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RENEWABLE ENERGY AND SUSTAINABILITY: AN APPROACH TO THE USE OF PHOTOVOLTAIC AND WIND ENERGY MATRICES FOR THE AMAZON REGION

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ABSTRACT

Electricity is practically indispensable for the development of a country.In this sense, for its production, it is currently widely used non-renewable natural resources such as oil, gas, water, coal, uranium and others.Aiming at the environmental protection and sustainability of these resources, it is necessary to implement measures to implement electricity generation from renewable sources such as photovoltaic and wind energy.The objective of this work is to address the renewable sources of electricity generation using the photovoltaic and wind energy matrixes focused on the sustainability of natural resources currently used for the production of electric energy in Brazil as well as in the Amazon region.To do so, the methodology used to perform this work was the research of data in scientific works that covers the main focus issue of this work.And, based on the results already widely analyzed and discussed by several authors, a discussion is applied on the use of these two sources of renewable energy for the Amazon region, in order to discuss the viability or not of the electric energy generation using of the photovoltaic matrix or region.Where, at the end of the work, it is concluded that, due to the characteristics of the Amazon region, even though it is an expensive energy generation matrix, the generation of electric energy using the photovoltaic energy matrix is the best and most Electricity generation in comparison with the production of electricity through the wind energy matrix for the Amazon region.

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INTRODUCTION

The world population growth is undoubtedly a preponderant factor for the increase in energy consumption across the planet.Since it is necessary, greater environmental resources to produce electric energy, to guarantee food, consumer goods among others that can meet the population demand and the development of the nations. In the modern world, within the borders of countries, practically all activities developed to provide a quality life for people depend on the use of electricity.Therefore, the generation of electric energy is treated strategically by governments. After all, the progress of each nation is indelibly linked to the production and/or availability of this important input (1). Given this scenario, it is extremely important to apply all technology, knowledge, tools, processes and other means that can mitigate the degradation of the environment due to the need to be generated more and more electric energy to meet the consumption of population demand. The development of alternative sources of energy, such as solar energy, wind, biomass, among others, has been receiving more and more attention in recent years.One of the main motivations was the increased environmental concern, in particular due to possible greenhouse consequences for future generations (2). In 2013, about 80% of all energy produced came from the burning of fossil fuels, which are greenhouse gases. Fortunately, this dependency has been decreasing in recent years, thanks to the use of renewable energy sources (2). It is important that governments of all nations invest in the production of policies that focus on mixing the dependencies of the use of non-renewable sources to produce electric energy and, with special attention to the sustainability of natural resources. Brazilian energy policy has advanced in several directions over the past 50 years.Since the so-called "Brazilian miracle", attributed to the impulse given to the construction of infrastructure in the country, we have historically witnessed spatial transformations in the Brazilian territory in the name of the accelerated process of industrialization (3). The discourse of development was justification for the installation of several hydroelectric plants in the main hydrographic basins of Brazil and strongly marked our energy park.Of the electric energy generated in Brazil, more than 60% is produced by hydroelectric plants, an inheritance associated with the abundance of water resources in the country and the potential for generating national rivers. However, more recently, other sources were introduced into the Brazilian energy matrix, of technological advances (3). In this article, we discuss the importance of the generation of renewable energy sources and the sustainability of the natural resources used for electricity generation in Brazil, especially in the Amazon region.Among these renewable sources of energy, we have the example of solar Photovoltaic (PV) and wind.

Although the sustainability discourse surrounding the wind power generation process is widespread, there are risks involved from the installation process to the generation process.In this sense, the environmental licensing and the economic and environmental feasibility studies of the projects call attention to several factors, from the impacts to the migratory fauna to the social responses to the lease of land for the installation of the wind towers (3). Wind energy is clean, environmentally friendly in technological terms, compatible with large-scale electric generation, has reduced environmental pollution and water consumption and does not produce CO_2 (4).In addition to the risk of supply insecurity being small (5). The installation of the project is quick compared to other energy sources since wind turbines are produced on an industrial scale and can be quickly installed and connected to the power grid (6). It is considered that the major solution to global environmental problems lies in renewable energy technologies, which would be the basis for global sustainable development, especially when considering the problems associated with pollutant emissions (7). From another point of view, solar energy is also another source of energy that contributes positively to meet the demand of electric consumption as well as the environment, since it is a renewable and clean source of energy. The use of the energy generated by the sun, inexhaustible on the terrestrial scale of time, both as a source of heat and light, is now one of the most promising energy alternatives to provide the energy necessary for human development.When talking about energy, it should be remembered that the sun is responsible for the source of virtually all other sources of energy on earth (8). It is from the energy of the sun that the evaporation takes place, the origin of the water cycle, which allows the damming and consequent generation of electricity (hydroelectricity).Solar radiation also induces large-scale atmospheric circulation, causing the winds. Wind energy is also an indirect form of the manifestation of solar energy, since the winds are formed from the conversion of solar radiation into synetic energy, due to a different balance in the different latitudes between incident solar radiation and terrestrial radiation Issued (8). Oil, coal, and natural gas were generated from plant and animal residues that originally obtained from the resource energy needed for its development (8). Therefore, the motivation for this work was to seek to address about the importance of the generation and use of renewable energy sources, with a comparative focus between the use of solar Photovoltaic (PV) and wind in order to weigh the advantages and disadvantages from one to another to meet the consumption of demand that arise due to human needs, especially in the Amazon region. But also, the use of said energetic matrices throughout the Brazilian territory and especially in the Amazon region, with a view to preserving the non-renewable natural resources used for the generation of electric energy, such as oil, natural gas, coal mineral, uranium and water, currently in scarcity all over the planet as well, in some regions of Brazil.Therefore, using renewable sources of clean energy contributes to the sustainability of the natural resources currently available.

