http://dx.doi.org/10.5902/2236117034211
Revista do Centro do Ciências Naturais e Exatas - UFSM, Santa Maria
Revista Eletrônica em Gestão, Educação e Tecnologia Ambiental - REGET
e-ISSN 2236 1170 - V. 22, e10, 2018, p.01-15

REGET/UFSM
Revista Eletrônica em Gestão, Educação e Tecnologia Ambiental

Sustainable energy public policies planning: encouraging the production and use of renewable energies

Planejamento e políticas públicas de sustentabilidade energética: incentivo à produção e uso de energias renováveis

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Abstract

This work analyses the model of energy production and the use of renewable energy in Brazil with a sustainable development point of view. In this regard, it is pointed out the production of renewable energy as an alternative solution to reduce expenses costs through initial investment in the implementation of an own energy generation model towards sustainability. The diversification of the energy matrix with clean and renewable sources in substitution of the energy model based on fossil energy sources, besides being environmentally correct, has a relevant national importance. In the methodological scope, it is rational to leave this writing as a theoretical study, a qualitative approach and a technical bibliographic procedure. Some results, a priori, indicate that the use of alternative sources minimizes the consumption of conventional energy sources, which generates large degradation to the environment. Many of these alternative sources are plentiful in the country. Finally, we present some public policies that the Federal Government is implementing in Higher Education Federal Institutions (IFES) for the incentive and use of renewable energies.

Keywords*: Planning; Energy Sustainability; Public Policy; Renewable Energy; IFES*

Resumo

Este estudo tem por objetivo analisar o modelo de produção energética e o uso de energias renováveis no Brasil com vistas ao desenvolvimento sustentável. Neste sentido, aponta-se a produção de energias renováveis como solução alternativa para redução das despesas de custeio mediante investimento inicial na implantação de um modelo de geração própria de energia visando à sustentabilidade. A diversificação da matriz energética com fontes limpas e renováveis em substituição ao modelo energético baseado em fontes de energias fósseis, além de ambientalmente correto, possui uma relevante importância nacional. No âmbito metodológico é racional deixar posto que está escrita se trata de um estudo teórico, de abordagem qualitativa e de procedimento técnico bibliográfico. Alguns resultados, a priori, indicam que o uso de fontes alternativas minimiza o consumo das fontes energéticas convencionais, que geram grandes degradações no meio ambiente. Muitas destas fontes alternativas são abundantes no país. Por fim, apresentam-se algumas políticas públicas que o Governo Federal está implantando nas Instituições Federais de Ensino Superior (IFES) para o incentivo e uso das energias renováveis.

Palavras-chave*: Planejamento; Sustentabilidade Energética; Políticas Públicas; Energias Renováveis; IFES*

Recebido em: 08.08.18 Aceito em: 02.09.18

1 Introduce

The civil construction sector in Brazil is known for being one of the biggest energy consumers, environmental prejudice generators and consequently responsible for many natural resources collapse problems.

According to the Brazilian Association of Refrigeration, Air Conditioning, Ventilation and Heating (ABRAVA, 2016), the real state sector is responsible for the consumption of 21% of treated water, 41% of generated electricity, which produces 65% of waste and 25% of CO_2 emissions.

A significant amount of the consumed energy in a building, despite its purpose, comes from its lifespan period indicating the need for a well-planned construction project and a sustainable and rational system to support its own consumption (AGOPYAN; JOHN, 2011).

According to Brazilian's Article 225 of the Federal Constitution of 1988, every Brazilian citizen should be entitled of an ecologically balanced environment, a common right and crucial condition to people's well-being, and thus, it is the Public Authority and Collective Society's duty to defend and preserve them for the sake of future generations.

The Inter-ministerial Ordinance 244 of June 6, 2012 instituted the Sustainable Esplanade Project (PES, in Portuguese) with the main objective of integrating actions, which aims the increase of efficiency in the rational utilization of public resources and the insertion of the socio-environmental. The environmental variable in the workplace contributes to the great relevance in the continuous and improved pursuit of actions of responsible and sustainable development of institutions and public sectors.

Although there is a considerable number of studies and statistics produced by the most diverse organisms, from private and public sectors in the country, Higher Education Institutions lack diagnostic precise information which gives accountability of transformations occurring in the last couple of years in this field of life and society. This fact represents important transformations, especially realized in the last decades, which are related in general, to the new processes and relationships coming from environmental impacts, the sustainable techno-scientific development, the deepening of the global warming and the impacts of public policies implemented in the country for the educational sector.

In face of this reality, the federal government, public authorities in the most varied spheres as well as society itself are called upon to be transformational agents in the energy policy of the country in order to establish, as priority, strategies for the implementation and development of actions and public policies of stimulus and use of renewable energy.

Public administrators as socio-environmental agents should think of institutional sustainability development, on a daily basis, as well as the need and relevance of exposing various viable practices in the work place, which, in turn, will result in socio-environmental benefits of a local policy.

Thus, this work aims to identify the challenges and opportunities to using renewable energy sources towards energetic sustainability, pointing out the underrated natural resources poorly used in Brazil, which could generate an alternative solution for technological development and energy production.

The paper reviews a series of studies to support and implement strategic actions or public policies that stimulate the use of renewable energy sources for specific programs and projects that provide elements for designing new interventions or improving ongoing policies and programs even as part of reports of public accountability in Higher Education Institutions (FARIA, 2005).

