CLEANTECHS AND THE COMPENSATION VALUES FOR ENERGY RETURNED ON THE NETWORK ON SOLAR PANELS: SUSTAINABLE DEVELOPMENT IN PERSPECTIVE

AS CLEANTECHS E OS VALORES DE COMPENSAÇÃO PELA ENERGIA RETORNADA NA REDE SOBRE PAINÉIS SOLARES: O DESENVOLVIMENTO SUSTENTÁVEL EM PERSPECTIVA

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ABSTRACT

Objective: This article analyzes the Cleantechs of the solar energy segment as a sustainable source of clean energy generation, which has grown in Brazil, albeit in an incipient way. The search for alternatives in the generation of electric energy has been the main reason why these startups have been sought, allied to the good climatic conditions found in the country during most of the year.

Methodology: It uses the deductive method, through bibliographic research and scientific articles on the theme, as well as national legislation.

Results: It is concluded that there will only be a sustainable consumption of clean energy when there is the possibility that more people will have access to this technology. For the time being, the compensation amounts will depend on the rates practiced by the concessionaires, which take into account a number of factors, including geographic position. The likelihood that there will be a cost reduction in the installation is still a distant project, but not impossible.

Contributions: The research is relevant since there is a promising market in the field of clean energy generation and in terms of the forms and values of compensation for the energy returned in the network on solar panels. The use of this technology is within the perspective of the energy transition towards sustainable development.

Keywords: Cleantechs; Solar energy; Electricity compensation system; Clean technologies; Sustainable development.

RESUMO

Objetivo: *O presente artigo analisa as cleantechs do segmento de energia solar como fonte sustentável de geração de energia limpa, que tem crescido no Brasil, ainda que de forma incipiente. A busca por alternativas na geração de energia elétrica tem sido o principal motivo pelo qual essas startups vêm sendo procuradas, aliadas às boas condições climáticas encontradas no país na maior parte do ano.*

Metodologia: *utiliza-se do método dedutivo, por meio de pesquisa bibliográfica e artigos científicos acerca do tema, assim como legislação nacional.*

Resultados: *Conclui-se que só se terá um consumo sustentável de energia limpa quando houver a possibilidade de que mais pessoas tenham acesso a essa tecnologia. Por enquanto, os valores de compensação dependerão das alíquotas praticadas pelas concessionárias, que levam em consideração uma série de fatores, inclusive de posição geográfica. A probabilidade de que haja redução de custos na instalação ainda é um projeto distante, mas não impossível.*

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Contribuições: *a pesquisa se mostra relevante vez que há um mercado promissor no ramo de geração de energia limpa e no tocante às formas e valores de compensação pela energia retornada na rede sobre painéis solares. A utilização dessa tecnologia situa-se dentro da perspectiva da transição energética rumo ao desenvolvimento sustentável.*

Palavras-chave: *Cleantechs; Energia Solar; Sistema de compensação de energia elétrica; Tecnologias limpas; Desenvolvimento sustentável.*

1 INTRODUCTION

The rupture of the market with the emergence of new technologies, driven by the idea of sustainability, makes Cleantechs seen in the financial markets and in the startup segment as a great marriage between incipient and profitable sectors. New paths and strategies emerge in the economic scenario; always seeking to ally with sectors whose social visibility can assist in the alleged raising of national and foreign resources.

Outside of Brazil, there is already a heated market with regard to renewable energy sources, which places Cleantechs as propellants in the solar energy sector associated with environmental issues. The production of this type of energy requires initial investment compatible with the subsequent gains, helps to preserve the environment and is often shown to be healthy in regions where electricity production is scarce or non-existent. The possibility of installing domestic and business panels (voltaic system) was a great advance with regard to the generation of clean energy and a possible compensation of energy and costs, reflecting in the values of the electricity bills directly to the final consumer.

In this way, it was possible that the traditional transmission lines could receive the energy back through the voltaic system that returns to the network for the distributors, causing the exchange of the use of the energy generated by hydroelectric and wind power, and, to a lesser extent, to be exchanged, in nuclear and thermoelectric plants. The growth of the sector has captured more entrepreneurial views for the sector, although it is still incipient in relation to international demands.

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Brazil, for having a generous water network, has invested throughout its history in the generation of electric energy through hydroelectric plants, despite having favorable climatic conditions most of the year, and, in some regions, practically in all seasons. This self-confidence was gradually demystified in the face of the progressive increase in the demand for energy supply, caused by the increase in population and the massive use of electrical appliances, in addition to industrial growth.

Some electricity demands in the country have been obtained through the generation of thermoelectric, nuclear and wind power plants.

In view of this situation, investors saw the possibility of implementing Cleantech projects in Brazil, in light of the good experiences that have been fruitful worldwide, both in economic and environmental matters. It is to say that the two perspectives were allied at a time when the world starts to be more concerned with the future of the planet, but does not give up maintaining the use of technologies and the modern way of life.

The electrical potential has changed a lot over the years as a result of the increase in consumer demand. Fernandes (2018) assures in relation to the possibility of using renewable energies for the production of electric energy that “the processes and forms of electric energy production have had a constant and continuous evolution, always in search of the best techniques and the lowest costs, which result in efficiency.”