Bibliographic Revision

Solar resource as an energy generator: The sun is the main source of energy on earth.In addition to being responsible for the maintenance of life on the planet, solar irradiation is an inexhaustible source of energy, and there is an enormous potential for its use by means of a capture and conversion system in other energy sources, such as thermal and Electrical (8). The sun is basically a sphere of incandescent gas, at the core of which happens the generation of energy through thermonuclear reactions.Its structure, (Figure 1), is composed of the main regions: nucleus, radiative zone, convective zone, photosphere, chromosphere, and crown (sometimes called corona) (8). The nucleus, with a temperature of about 15 million degrees Kelvin, is the densest region and where energy is produced by thermonuclear reactions.Just above is the radiative region, where the energy produced in the nucleus is transferred to the upper regions through the radiation (8). The average annual energy flux from solar radiation (solar irradiance), when measured in a plane perpendicular to the direction of propagation of the sun's rays at the top of the earth's atmosphere, is called the "solar constant" and corresponds to the value of 1,367 W/m^2 (8). Considering the radius of the earth 6371 km and, considering the value of the irradiance of 1,367W/m^2 focusing on the projected area of the earth, it is concluded that the total power provided by the sun to the earth, the top of the atmosphere is approximately 174 thousand TW (terawatts) (8).

Distribution of average solar irradiation: The value of the solar irradiation incident in a plane oriented in the direction of the Equator and with a slope equal to local latitude allows to calculate the electrical energy that can be converted by a fixed photovoltaic system. The (Figures 2 and 3) present maps showing the average annual irradiation of Brazil and European countries.It can be observed that the potential available in Brazil is higher when compared to countries in Europe, where photovoltaic conversion is already widely used.In addition to the size of the country, it is observed that in the whole Brazilian territory there is availability of equivalent solar irradiation or better than in the countries of

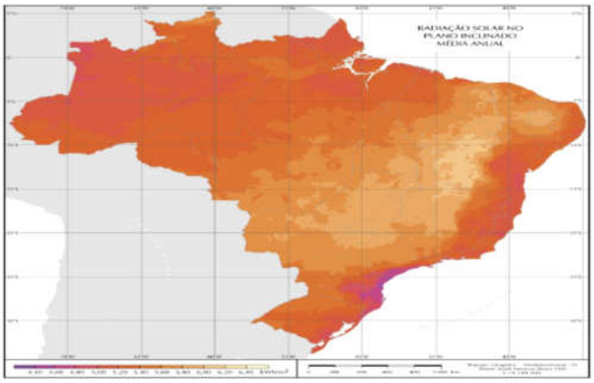

Figure 2: Brazilian map of solar irradiation on an annual average (10).1

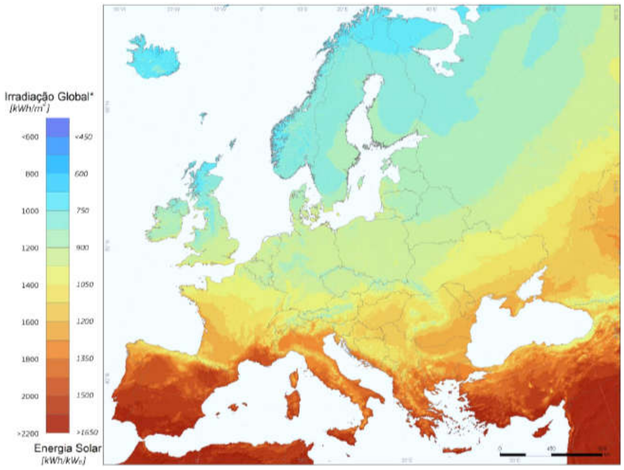

Figure 2: European map of solar irradiation on annual average (10).

southern Europe and surpassing countries such as Germany, a country with significantly installed generation system capacity Photovoltaic (8). The amount of energy in the form of heat and light coming from the sun is continually measured in petawatts 121.8 ($121{,}8x10^{15}$ Watts). This is absorbed by clouds in the land, sea and land masses.This colossal energy, one of the indispensable elements for the existence and maintenance of life on our planet, can be utilized, through the use of technical processes, in other forms of energy controlled to meet the needs in improving the quality of life of the people. The harnessing of solar energy has been done in various ways over time by human societies that have already existed and exist.Some inventions or attempts to use the old solar energy were not successful because they were not efficient or practical. Solar energy emerges as a promising alternative, in virtue of great energy potential, especially for Brazil, which is in a privileged geographical position of the planet. (2) However, the production of solar photovoltaic energy worldwide has a 0.7% market share of renewable energy, representing 22.1% of the total, of which about 90% of the solar modules are commercialized, are based on photovoltaic cells of mono and polycrystalline silicon, which have a high cost (12). In this way, the low representation of the photovoltaic market Comes from the high cost of manufacturing these solar cells, which represents an obstacle to the popularization of this energy source (2). In this context, solar cells titanium dioxide (TiO_2) dye - sensitized (English: *DyeSensitized Solar Cells* - DSSC) or simply cells *Grätzel,* which arose in the early 90's, represent an interesting alternative to produce low cost solar modules (12). The photovoltaic source has a characteristic that is not found in any other known: it can be used anywhere, generating electric energy near the consumer, generally, without the need to build long transmission lines (14).

The potential for photovoltaic use, however, is immense, and can be estimated from tens to hundreds of MWp only in the Amazon region, even if only a portion of the existing 286 diesel generating plants with a capacity of 620MWA could adopt photovoltaic modules in an Optimized diesel-photovoltaic ratio (15).In addition, while the distribution of solar radiation in the region is considerable, and with little seasonal variation, as shown by the mapping presented (Figure 2), the distribution of wind resources in the region is one of the worst in the country (26.45 TWh/Year) (16). In this way, photovoltaic solar technology is one of the most viable renewable energy alternatives currently available to meet the region's demand, which is dispersed and relatively low energy density.Fossil fuel economy and greenhouse gas emission reductions are examples of the benefits brought about by the adoption of a simple system with the addition of photovoltaic generator without energy storage capacity to a thermal plant fueled with diesel oil.Adding to this the prospect of future conversion to a photovoltaic/fuel cell configuration would result in a 100% "clean and renewable" generation based exclusively on the solar resource (17).