2 Brazil's sustainable scenario

Worldwide, the discussion over the preservation of the world's natural resources seems to be everyday more increasing. Nevertheless, this discussion will not become real or effective actions. In addition, it seems that the consensus that human beings have used natural resources throughout its evolution in irrational ways, which led us to significant damage to our planet, is slowly developing, therefore, needs rethinking.

The Developmental, Industrial and External Commerce Ministry (MDIC, 2015). Shows that, overall, the internal energy supply (OIE, in Portuguese) comes mainly from fossil sources.

Burke and Ornstein point out the problem of this practice associated to the short-term results aim, without taking into account the long-term costs. The authors call attention for the steps taken by human beings development along its history where, never, damage or risks are predicted. Still, each action interferes in the way humanity relates to nature. As a result, todays environmental damage is real and highlights the need for individual initiatives, which, in turn, should reflect joined actions towards the reversion and deceleration of all environmental degradation process (BURKE; ORNSTEIN, 1999).

In many countries, like in Brazil, the civil construction industry continues to negatively interfere in the environment, as it is known for being "one of the most natural resource consuming sectors and generating great amounts of waste, from the production of used inputs, the construction work and its own use" CBCS (2013).

In Brazil, construction work is still done in the same way, with similar materials and same technology as it has been done for decades, with low construction reasoning, savings and energy exploitation, whereas with high waste generation. Much of this is due to the number of unlicensed professionals that build informal constructions. In addition, the lack of technical instruction and level of education most of the work force has, interfere in the proper way to conduct and perform correct techniques and technologies.

In the other hand, we also observe that the archaic model of construction mentioned by several researchers, also do not consider any means of sustainability or energy efficiency that could minimize or mitigate the environmental impacts. Point out that market mechanisms interfere in the work development and low energetic performance, resulting in high environmental impact buildings and low energetic performance, which endures throughout the building's lifetime (DORIGO et al., 2009). Therefore, it is clear that there is an urgent need for change in the way construction work is conducted in Brazil, adopting new technologies to generate more effective constructions and benefits to the ones that already exist.

A rising concern about the scarcity of traditional energy sources is present when considering the way buildings are made. The propagation of "green" buildings is a step toward this paradigm shift. The use of renewable energy in the construction work is still a high cost for business owners compared to conventional energy systems, and thus, represents a fair obstacle for the dissemination of that kind of energy systems.

Considering only the technological aspect, the advancing potential is great, such as cutting-edge material engineering and systems projects, allowing buildings that are more efficient with constructive rationality, therefore, creating sustainable environments, ecologically driven and with low energy consumption.

The challenge faced is to reduce costs to providing these new technologies whereas a great number of obstacles are met, such as the lack of information and fractioned incentives to consumers' preference for unsustainable products. These are some of the reasons why the adoption of new technologies is restrained.

3 Brazil's energetic sector

3.1 The Brazilian Energy Model

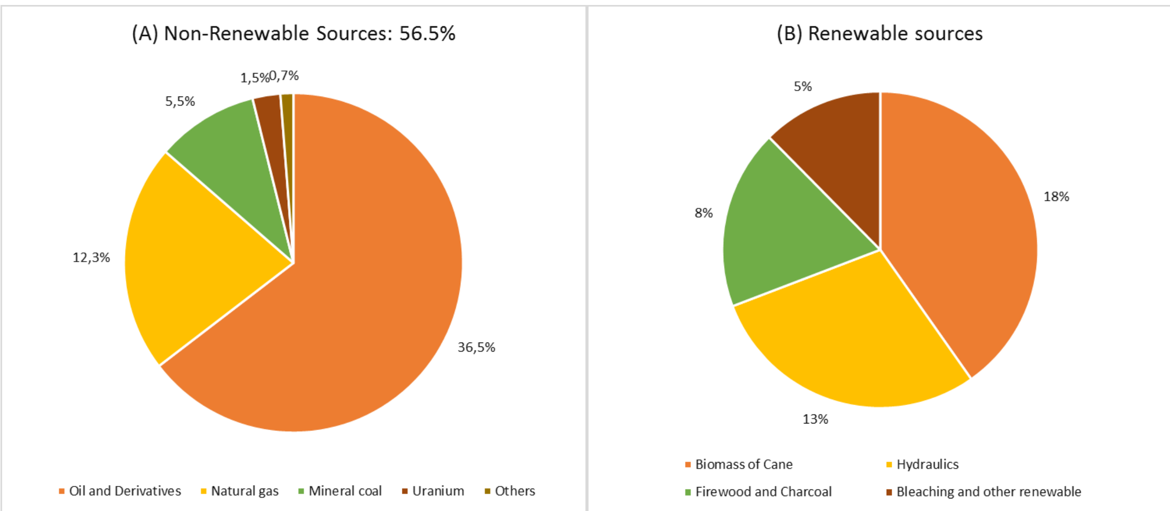
The newest global achievement is resumed to the search for self-sufficiency in energy generation, allied to the diversification of the energy matrix, that is, the search for various alternative energy sources that are able to fulfill worldwide countries' internal demands, in case of scarcity of fossil fuels (PACHECO, 2006).

This diversification should also bring more safety in the offering of energy without undergoing market's pushed input prices or climate adversities. It is, therefore, urgent the need to invest in the field of fuel and energy generation, even though there would not probably be enough government resources to do it so.

