botucatu municipality in São Paulo state, with a wind-photovoltaic hybrid generator. It was found that there was complementarity between wind power and the solar incidence on the photovoltaic panel of the wind-photovoltaic hybrid system in most of the period. The overall solar values were 25 times higher than the wind power available. For this reason, the solar radiation was the energy source which most contributed to the total amount of energy available for the hybrid system[88]. This supports the need for local factor analysis before a implementing a system, because depending on the geographical coordinates and the availability of natural resources, solar power may be

86 FEDRIZZI, op. cit., p. 102.

87 GUSMAO, Marcos Vinícius, PIRES, Sílvia Helena, GIANNINI, Marcio et al. O programa de eletrificação rural "Luz no Campo": resultados iniciais. In: **Encontro de Energia no Meio Rural**, 4., 2002, Campinas. Proceedings online. Available at: <http://www.proceedings.scielo.br/scielo.php?script=sci_arttext&pid=MSC0000000022002000200035&lng=en&nrm=abn>. Access: 20 July 2016.

88 SIQUEIRA, Jair Antonio Cruz; SERAPHIM, Odivaldo José. Comportamento da energia solar e eólica em um sistema híbrido de pequeno porte para energização rural, **Revista Energia na Agricultura**, Botucatu, vol. 22, n.2, 2007, p.38-50.

lower or there might not be enough wind. This should create a better viable alternative to ensure continuity and quality in providing the service.

An interesting point is that a poorly conducted electrification process can aggravate and increase economic inequality in the countryside, allowing that groups with potential energy access earn economic profits faster than other groups without it, enabling them to acquire small properties nearby considering its future prospect of real state appreciation[89].

Conclusion

The universal scope of access to clean energy is a challenge that must be faced constantly. There is no doubt that the current technologies and accumulated scientific knowledge allow us to state that it is possible to provide electricity to isolated and rural communities indiscriminately. The role of the government, along with the private sector, could enable the implementation of clean generators in remote areas or isolated systems. However, requirements such as planning, analysis of local natural resources, types of generators, cooperation and integration with the community and proper guidance and assistance to local populations are factors that should be considered for any concrete initiative.

The Light for All Programme already provides the legal and economic basis to promote these initiatives but is in need of improvement, including, in practice, the local analysis of natural resources to mitigate eventual environmental damage. Harnessing renewable resources in isolated areas make the community more autonomous by enabling energy security through a continuous and qualitative energy supply. In this context, small scale hydroelectric plants, use of biomass (dedicated and residual) and the exploitation of wind and solar energy resources are the suggested options to the Brazilian rural or isolated areas. Each case must be particularly analyzed to identify the best viable solution, always considering the socioeconomic and environmental tripod base of sustainable development.

Lastly, the Brazilian Amazon region was identified as the place with the biggest challenges to energy access expansion. The government should

89 GUSMÃO et al. op. cit.

plan cautiously as to avoid irreversible environmental and social damages. Therefore, the exploitation of the different renewable sources on a smaller scale and in a coordinated manner to produce the least possible impact is highly recommended. Due to the obstacles caused by the inaccessibility to these sites, it is strongly suggested that solar energy generation is used.

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