Nternal Energy: The wind consists of the displacement of air masses, which brings with it energy with an enormous potentialparaser used in the generation of electricity.This branch of electricity generation has been expanding widely in recent years because it is a clean and abundant energy and for already presenting a cost of generation feasible to the point of being inserted in the Brazilian energy matrix (5).
Concerns about issues such as environmental impacts and global warming have created a need for changes in electricity generation in several countries around the world.Several countries have set targets and defined programs to create a more favorable environment so that alternative sources of electricity could have a more effective participation in the electric power generation matrix, also reducing dependence on fossil fuels (23). At the end of 2013, global wind capacity reached 318GW and annual installed capacity has been around 40GW since 2009, with variations of 10% in line with fluctuations in the world economy (24).The share of renewable energy in the Brazilian electric energy matrix is around 85%, while the global average is around 20% (25).Hydropower is the main responsible for this significant participation of renewable energies in the electric matrix.Hydraulic generation participated in 2012 with approximately 77% of the electric power generation in Brazil, while in 2011 this share was 82%.This situation makes the country dependent on weather conditions for electricity generation.The share of wind energy jumped from 0.5% in 2011 to 0.9% in 2012 (25).

Obtaining electricity from the wind has many benefits and the functioning of this system involves several fundamental contents of the physical.The basic principles for the generation of electric energy from the wind are closely related to major themes studied by physics that can serve as an aid to the study of these contents.The study of the physics that contemplates the wind energy passes through subjects like the formation of the winds, mechanical energy produced by the wind, the transmission of this energy and its transformation into electrical energy (5). Wind energy is one of the forms assumed by solar energy.Wind is the movement of air as a result of an irregular heating of the atmosphere by the Sun. The earth's atmosphere is heated unequally due to the solar radiation incident on the terrestrial surface that is not equally distributed and to the rotating movements of the planet itself (26). Wind energy can be considered as one of the forms in which the energy coming from the Sun manifests, because the winds are caused by the differentiated heating of the atmosphere.This non-uniformity in the heating of the atmosphere must be credited, among other factors, to the orientation of the sun's rays and the movements of the Earth (27).

This process known as thermal convection, where thermal energy is transmitted through matter, also occurs in other cases, such as with breezes.During a sunny day, the air heats up in contact with the earth's surface and rises while on the surface of the water or oceans this process, in the same time interval, is slower due to the specific heat plus water.Therefore, during the day, the winds blow from the water to the mainland.Already at night, the water takes longer to cool than the earth, so the inverse process occurs, and the atmospheric air will blow from the earth to the water (5). The wind is very variable, both geographically and temporally, being influenced by various aspects, which affect its intensity, direction, and direction, such as soil and relief conditions, the presence of obstacles, among others (5). The energy contained in the wind can be used to power electricity.A wind system can be used in isolated systems, hybrid systems or systems connected to the grid.Hybrid systems present the use of more than one source associated with the generation of electric energy, such as wind turbines and photovoltaic modules, diesel generators, among others. (5). Isolated systems are used to supply certain regions, in rural areas, on farms or in homes.Systems connected to the grid, such as wind farms, correspond to systems where all generation is delivered directly to the grid (26).In addition, wind power generators can be positionated at sea which are called offshore.A device designed to obtain electricity from wind is called a wind turbine.According to aspects related to the construction project, the aerogenerators can be classified according to the position of the axis of rotation of the wind rotor (5).

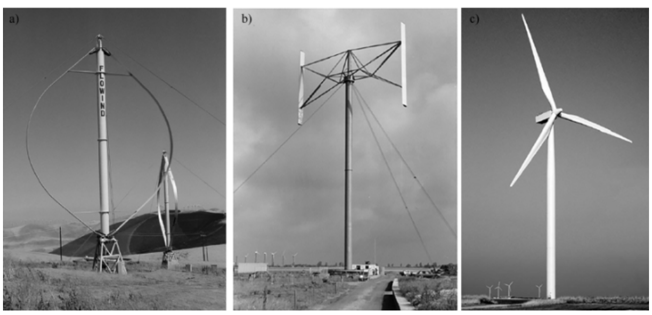

Figure 3: Aerators classified according to the axis of rotation (a) axis of vertical rotation (b) axis of horizontal rotation (29).

Energy quality in the context of wind generation describes the electrical performance of the wind generator's electricity generation system where any disturbances over the power grid must be maintained within established technical limits according to the level of demand imposed by the network operations manager. For the most part of wind turbine applications, the grid can be considered as a component capable of absorbing all the power of these units, with constant voltage and frequency.In the case, for example, of small isolated systems, situations can be found where the electric power provided by the aerogenerator achieves values compatible with the capacity of the network.Where the grid is weak, energy quality should be one of the main issues to be observed regarding the use of wind turbines (size, type ofControl, etc.) (27). A wind system can be used in three different applications: isolated systems, hybrid systems and systems connected to the grid.The systems have a basic configuration, require a power control unit and, in some cases, a storage unit (27).

MATERIALS AND METHODS

For the development of this article, it was necessary to use bibliographic research methods in books, dissertations and articles already published by both national authors and authors from other countries that deal with the subjects described here, and all authors are cited in the references of this article job. Through the reading and interpretation of the subjects focus of this work, written by different authors, it is verified that the methods of electric power generation with the use of photovoltaic and wind energy sources contributes significantly to the sustainability and maintenance of the nonrenewable natural resources that are currently used for electricity generation. The main focus of this article is extensively studied and supported by the aforementioned authors who carried out fieldwork, interviews, information, meetings with community leaders and conversations in several traditional communities regarding the implementation of a photovoltaic clean energy generation system and wind. In some regions of Brazil there is still occurring, to a lesser or greater degree, the generation of electric energy generating units in industrial, commercial and residential buildings, whose projects fit and benefit from the advantages of this generation/ consumption system by the physical reduction in final consumption. In buildings of this type are implanted to generate one of the following sources of energy systems:

Photovoltaic: generation by the action of sunlight with the installation of photovoltaic modules, equipment, and materials by specialized companies. As it is a modular system, it is possible to generate very variable powers. The available area of the building property for installation of the solar modules defines the maximum power to be obtained (1).