According to the Industrial and Commerce Development Ministry (MDIC, 2015) in the BRIC countries (Brazil, Russia, India and China) mineral coal is responsible for half of the energy matrix, followed by oil, responsible for 20% of all energy produced in the four mentioned countries. Among these four countries, Brazil is the far most renewable energy generator. While the production of renewable energy worldwide represents 13%, in the BRIC it is 15%, and Brazil accounts for 46% of that production. The hydroelectric energy matrix only, surpasses 82.5% of all energy produced in Brazil. Still, only 30% of the hydroelectric potential in the country has been explored. We concentrate 12% of all consuming hydro resources (from fresh water) available and 10% of the hydroelectric potential worldwide. We are also responsible for 7.2% of all renewable energy generation with the biggest fresh water reserve in the planet.

Nowadays, energy dependence in all sectors of Brazilian society is increasing and increasing, and as we seek to meet this energy demand, there has been an increase in the environmental damage caused by the emission of polluting gases into the atmosphere. In 2016, the total of anthropogenic emissions associated to the Brazilian energy matrix reached 428.95 million tons of carbon dioxide equivalent (Mt CO_2-eq), the majority (194.3 Mt CO_2-eq) generated in the transportation sector (BRAZIL, 2017). This occurs mainly because in the Brazilian energy matrix there is a predominance of non-renewable sources as can be seen in Figure 1 (A) and (B).

Figure 1- Power supply in the Brazil: (A) non-renewable sources e and (B) Renewable sources



Source: Adapted from BRASIL (2017)

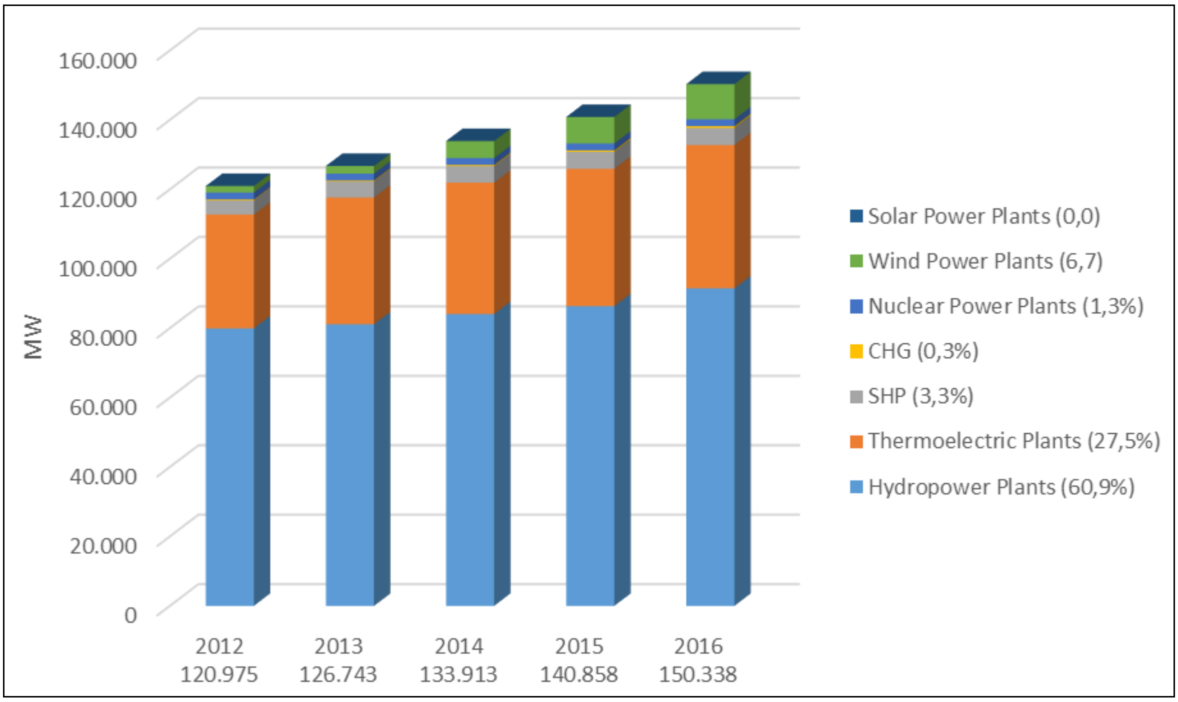
According to the national energy balance of 2017, Brazil's domestic energy supply was mostly from non-renewable sources, with oil and its derivatives predominating, followed by natural gas and coal, reaching 56.5% of the supply this is worrying in view of the scarcity and lack of renewability of these resources. The supply of energy from renewable sources was 43.5%, which prevailed the biomass of sugarcane, followed by hydroelectric power, firewood and charcoal, and lastly the bleach and other renewable (BRASIL, 2017).

Considering that renewable energy is all that coming from a source that is naturally renewable in a cyclical way, in human time scale, there are several renewable energy sources available today, among which are: waters, sunlight, winds, tidal waves and biomass (BLUE SOL ENERGIA SOLAR, 2018).

Despite all the discussion above, the implementation of hydroelectric stations brings several environmental impacts, such as: the flood of the proximities, the rise of rivers' level and the shift of its natural course, which produces damage to the flora and fauna modifying ecological systems of local species. In addition, The Water Code 1934 states that the hydro electrical energy use should account for the needs and food supply for its riverside population, the public wellbeing, the river's navigation, irrigation, the caution for flood, conservation and free circulation of the fish and draining of water rejections (BRASIL, 1934).