Wind: generation by wind action, with vertical or horizontal axis machines capacity deaté 5kW, 110-220V domestically manufactured or imported (1). Although wind power is considered clean and renewable, the installation of wind farms is promoting major impacts on the environment and the traditional way of life of the locals, however we glimpse some solutions (37). The research methodology of this study was based on the critical and analytical reading documents books, theses, articles published in prestigious journals that address on the subject matter hereof, and ordering with cohesion and coherence topics here to clarify the issues addressed here.

ENERGY MATRIX IN BRAZIL

Figure (6a) presents the structure of the Brazilian primary energy supply matrix and figure (6b) is used in the production of electricity. The burn of the fossil fuel anwers the demand for much power in transmission and serves setordecercade 40% of the energy used to agricultural Brazilian sectorcausingmaisimportante contribution of gases greenhouse emissions (cabon CO dioxide 2 and carbon CO monoxide, etc.) in Brazil. Programasde incentive to dequeima adoption of biomass (ethanol and biodiesel) are being implemented in the country expected that in the near future, biomass has significant contribuition of these sectors reducing the Brazilian contribuitionto the global emission of greenhouse gases (16).

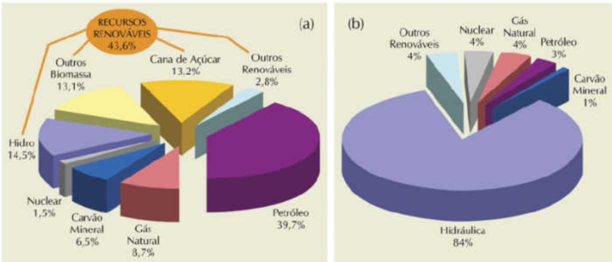

Figure 4: a) Brazilian energy matrix andb) Brazilian power matrix (16)

Currently, hydropower is the main source of electricity generation of energy in Brazil. Although considered a renewable font clean, hydroelectric plants produce environmental impact not appropriately evaluated, due to the large cultivated areas alagamentode (38). Studies show that efeitoestufa gases, mainly methane (CH_4) are emitted into the atmosphere in consequence anaerobic degradation of organic matter processes that occur in wetland (39). In addition, Brazilian river main rivers capable of generating high energy density of hydroelectric are almost already exhausted in the main consuming centers of the country (16). Nuclear power source is referred to as a "clean" of electrical energy by not cause the emission of greenhouse gases to aatmosfera. From the point of view of development, it is aalternative for cover the expected energy deficit, diversify sources of energy and enable the Brazilian nuclear program. The country has a coma world's sixth largest uranium reserves and only 25% of national territory were mapped. As a result, government The Project resumed construction of the nuclear plant Creek III, capacidadede 1.300 MW, thus completing the cycle that began with Creek 1 em1985. However, nuclear power has not been well accepted civil by society because of questions about the risks associating the problem of storage of radioactive waste generated (16). Among the renewable sources of energy, wind energy is wich has received more investment because of the Incentive Program for Alternative Sources of Electric Energy(PROINFA), coordinated by Mines and Energy Ministry (MME). The technological capability of domestic industry and decreasing the costs of wind electricity, when huge national wind potential association are (143.5 GW according to the Atlas of Brazilian Wind Potential (40)) indicate that this form of generation will be able to occupy in the medium term, an important role in the country, mainly acting as a decentralized source and complementarde energy coupled to the power grid.

However, according to this mesmafonte of information, much of Brazil, including praticallythroughout the Amazon and central Brazil, presents condition not suitable for wind power generation. On the other hand, Brazil, as a country located the most Partena inter-tropical region, has enormous potential for solar energy utilization throughout the year (41,42). The use of solar energy brings long-term benefits for the country, enabling the development of remote regions where the cost of electrification by conventional network is too high in relation to the financial return on investment, regulating the energy supply in times of drought, decreasing dependence on the oil market and reducing emissions of greenhouse gases to the atmosphere as established by the Kyoto conference (43). There is a wide range of possibilities in the medium and long-term use of this abundant form of renewable energy, ranging from small autonomous photovoltaic systems to large plants that use concentrated solar power, or hydrogen production systems for use in fuel cells production work with zero emissions of CO_2. However, today this energy still has an incipient participation in the Brazilian energy matrix - just solar energy for water heating has aroused interest in the domestic market, mainly for employment between the A and B classes of society, industry and in hotel services (16).

Internal energy offer in brazil: Most energy sources, such as hydro, solar, wind, biomass, and fossil fuels, can be considered directly or indirectly from solar energy (44). In 2015, the domestic energy supply (total energy available in the country) reached 299,2 Mtpe, registering a decrease of 2.1% over the previous year. Part of this decrease was influenced by the behavior of the domestic supply of oil and derivatives, which drew 7.2% in the period, due to the surplus flows in export and import of these energy sources. Also contributed to the fall in gross domestic supply weakening of economic activity in 2015, the year that the Gross Domestic Product (GDP) contracted 3.8%, according to the latest data released by the Brazilian Institute of Geography and Statistics (IBGE) (45). In the case of electricity, it has also been found a decline in domestic supply of 8.4 TWh (1.3%) compared to 2014. For the fourth consecutive year, due to unfavorable hydrological conditions, was made available hydraulic energy reduction. In 2015 the decrease was 3.2% compared to the previous year. Although the minor water supply, was a breakthrough in the share of renewable energy matrix para75.5% 74.6% explained by the decrease of heat generation derived base oil and the base of the generation increase biomass generation and wind reached 21.6 TWh - growth 77.1% - thus exceeding nuclear generation in 2015. the wind power reached 7633 MW, 56.2% expansion (45).

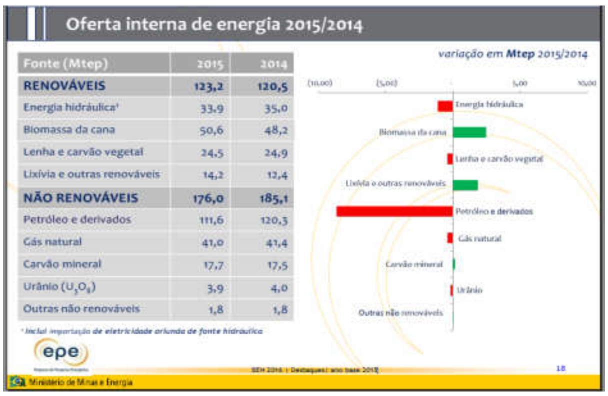

Figure 5: Internal offer energy 2015/2014 (45).

As for the costs of electricity, these consist of a fixed part corresponding to the amortization of the invested capital - and a manageable part, composed of the expenses necessary for the operation of the power plant (6). The fixed part covers the costs incurred in the implementation of the plant (design, equipment, construction, assembly and testing), and the administrablepart is the cost of operation and maintenance, insurance, wages, etc. encargostrabalhistas low rates implies rationalization of these expenses and therefore incompatible with corporate pressures and mercantile interests decurto term (6). In the case of nuclear power plants, there are also fuel costs, of decommissioning the end of life and management of waste radiativos. The costs actually practiced should be established through the negotiations between the grantor and the investor, in which enter subjective criteria such as "attractiveness" for the investor and "reasonableness" for the consumers; hence the ethical imperative that the process be absolutely transparent. It is calculated that in Brazil, the cost of hydropower stays at around R $ 80/MWh and nuclear at $ 200/ MWh.between both come wind power which was negotiated by approximately R$ 100/MWh, in recent auctions held by the Ministry of Mines and Energy (6). Equation unit cost for photovoltaic power can be obtained from the graph (Figure 8), which has been generated according to some power values and their unit cost (49).

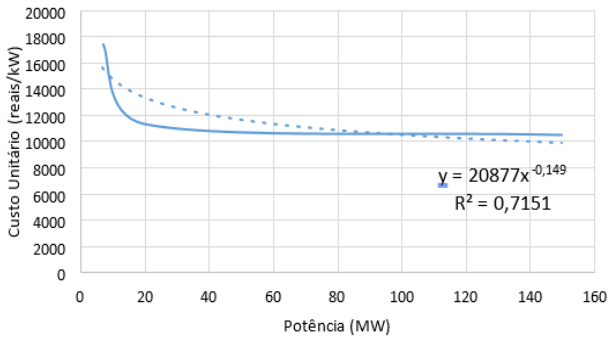

Figure 6: Graphic unit cost as a function of power (49).

Since the unit cost equation for wind energy can be obtained through the graph (Figure 9), from investment actual values of Brazilian wind parks and their powers (49).

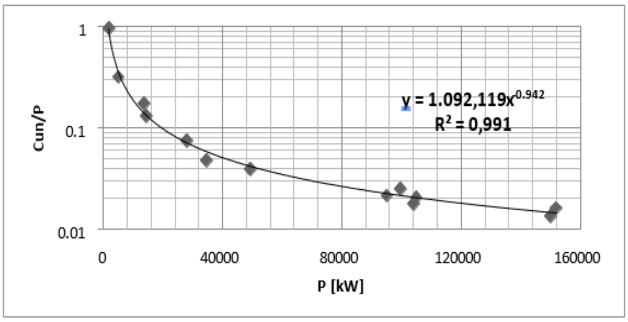

Figure 7: Curve for determining the unit cost of a Brazilian wind farm (51).

The (Figure 10) shows the cost of capital for each type of source as a function of power. It can be observed that the smaller the less power the total investment. In addition, it is noted that energy with the largest investment is the photovoltaic and the cheapest is wind energy.

Regarding Small Hydro Power (SHP), it can be seen that the higher the waterfall, the lower the cost of capital (49).

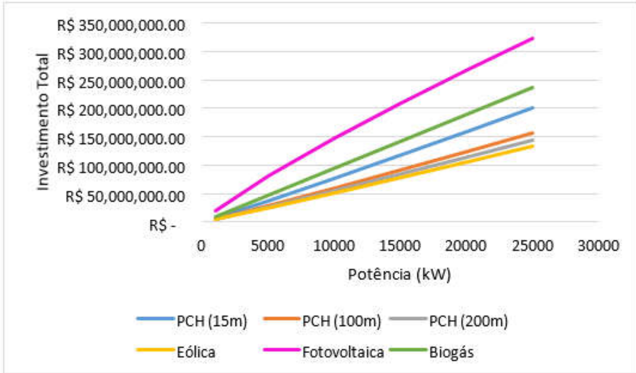

Figure 8: Capital cost for each type of source as a function of power (49).

Photovoltaic Energy In Brazil: The solar energy incident on the earth's surface is more than about 10.000 times the gross demand current power of humanity. However, its low density (energy/area) and its geographic and temporal variation represent major technical challenges for its direct use on a large scale. In search of the direct use of solar energy, various technologies have been studied, with particular emphasis on photovoltaic conversion, thermal conversion and bioclimatic architecture. (44) The photovoltaic conversion constitutes the direct conversion of light energy into electricity through the photovoltaic effect. The thermal conversion constitutes the direct use of sun thermal energy, either for immediate use (heating water, industrial processes, etc.) or to generate electricity via a thermodynamic process (steam generation, etc.) (44). Most of the impressive growth of the PV market is related to installations connected to the grid in developed countries. There is a huge potential for this application in sunny urban areas around the world. Brazil is particularly well situated for this type of application, because of the considerable availability of solar energy resource, and the high value that can be given to PV systems in commercial areas to urban centers. (52)

The solar radiation maps on an inclined plane in the value of local latitude (Figure 13) show both the possibility of use of PV nationwide as the small seasonal variation throughout the year. In the survey of the economic viability of PV projects, more detailed information of the seasonal solar radiation distribution is required, and the project database Solar and Wind Energy Resource Assessment (SWERA) provides the mapping of this solar resource in temporal resolution (10). PV systems can contribute to the maximum capacity of umarede the peak demand occurs during the day. Comercial regions with high air conditioning loads in the overall noon time have demand curves in good sync with the solar radiation (53,54). Another important factor in this analysis is the comparison between the peak load values in winter and summer. The higher demand in the summer compared to the winter period, the greater the chance of the load coincide with the availability of solar resource. This is typical behavior in most of the capitals of Brazil (10). Consumption data curves of urban areas around the country show the difference between the areas where commercial buildings dominate, with peak demand during the day, and residential areas, where the demand peak values occur at dusk.