According to Figure 2 of the "Anuria Statistic de Energia Electrical" (2017), the installed capacity for electric generation in Brazil in 2016 reached close to 150,000 MW and compared to 2012, there was an increase of about 24.2%. The representation of the energy matrix in other renewable energies such as; wind power, hydroelectric generating stations (CGH) and small hydroelectric plants (SHPs), obtained a discrete representation over the five years in the matrix, but in the last year there was a notable increase in wind power sources, which totaled 6.7 percentage points. On the other hand, hydroelectric plants maintained a considerable representation between 2012 and 2016, and in 2016, their share represented approximately 60.9% of all installed capacity in the country. It can also be seen in figure 2 that there was an increase in the representation of the thermoelectric power plants in the country, accounting for about 27.5% of the total amount of installed capacity in Brazil.

Figure 2 - Brazil Eletricity Generation Installed Capacity (MW)



Source: Adapted from Statistical Yearbook of Electrical Energy (2017)

The change of the draining common behavior of the rivers' basins that produce energy, or the change in the probability of external events to happen (storms or severe dries) may jeopardize the station's operation in the hydroelectric systems in Brazil.

3.2 The Future for Brazil's Energy Matrix

Energy is one of the drivers of a country's economic growth by creating new job openings, improving productivity, service delivery, enhancing the private sector and therefore pushing the development and life quality of its population.

The initiatives for the adoption of energy efficiency in public institutions has been getting much attention from many countries for its relevance in contributing for the reduction of emissions that affect the climate or even for its strategic technological role in companies in sectors everyday more competitive and global.

The search for energy efficiency in the public sector has a fundamental role for public policy, as an example to be fallowed and as an influencer on the market. In addition, furthermost, it shows society government's consistency between speech and actions.

Barroso Neto (2010) says the viable way for Brazil to reach a reliable energy safety situation is through the investment on generation and transmission of energy efforts, by the construction of new hydroelectric and nuclear stations or in the development of alternative sources of renewable energy.

From the energy planning point of view, the National Energy Plan (PNE, in Portuguese, 2030), put together by the Energy Research Enterprises (EPE, in Portuguese), which states that in the long term, the use of different sources of energy would be a viable solution for the safety of the national electricity supply, considering the availability of resources found in Brazil.

The Alternative Electric Energy Sources Program (PROINFA, in Portuguese) has the goal to increase the electric energy production through Eolic, biomass and small hydroelectric centers (PCH, in Portuguese) sources, promoting diversification in the Brazilian energy matrix and alternatives for the energy supply not mentioning the appreciation of local characteristics and potentials.

PROINFA will implement 144 energy stations with 3.3 GW of capacity, where 1.2 GW are PCHs, 1.4 GW of eolic stations and 685 MW from biomass source. In a little more than 3 years, Brazil has passed from 22 MW of eolic energy installed to its actual 414 MW.

In this context, the northeast of Brazil is highlighted for its solar, Eolic and biomass potential, among others, which favors the rise of autonomous energy generation systems, through the efficient use of these renewable sources. The economic growth requires an increase in the country's energy supply, which leads to the search for alternative, economic and sustainable technologies viable in the short term.

4 Sustainable energy

This century is marked by the need to transition toward a future with sustainable energy. To reach this goal it is necessary the change of the way energy is supplied and used.

The industrialization and development processes require energy. The demand for more energy should rise in the next couple of years, due in part to the global population's exponential growth (MANZANO-AGUGLIARO et al., 2013). Around 16% of the global population does not have access to electricity and we are highly dependent on fossil fuel to supply our basic energy needs, like lighting. That may cause poverty and development barriers (ZUBI et al., 2017).

The available resources in the planet are being disposed in a generalized way, where more than 80% of the world's primary economy depends on fossil fuel to generate energy and as a result, comes the environmental impacts, which produce the greenhouse effects. According to the International Energy Agency's estimates, there will be a rise of 53% on the consumption of energy worldwide until 2030; thus, the safety of the population's energy supply depends on the substitution of energy derived from fossil fuel to sustainable sources (STAMBOULI et al., 2012).

With the growing number of the world's population, advance of technologies and the economic growth, there will be an increase of the demand for energy in order to sustain our life styles. The use of fossil fuel causes a series of environmental problems such as climate change, global warming, air pollution and acid rain (PENG; YANG, 2013). Therefore, it is urgent the development of sustainable energy technologies that are able to deal with political, economic and environmental issues that involves electricity generation. The rise of such energy sources in the last couple of years have pushed in great part researchers, political and world leaders' interest to understand the viability of new energy sources (KIM et al., 2014).

The use of alternative sources of energy also minimizes the consumption of conventional energy sources that are devastating to the environment. Many of these alternative sources of energy are known as "clean" energy, nonpolluting, characterized as "renewable", when its origin comes from recomposed and inexhaustible means. The use of such clean and renewable energy sources represents ways to reduce the impact caused by human beings, and with energy sufficiency focus, may be seen as a sustainable engineering strategy to the construction of buildings that guarantee the environmental comfort to its users by using energy in an efficient way, minimizing the environmental damage. This potential is clearly reflected in Table 1, which shows the estimated theoretical, technical and economic potential of different renewable energy resources, with a total technical potential of about 85 TW (BLANCO et al., 2009).