To make best use of the distributed nature of solar electricity generation, it is important to know the PV capacity in different areas of the city when installing a new PV station, to select consumers with higher credit potential (10). In this context, the Concept of Effective Potential Load Easing (ECCP) of PV was set to quantify the credit potential of a PV facility located strategically (54,55). (Figure 12) shows that for a typical demand curve in an urban center, the peak reduction effect by adding a small number of PV modules (for example, $2m^2$ thin film photovoltaic amorphous silicon 15% efficiency) to assist in reducing the network load requirements. To determine the potential benefit of PV systems (Figure 12), it is necessary to know the distribution of solar radiation on an hourly basis, and this information can be accessed throughout the Brazilian territory through the database generated in SWERA project. In the near future, when the use of PV systems interconnected to the grid become more widespread, with the cost reduction and recognition of the benefits of the generation PV distributed, lifting the effective potential load mitigation will be of high strategic value for suppliers einvestidores of energy. In developing countries, solar power has had the booster agent to their application to meet small demands in isolated areas. With a significant portion of the population living in the countryside and still without access to electricity and basic social services, Brazil and several other countries have found this technology possible solution (44). In Brazil, another motivator certainly be a strategic concern for the Amazon region, in which there is field for the application of photovoltaic hybrid systems/diesel. Brazil has a significant advantage over the developed countries regarding the use of solar energy as it is located at a latitude range in which the incidence of solar radiation is much higher than that in those countries (44).

Photovoltaic energy in the amazon region: Due to its large land area, it is a challenge for utilities bring energy to all inhabitants of the Amazon region. The Amazon region (AC, AM, AP, MA, MT, PA, RO, RR, TO) is sparsely populated, with approximately 17 million people ocupando5 million km^2, which means 12% of population the country about 59 % of its territorialextentions. The power generation, where it exists, based on it's mainlythermoelectric isolated systems with power ranging from a few kW paraas small houses tens of MW bigger cities the paras. Only 9% of the country's electrical energy consumption are found in the Amazon region, and it is estimated that about 30% of the population of region not have access to electricity (44) .More than 300 small isolated diesel generation systems are operated in the Amazon concessionáriasde electricity sites, and other thousands are used by private owners (44).Currently, is widespread that of distribution decentralization of energy and energy sources utilization is the only way to deliver electricity to billions of people who have access to this yet notessential commodity for quality of life.Not in the capital available and cost effective undermines the traditional naforma distribution. The long distances and demand relativelt low to make the transmission and distribution costs prohibitive (16). Thus, solar technology is one of the most alternative energy available now had answered demand in the region, which is scattered and relatively little density energy. The fossil fuel economy and emission reduçãode greenhouse gases are examples of benefits brought by adopting a single system with the addition of photovoltaic generator without energy storage capacity to thermal a plant fed with diesel fuel. Added to this aperspectival future conversion to a photovoltaic configuration /fuel cell generation would result in a 100% "clean and renewable" based solely on solar resource (16).

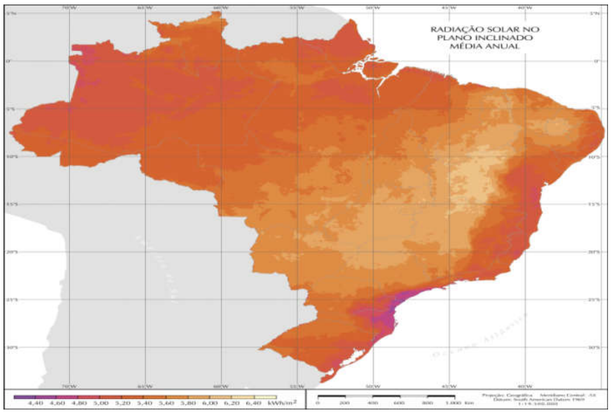

Figure 9: Solar radiation on tilted annual average plan (10).

The mappings of solar energy resources show a high solar radiation flx in the Amazon region (about 5.5 MW/m^2) with low variability inter-seasnal and appropriate the technical standards recommended for hybrid mini-systems technology. The (Figure 14) shows that, on a yearly average, the potential available for daily generation PV in kWh/kWp, which can be expected to PV technology of amorphous silicon employed thin film in the Amazon region, with the small towns and local villages and diesel generation unit'sregion (10).

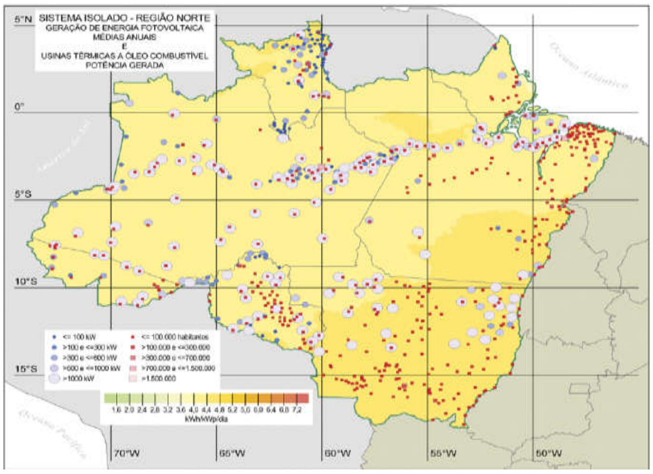

Figure 10: Potential available for daily generation PV in kWh/kWp, in the Amazon region (57).

Energy wind in brazil: Obtaining electricity from wind has many benefits being that function of system involves several physical and fundamental content. The basic principles for generating electrical energy from wind relate intimamentecom major themes studied by physics that can will serve as an auxiliary to the study of such content. The physical study of contemplating the wind passes by themes such as the formation of the wind, the mechanically made wind energy, the transmission of energy and asua transformation into electricity (58). The wind is considered a renewable source of energy and its use occurs by converting the kinetic energy of translation into kinetic energy of rotation, with the use of wind turbines to generate electricity or pinwheels and mills for mechanical work such as pumping water (59).

The wind energy exploitation began with shipping, with vessels sailing moved for thousands of years. However, the winds began to be seen as important in electricity generation only from the early nineteenth century, and a century later, with the first major 1970 oil crisis, when there was, in the West, political interest and sufficient investment to enable the development and production of wind power generation equipment on a commercial scale (60).

Several countries, including Brazil, spent efforts in research on the use of wind energy for electricity generation (61). However, it was from the stimulus experience market held in California in the 1980's, Denmark and Germany in the 1990's, that the wind-electric utilization reached significant levels in terms of electricity generation of economy (62). Wind power offers a commercial and mature technology that has been used on a large scale in developed nations since the early 90's, often with government subsidies (44). Brazil has water and wind potential to open his possibilidadede produce renewable and sustainable manner, all the energy elétricaque consumes at present and consume from 2050, when, according to the Brazilian Institute of Geography and Statistics (IBGE), the population will be stabilized at 215 million (50). The history of wind power in Brazil is directly related to the state of Ceará and developed forcefully in the 1990's this period date the studies for the wind energy potential that is concentrated in the states of Ceará and Pernambuco. Began the measuring towers between 30m to 50m installed at selected locations on the coast of the states of Ceará, Bahia and Paraná, as well as areas in Minas Gerais, which were studied since 1983. Strategically, the government established the first Ceará wind energy commercialization projects, attracting the state national and international investors, and in 1993, towers were installed to prospecting for wind potential, the energy Company of Ceará (COELCE) and the Hydroelectric Company of São Francisco (Chesf) that enabled, in 1996, the first demonstration project of wind technology in Brazil (59). In 2001, the Center for Energy Research (Eletrobras/Cepel) conducted an inventory of the Brazilian wind potential, estimating it at 143 GWpara turbines found on the market, installed in the most recent 50 meters. Study towers show that, with the development of more efficient turbines and higher towers, the potential may exceed 280GW (50). Currently, the research focused on new materials that enable the development of wind turbines larger. Today, the industry manufactures wind turbines with power range of up to 2MW. There is now strong intention of applying this technology, especially on the coast of northeastern Brazil, where winds schemes are considered good. On the coast of the state of Ceará, for example, are already installed more than 15 MW of wind generation, the majority of private sector. Already there are also facilities in the states of Paraná and Minas Gerais (44). In Brazil still find themselves other promising locations where measurement of winds campaigns is being carried out, for example, the north coast of the state of Rio de Janeiro (44).

RESULTS AND DISCUSSION

Grounded on all the information produced by different authors mentioned above in this article, about the generation of electricity using for this renewable source of clean energy dedicated exclusively to power generation using solar energy (photovoltaic) and wind (wind), it can be said, from the data presented in this paper, it is possible to meet the world population demand, but especially to Brazil, making use of these technologies (photovoltaic and wind). In general, it can be seen (Figure 16) which, in the case of Brazil, the use of wind power has evolved over the years. And that, for certain regions (northeast, southeast and south) where the predominance of winds (Figure 17) are favorable in most of the year, up to viable investment from the government, companies and generating private industries of electricity, expand wind farms already existing in these regions, making better use of the wind potential regions that do not have wind farms for implementation of new generating parks electricity. Thus, it becomes possible to produce electricity by means of renewable energy generation, contributing to the sustainability of non-renewable natural resources are scarce and are currently needed for the generation of electricity. In the case of Amazon, in regions where the main source of electricity is with the use of disel oil burning for the operation of power plants. It is important to bring some examples, considering the experiences of other countries, good practices related to planning, installation and operation of wind farms, as regional and local plans for the deployment of wind energy projects in Germany, Ireland and Australia that outline clear guidelines for integrating wind turbines with other land uses (63). In Brazil, despite having more than 90% of clean generation (hydroelectricity), there is still broad scope of renewable energies, since over 90% of its land area are located in the tropical region, with excellent solar resource, plenty of biomass, and good wind regimes in some regions, causing Brazil undoubtedly is one of the largest countries in the world for application of these technologies (44). The critical magnitude for evaluating the wind potential of a region is the local wind speed (v), which influences cube - shaped (v^3) in calculating the available potential (64). Therefore, the feasibility or otherwise of the use of wind systems essentially depends on the wind regime of the area concerned, and may be said, through the inúmetos cases already studied, that in general the operation of electricity generation through wind turbines should be considered only at locations which have a higher average velocity of the wind or of 6 m/s. For regions where the winds have available speeds below this, you should think only in the use of wind energy for water pumping (service small communities, irrigation, etc.), yet in places not served by the electricity grid, or where costs are high (64). The Brazilian wind map produced by Eletrobrás (1988), from data obtained by the Ministry of Aeronautics (at airports), and Secreetarias of Agriculture (meteorological ports), indicate that for the Manaus region an average speed of about winds 1,5m/s. Moreover, the study of ELETROBRAS also indicates the occurrence of high periods of calm produced by the influence of quante air masses that dominate the region, such equatorial landmass and intertropical convergence, the latter acting in almost every year, causing instability and the predominance of vertical movements of air masses instead of horizontal movement (64). Considering now the Manaus geographic localization, its high rainfall and the enormous array of small rivers and streams that cross the region, the little need for irrigation or water accumulation, it is concluded that the use of option wind power in this location must be virtually ruled out. This finding coincides with several other studies, such as the plan 2015 Eletrobrás (1994), citing only the north of Roraima as a promising area for wind energy utilization in the northern region of the country, and the study by the Electric Company of Amazonas (CEAM) (65).

As mentioned above, the Amazon region to the wind conditions for installing wind farms do not provide favorable conditions as shown in isopleta winds (Figure 17). So, do not be investment makes possible this kind of renewable power generation depending on wind conditions and other factors, for example, environmental conditions of the region, due to be the largest forest area in the world and a heritage of humanity in which all aim at forest protection, and also not provide conditions of large open areas such as the coastal areas of the northeast, southeast and south that, for the implementation of wind farms. However, for the use of renewable electricity generation from the use of photovoltaic cells, the Amazon region has an enormous potential and many challenges. However, in the Amazon, the challenges to bring electricity to the communities are extremely complex given its large territory and those humans habitating areas with compact, dense forest hydrographic web and in this condition, solar photovoltaic energies are considerated an alternative to energizing isolated and remote areas (65). The sparse populations in large areas of Brazilian amazon are difficult, in turn, the use of conventional electrification, but can be met by renewable energy, which even had a strategic character in border regions (44). In Amazonas state, we found several communities distributed along the rivers, distant from each other. Most of these communities are remote, remote areas of the capital and the cities of the state eainda difficult to access, being considerated by residents of these isolated community's dependent on forest resources and rivers for their survival(66).