Table 1 - Yearly estimated potential of different renewable energies (1 TW = continuous power production of 1 TW during the year = 8760 TWh = 31.53 exajoules). Total primary energy consumption in 2005 = 15.18 TW

Renewable energy sources	Gross theoretical useful potential	Technically feasible potential	Current economic potential	Total installed capacity (2003)
Biomass	8–14 TW	6–8 TW	No data[a]	1.6 TW
Hydraulic	4.6 TW	1.6TW	0.8	0.65 TW
Geothermal	66 TW	11.6TW	0.6 TW	0.054 TW
Wind	20 TW	2TW	0.6TW	0.006 TW
Solar	600 TW	60TW	0.15–7.3 TW	0.005 TW
Ocean	234 TW	No data	No data	-
Total	1030 TW (approximately)	85 TW (approximately)	7 TW (approximately)	2.3 TW (approximately)

[a] Water availability may become an important limiting factor
Source: BLANCO et al. (2009)

Renewable energy sources have great potential to play an important role in the future of the world (DEMIRBAS, 2000). Renewable energy sources can be used to produce energy to subtract the energy generated by hydropower. These energy sources include solar energy, wind energy, geothermal energy, marine energy, biomass energy, biofuels and more. Renewable energy sources have the capacity to provide energy free of atmospheric pollutants and greenhouse gases (HUSSAIN et al., 2017).

Recently, renewable energy sources supply about 23.7% of the total world energy demand (REN21, 2019) which was 2% in 1998 including seven exajoules of modern biomass, and two exajoules of all other renewable sources (UNDP, 2000).

According to data from an article in Galileu's publication (GALILEU, 2016) each m² of a solar collector installed generates a 55 kg economy of liquefied fuel gas (GLP in Portuguese) a year or 66 liters of diesel a year or it can even avoid the flood of 56 m² to generate electric energy and can also eliminate 215 kg of wood burned.

Also, according the work entitled 'Lighting the way: Toward a sustainable energy future' (COUNCIL, 2007) the concept of sustainable energy covers not just the inevitable need to guarantee adequate energy supply, but also, it should do so in a way that:

(a) is compatible to the preservation of essential natural systems fundamental integrity, including the prevention for catastrophic climate change;

(b) extends the basic energy supply to more than 2 billion people around the world which are still restrained from energy access and;

(c) Reduces the risk of safety issues and geopolitical conflicts due to rising competition of energy resources randomly distributed (GALILEU, 2016).

Another vigorous debate on a regional, national and international level, predicted for the next decades is energy's safety. Defined as adequate energy supply access, when necessary, in a necessary way and at accessible prices; energy's safety is a central priority to all concerned nations that are interested in promoting a healthy economic growth as well as the internal and external stability.

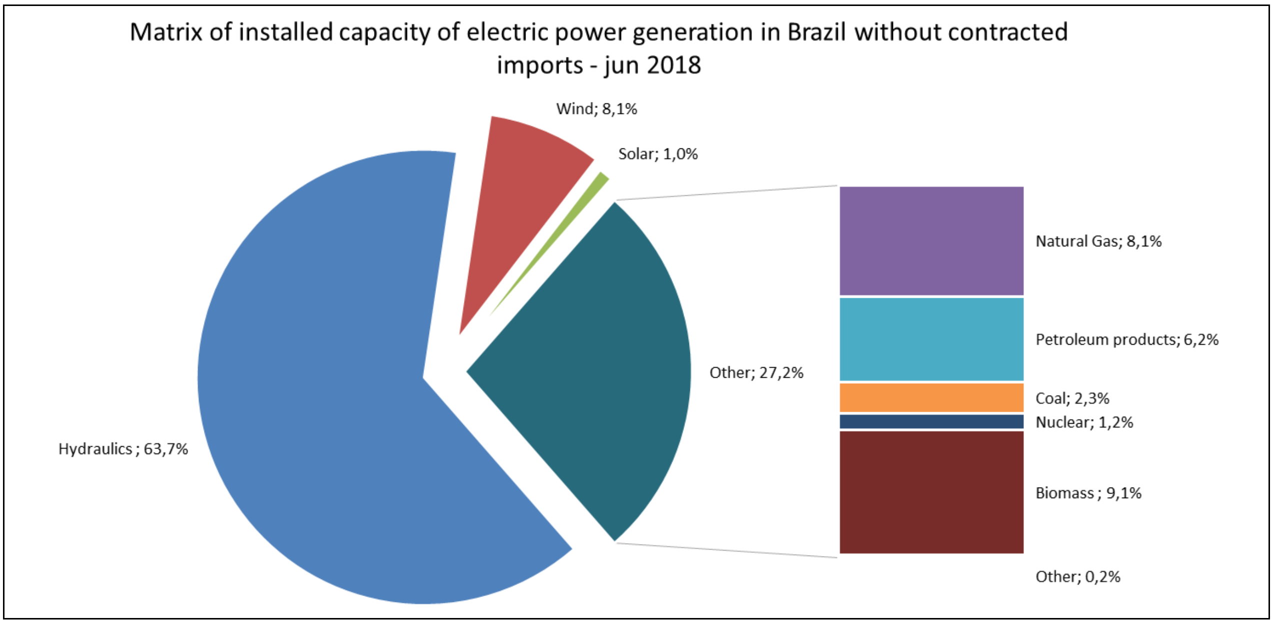
Promoting the diversification of its energy matrix is strategic for Brazil, contributing to energy security and enhancing regional potential. Efficient and safe energy supply is essential for maintaining the pace of economic growth experienced by the country, while the universalization of access to energy contributes directly to poverty reduction and social inclusion (MDIC, 2015).

In addition, it is observed that Brazil has a large multiplicity of available energy sources with developmental disposition in all (see Figure 3). The energy generation base in Brazil is largely consisted of renewable sources, mostly represented by hydroelectric generation, which is estimated at 63.7% of the total generation of energy produced in the country. Other sources include 27.2%; natural gas contributes 8.1%, biomass 9.1%, followed by coal 2.3%, and nuclear 1.2% and petroleum derivatives 6.2%. The remaining 0.2% is from other sources with little representativeness in the current energy matrix. It should be taken into account that generation by wind and solar energy equals 9.1% of the country's energy generation. This represents that renewable sources accounted for 81.9% of the installed capacity of Brazilian electricity generation in April 2018 (Hydraulics + Biomass + Wind + Solar) and non-renewable sources were equivalent to 18.1% in the same period (natural gas , petroleum, coal, nuclear, thermal and others) (MME, 2018).

However, Bronzatti and Iarozinski Neto (2008) argue that there is a need to plan and execute short- and medium-term investments in exploration, production and distribution. In the long term, investments are needed in technology and materials engineering for the production of clean energy generation equipment (wind and solar) at competitive costs, as well as the execution of efficient projects that can provide energy to a low cost.

Faced with the increasing population and consumption of fossil fuels, it is necessary to adopt a system of production of energy that is totally and partially clean, representing solutions to the increasing global energy demand aiming at minimizing the negative impacts on the environment among such solutions those based on inexhaustible sources of energy such as solar, biomass and wind, which gradually increases due to the environmental awareness of the people as the economy that leads to a better financial and energy use (KEMERICH et al., 2016).

Figure 3 - Matrix of installed capacity of electric power generation in Brazil without contracted imports – Jun/2018



Source: Adapted from Monthly Bulletin of the Brazilian Electric System Monitoring – jun/2018, MME (2018)

4.1 Eolic Energy

Eolic energy is been around for over 3000 years. Initially, its use was restrained to move sailboats, refrigerate houses, move machines used in the field and at small production installations. In the end of 1800 and beginning of 1900, the conversion of eolic energy to electric energy marked a shifting point to the eolic energy industry. Due to crises and political and social changes, eolic turbines were spread all over the world, even though eolic energy is far from reaching its exploitation potential (ALLAEI; ANDREOPOULOS, 2014). State that eolic energy's market represents the most developed among other alternative energy sources, with a 40% annual growth worldwide (SALGUEIRINHO, 2011).

Because of the technological advances and the production in large scale, this energy source is considered economically viable to compete with traditional energy sources in countries like Germany, Denmark, USA, Portugal and Spain. Furthermost, it is still a great potential unexplored in many countries, like Brazil.

There are still technological opportunities to improve eolic energy efficiency reducing its production costs and allowing for ambitious goals setting for this segment.

In Brazil, notably in the northeast region, eolic energy is a complementing energy source for hydroelectricity, as the period with the highest Wind marks occurs when there is low rain precipitation. It is also notable that the northeast region has the greatest potential for eolic energy. Nowadays, the installed eolic potential in the country is 1 GW, distributed along the 50 endeavors in operation in national territory.

The Figure 4 shows, Ceará state has the highest proportion in Brazilian wind generation, with 39.4%. Next came the states: Rio Grande do Norte and Rio Grande do Sul, with 35% and 29.3% each. In terms of capacity factor, considering the size of the park by UF, Piauí state presents the most significant indicator, of 41.2% followed by the states of Bahia and Paraná with approximately 40% (ABBEÓLICA, 2014).

Figure 4 - Installed capacity of wind farms by State

Brazil - Generation and Power Installed by State (2014)				
State	**Generation (GWh)**	**Power Installed (MW)**	**Capacity Factor (%)**	**Structure of the Generation (%)**
CE	2,223	644	39.4	33.8
RN	1,297	423	35.0	19.7
RS	1,280	499	29.3	19.5
BA	766	218	40.1	11.6
SC	550	236	26.6	8.4
PB	170	69	28.2	2.6
SE	75	35	24.9	1.1
PE	69	27	29.6	1.1
RJ	66	28	26.7	1.0
PI	65	18	41.2	1.0
PR	9	3	40.0	0.1
MA	7	3	30.0	0.1
Brazil	**6,578**	**2,202**	**36.2**	**100.0**

Source: Boletim-Dados-ABEeolica-julho-2013-Publico (ABBEÓLICA, 2014)

This goal was achieved when the Elebrás Cidreira 1 eolic park started working, belonging to the associated EDP Brazils' energies, located in the municipality of Tramandaí in the state of Rio Grande do Sul. There are 31 eolic generators delivered by Wobben Wind Power, with a total capacity of 70 MW.

With this in mind, according to data from the Electric Energy National Agency (ANEEL in Portuguese), the eolic stations represents almost 1% of granted energy available in the country.

4.2 Solar Energy

Photovoltaic solar energy, after hydraulics and wind power, is the third most important source of renewable energy in terms of installed capacity in the world; more than 100 countries use this source of energy generation (CAMARGO, 2017).

The world's photovoltaic's solar energy Market continues to grow annually. In just a decade, it has doubled in size four times. Within the installed capacity in 2004 (770 MW), 94% came only from Japan, Germany and USA. As for Brazil, it is still in its early stages, limited to a few governments' initiatives and some isolated communities' electrification projects (SALGUEIRINHO et al., 2011).

Many attempts were made to eradicate the lack of energy access in developing regions using photovoltaic solar systems. Is instantly became a sustainable option to conventional energy sources. Photovoltaic systems are quite simple, accessible and have zero environmental impacts (ZUBI et al., 2017). These systems are able to improve the efficiency of concentrated solar energy, usually through refractivity image optic using lens or nonmagnetic optic through parabolic composite or luminescent solar concentration (AKBARI et al., 2017).