Conclusion

The concept of sustainability in the generation and use of electricity aims to manage the ecosystem to establish a commitment to a harmonious relationship with the environment in an assessment of results and impacts on soil, water, flora, fauna and all the elements of nature. The buildings housing projects must therefore consider all the technical requirements always framed this concept to consider quality and sustainable projects (1). Brazil is a country rich in renewable resources, but needs to invest more in these areas and become less dependent on electricity polluting sources such as those used in power plants, and has water and wind potential that open you the possibility to produce in order renewable and sustainable, all the electricity it consumes in the present and future.

As shown in this work, we see the enormous potential that Brazil must generate electricity, in addition to the main headquarters that the country has for power generation (hydropower). However, on the advantages and disadvantages that each system has, we highlight for photovoltaic systems the following positive points.

Renewable and Sustainable: Solar radiation is a phenomenon naturalnão pollutant, and with the great advantage of being inexhaustible, plus desertion free, it does not require processing for your use. Poroutro hand, the manufacture of the equipment and materials necessary parauso the mounting system is for industrial processes in totalmentecontroláveis environmental pollution aspect, aprodução including solar panels. It is therefore a process of generation of electricity framed as sustainable. There is no mechanical movement motoresou parts in the system, there is no production deruídos (1).

Installation area: In residential projects, solar panels sãonormalmente installed on rooftops or buildings, ieemespaços unused constructions. In areas of parking, it has also been installed solar panels that serve as coberturapara cars.

Modular: If need to expand capacity in geraçãoelétrica, the system is modular, allowing additions by adding other panels (1).

Maintenance: The equipment and system components are simple technologies, so the need for maintenance is minimal. The duration, in terms of component life is long. The fabrication of photovoltaic cells and modules or plates is more sophisticated technology, particularly the cell due to the production of silicon (the most used today) with appropriate characteristics. Only countries that cell manufacturing technology are the providers worldwide (1). **Costs**: While the cost of investing in yet be high deployment, with the increased use of this type of generation already verified decay in prices, with continuous trend this fall. This tendency is making the generation of photovoltaic electricity a solution more economically viable. It is likely that in the near future, there is a faster evolution of this economic viability and the use of this power generation system becomes more popular. Operating source solar energy free (1).

Isolated Systems: The electricity generation by use of solar energy is umafonte excellent electrical supply to remote places oude difficult access, being isolated systems. Has been usually deployed to suit small loads of special purpose facilities (1). However, the disadvantage, the photovoltaic system consists of the following points:

Variable Generation: The amount of electricity produced has immediate variation linked to the weather conditions (cloudy, rain, snow). During the night there is some production, which requires the storage of energy produced in batteries during the day in isolated locations without public distribution network. The electrical energy storage in batteries, despite the continuous evolution, is limited in power to small powers (1).

Cost: Initial investment in Brazil is high more because dosmódulos photovoltaic transformation, which are always imported. Depending on the project, this investment may take longer to be amortized. You need to assess very carefully the costs versus benefits before deployment (1).

Performance and Limitations: Solar panels have up to 25% yield. This imposes a limitation on the performance of electric generation capacity because the number of solar panels that can be installed in the available area ownership. The conditions of atmospheric pollution in the system installation region may influence the photovoltaic generation capacity (1).

Difficulty: One aspect to be considered in the design of photovoltaic power generation in existing or new residential building, is about the direction in which the panels are to be installed, since, for greater efficiency must be oriented to the north, by because of better utilization of solar radiation. This aspect may not be framed as a disadvantage, but no doubt is relevant and may introduce additional costs (1).

As energy production with the use of energy sources from wind, you can highlight as positive points:

Environmental pollution and reduced water consumption don't produces carbon dioxide (CO_2) ; the installation of the project is fast compared to other energy sources; the wind is considered inexhaustible and renewable source of energy; wind power, has a sales and mature technology that has been employed on a large scale in developed nations since the early 90's; Brazil has water and wind potential that open you the possibility to produce, renewable and sustainable manner, all the electricity it consumes in this and consume from 2050; inventories of the Brazilian wind potential, estimated at 143 GW of turbines found on the market, installed on towers 50 meters and, more recent studies show that, with the development of more efficient turbines and higher towers, the potential may exceed 280 GW;

The disadvantage can stand out naturally: If the wind farm deployments are not properly planned correctly can cause environmental impacts that interfere with the migration routes of the winged wildlife, or cause acoustic impacts above tolerable limits in populated areas.

So, if conlcui that, alongside technical, economic and environmental requirements, the use of arising electric potential of photovoltaic and wind renewable sources is highly possible alternative economically and environmentally to be applied in electricity production that will meet the inhabitants of regions around the Brasil.When it comes to the Amazon, it is concluded that besides the main generator matrix of energy (hydroelectric) and the thermoelectric power matrix that serves the region, despite the costs are still too high, the photovoltaic renewable energy is one of the promising alternatives to meet energy demand in the region. However, in function of the factors already mentioned in this work, uses the energy matrix arising wind clean sources are not technically feasible for the Amazon region. Therefore, one can also assert that a clean energy system like the wind and photovoltaic, structured in Brazilian conditions would be entirely sustainable and would be able to indefinitely cover the Brazilian demand for electricity. This means that only with the use of sustainable clean energy sources, Brazil can, in the field of electricity, to match the highly developed European countries. In other words, development must be pursued through the improvement of education and public health, improved production processes and product quality, rationalization of telecommunications infrastructure and transport systems and so on - and of course, the rational use of energy for these purposes (68). Brazil is a country that is fully rich in sources of clean and renewable energy resources, however, it is essential that the government, private companies and society concienrizem and investammais in these areas to become less dependent on generating polluting energy sources, those used in thermal power plants.

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