Solar energy capture through photovoltaic panels is one of the most prominent markets in the renewable energy markets. Due to its rapidly growing perspective and high investments involved, the photovoltaic market is one of the most competitive in the world, especially in Europe, China and USA. In Brazil, we are starting to see some advance after the installation of some government initiatives (SAMPAIO; GONZÁLEZ, 2017).

Cording to Sampaio and González (2017), the modular feature that favors distributed systems is responsible for many installations in remote regions of Brazil and may be responsible for a larger number of applications on a larger scale in the next 10 to 20 years, all interconnected to electrical network. Silicon is the main material used in the production of photovoltaic systems around the world and Brazil has 90% of the economically usable silicon reserves in the world. However, many small national photovoltaic power generation projects are mainly intended to supply rural and / or remote communities with electricity located in the North and Northeast of Brazil.

These projects work with the pumping of water for domestic supply, irrigation, fish farming, public lighting, systems for collective use, such as electrification of schools, community centers and health and domestic services. Among others, there are telephone stations and remote monitoring, electrification of fences, ice production and water desalination

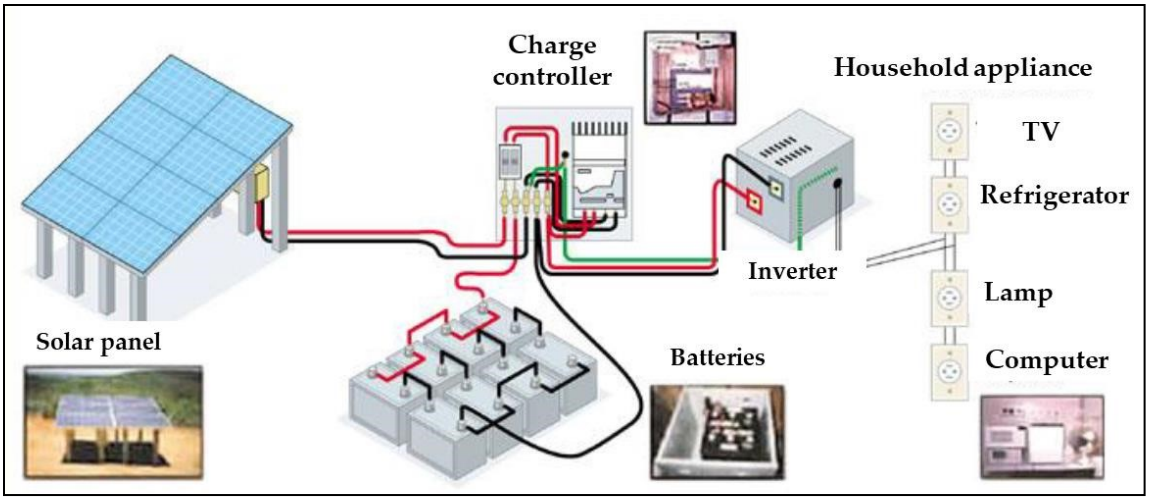
There are also hybrid systems that integrates photovoltaic panels with diesel group generators. According to (CRESESB, 2006) the photovoltaic cells are mostly made using silicon (Si) and can be composed of monocrystalline, polycrystalline or amorphous silicon crystals.

When sunlight reaches a photovoltaic cell, it produces a small electrical current. The current is collected by wires connected to the cell, and transferred to the other components of the system, thus, the more photovoltaic cells are connected in series or in parallel, the greater the current and voltage produced (PEREIRA et al., 2006). Figure 5 illustrates in a simple way the use of solar radiation for the purposes of energy use (CRESESB, 2006).

As can be observed in the Figure 5, from the collection of solar radiation, it is transferred to a load controller, which later passes through the inverter, which will transform it into electrical energy. The surplus energy is stored in the batteries, to be used at peak consumption times or when no radiation occurs. Photovoltaic solar energy is already feasible in several applications, but as an autonomous system for domestic use, it cannot compete with the electricity price of utilities through the public distribution network, especially in relation to implementation and maintenance costs. Given the great solar potential that Brazil has, it is possible to interconnect solar energy with a complementation in the current electricity grids (KEMERICH et al., 2016).

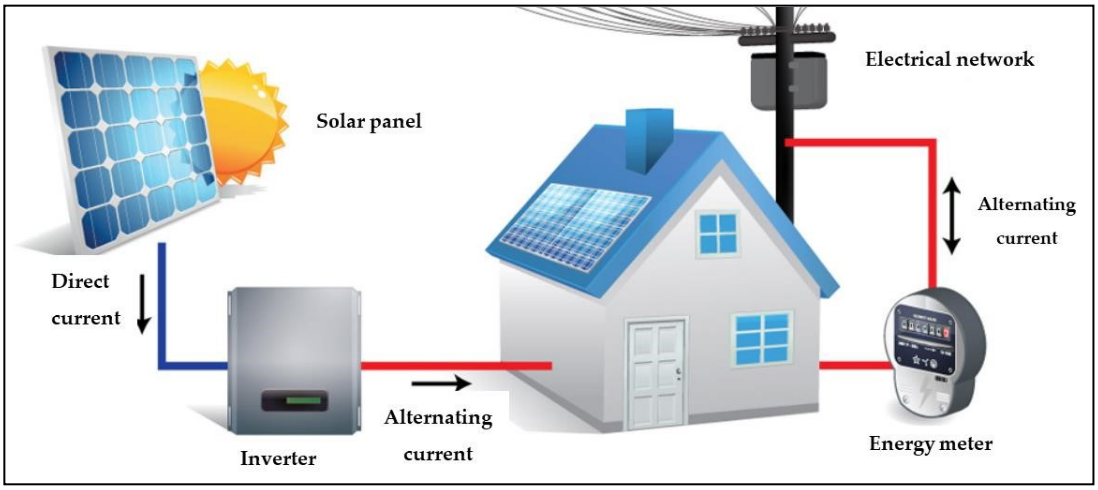
This energy supplementation generated by the hybrid systems must be introduced into the public distribution network and this system is economically more feasible compared to the isolated systems. The isolated systems serve a specific and local purpose, these systems are also able to supply energy to the generation network itself, injecting that energy into the network or used by any connected consumer, as shown by Camargo (2017) in Figure 6.

Figure 5 - Stages of the use of solar energy



Source: Adapted from CRESESB (2006)

Figure 6 - Representation of a grid-connected photovoltaic system



Source: Adapted from Camargo (2017)

The ONGRID or GRID-TIE connected systems have about 30% more efficiency compared to isolated systems because they do not use charge controllers and batteries. This generated energy can be used either to supply a residence or simply to produce and inject the energy in the electrical network (NEOSOLAR, 2018).

5 The sustainability in higher education institutions

A governmental coordinated action involving three Ministries: Planning, Budget and Management; Mines and Energy and, Environment created the project: 'Sustainability Efficiency at the Ministries' Esplanade', known as the "Sustainable Esplanade", with the aim of incorporating sustainable and efficiency criteria for the edification of the esplanade's buildings, in order to provide natural resources and financial cuts.

The main objective of this project was to turn the Ministries' Esplanade into an example to be followed, promoting the relocation of resources that enables the technological innovation in energy efficiency, sustainable buildings and the reduction of emissions, using the Federal Government is buying power to foment good management practice and influence the market to sustainable production and consumption.

The formers Ministry of State and, Education and Planning, Aloizio Mercadante and Miriam Belchior, celebrated in November 23, 2013, through an inter-ministry term of membership, the inclusion and participation of MEC in the integration of all members involved and the development of actions and efforts to implement the Sustainable Esplanade project.

Besides this initiative, laws, procedures, are slowly moderating public hiring and normative that creates and implement public policies hiring with the states' buying power to implement the national sustainable development, using fundamental criteria on the economic and social development, as well as to the environmental preservation.

Notably, projects that predicts low use of energy, that guarantees the health and well-being of users, taking into account the efficient and rational use of water and energy, acoustic, climate, ergonomic and lightening comfort, with appropriate colors that also needs little maintenance, are considered more sustainable and should be applied systematically in every edification of the public sphere.

Pointing out public policies in the higher education sector in Brazil, we notice a rapidly growth in the number of institutions widespread in the last 10 years. The rise of these educational institutions brings along, besides the expansion of vacancy numbers, courses and the increase of budget resources; a concern about the environmental impact of existing/new/implanted/conceptualized/expanded Higher Education Federal Institutions (IFES in Portuguese) that represents social urban facilities.

Thus, the evaluation system of IFES, which discusses its relicensing with the Ministry of Education and Culture (MEC in Portuguese), considers their infrastructure as a crucial issue, when the physical structure of universities represents "the space itself for debates and critical thinking of all social production and also the place to urge for alternatives to equate the greatest problems in our society" (COELHO, 1996).

In line with the guidelines for the construction of an Institutional Development Plan (PDI in Portuguese) from MEC and the Higher Education Institutions Monitoring System – SAPIEnS MEC (2015) an IFES infrastructure is a strategic item belonging to one of the essential thematic axes of the PDI.

Therefore, the responsible sectors for the infrastructure on IFES have vital responsibilities among universities and, should then adopt sustainable and constructive strategies, as well as use consumer goods and inputs in a rational mean, such as water and energy. These actions articulated by its technical group, should be well monitored and validated by its managers and directors.

6 Conclusion

Humanity faces a huge challenge in this century. That is, the transition to a sustainable energy future. In order to attain this sustainable scope there is an urge for change in the way energy is supplied and consumed.

In addition, the use of alternative sources of energy minimizes the consumption of conventional fossil sources that are responsible for much of degradation in the environment. And much of those alternative energy sources are found in great proportion in Brazil.

Energy is a vital force to the process of growth both economic and human development of a country. Knowing of this strategic importance, Brazilian government should encourage, as a guiding principle of energy policy, the great consumers in the public sector, especially IFES, to reduce the costs by means of initial investments in the implementation of own sustainable energy generators models. Thus, they should use the implementation investments resources of new sustainable technologies for the future defrayal reduction.

The benefits are many in generating renewable energy, such as zero or reduced emission of the greenhouse effect gases, the diversification of the energy matrix, contributing to the rise of energy safety, the creation of new work positions and the exploitation of biomass.

Notwithstanding, despite all the investment, studies and research developed within the alternative energy literature, Brazil still lacks structured public policies that can guarantee a compatible participation in the renewable energy field to its alternative energy potential.

Within this perspective, the scenario around Federal Higher Education Institutions has an urgent need for more research concerning the impacts, rational and sustainable use of natural resources and conception premises as well as the selection and definition of spaces, land acquisition, product conception and energy resources efficiency models project development.

Thus, the awareness of public administrators, in the sense of promoting sustainable development, in the conception, hiring and execution of public constructions and engineering services, requests great responsibility to lead the way to change the relationship with the environment, not just by the rational use of natural resources available, but also by the search for alternatives and technological solutions that comprehends the use of clean and renewable energy sources. Future studies should evaluate the impact on defrayal costs when using sustainable energy at IFES.

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