In this way, the infamous renewable technologies are being promoted at all times, under the seal of sustainability and savings in real spending, both for consumption and financial expenditure. The startup model in which it only presents advantages is very attractive to many investors. Nevertheless, the Brazilian federal government, through the National Electric Energy Agency, has been trying to regulate the matter by means of resolutions, which will be dealt with in the course of the research.

Using a deductive method, through bibliographic research and scientific articles on the subject, as well as national legislation, the research is relevant since there is a promising market in the field of clean energy generation and with regard to the forms and values of compensation for energy returned to the grid on solar panels.

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Furthermore, in order to carry out this research, the study was divided at the moment. At first, it will be discussed about clean technologies, the so-called sustainable technologies with the use of renewable resources, which in the case of this research, will be turned to solar voltaic energy. Below, some considerations will be made about Cleantechs and the generation of solar voltaic energy, that which comes from solar capture through panels in homes and companies. In the following, general lines will be drawn about the electric energy compensation system in Brazil, focusing on the compensation values for the energy returned in the grid on solar panels and the real impact on the users' electric bill. All of these issues will be addressed from now on.

2 CLEANTECHS AND THE VOLTAIC SOLAR ENERGY

Traditionally, environmental control measures have been based on the application of emission release standards, whether in the form of concentrations of pollutants or loads, and / or in the fixation of maximum concentrations allowed in the receiving bodies, the so-called environmental standards.

The policy of sustainable development in several areas has brought about a real revolution on a global scale. The new technologies promise to reduce the impacts arising from human developmental activities and problems such as environmental impacts arising from the damming of water from hydroelectric dams, the waste produced with the production of nuclear energy and the pollution of thermoelectric industries.

On the subject, Kiperstok (1999, p. 49) asserts:

> Nature as a supplier of resources, renewable or not, whose preservation is a prerequisite for the continuity of the productive activity. Nature as a provider of fundamental information for technological development.

However, perhaps because it is still an incipient technology in Brazil, the use of panels to capture solar energy still requires a high financial investment, inaccessible

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to most of the population. However, there is a real guarantee of financial return in relation to the payment of the electricity bill traditionally distributed by overhead networks, which should only occur in the long term for compensation purposes. On the subject, Souza Júnior, Ghilardi, Madruga and Alvarenga (2019, p. 65) point out:

> [...] the initial costs for installing projects to capture solar energy are quite high, which constitutes a warehouse in its acquisition especially for the public sector, given the context of the financial crisis that forces the rationalization of resources, requiring forecasts and analyzes of economic and financial viability. Studies on the feasibility of projects provide an estimate of the value added to the business of a company or a person in the face of an opportunity with its return over time.

From the current perspectives, investments in the sector have grown over the years in the face of greater social awareness about the damaging effects of the generation of so-called dirty energies. There is a great need to promote effective and brief measures to reduce the environmental impact and allow the country to continue growing, without this costing the environment to collapse.

The risk that humanity runs due to not taking due care of the planet is visible, as there are already cases of permanent extinction of animal species, river pollutions that are difficult to treat, in addition to the immense amount of waste in the soil, in rivers and also in the sea, like what was called “garbage island”, located in the Pacific Ocean. As Luciano Costa Miguel rightly observes, “the constituent legislator made it clear that the preservation of other animals occurs to the extent that it becomes necessary to ensure the effectiveness of the right of all (human beings) to a balanced environment” (2019, p. 131), that is, the protection of the environment is a means to reach the end, which is the promotion of human life in healthy conditions and with dignity, this in an anthropocentric view.

The big question is that nobody knows what to do with the garbage, which is constantly generated and which increases on a geometric scale. The environmental impacts caused by the hydroelectric dams with the damming of water and the devastation of the affected areas compromise both the local vegetation and the habitat and life and several animal species. As if this were not enough, production is not

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enough to meet the growing demand, which requires energy imports mainly from Venezuela.

For this reason, the implementation of projects focused on clean energy proves to be a very attractive alternative both for the market and for society, captures investments for the country and still brings benefits to the environment. However, it is expensive, too expensive, and it is not even in the best dreams to be accessible through the State, which is limited to regulating the activity, directing initiatives and promoting, through partners in research associated with colleges such as the Federal University of Rio de Janeiro. January - UFRJ. But it is not known how long it will take to have public universities. Thus, according to Rockenbach and Bergmann (2018, p. 02):

> As seen, government actions are focused on encouraging the use of so-called clean energy. An example of this is the approval of two normative resolutions, nº 482/2012 and nº 517/2013 by the National Electric Energy Agency - ANEEL, where micro generation and the compensation of electric energy are made possible. In the case of the surplus energy produced, the return is made to the local electricity distributor, and the installer unit is compensated in the form of credit to deduct the tariff post or the invoice in the next month.

Kiperstok (1999, p. 51) asserts that the “implementation of Pollution Prevention implies a paradigm shift both in the production process and in domestic life.” Further, he concludes that, "the development of an attitude of perception of the way waste is generated serves as a basis for eliminating the causes of its generation."

In the midst of this entire imbroglio, some companies are at the forefront in order to encourage sustainable consumption of electric energy by means of the voltaic compensation system, the one made by means of solar panels placed on residential or business roofs. The real gain in compensation in values can sometimes lead to the settlement of the electric bill that would have been traditionally paid to electric utilities, which will be better treated in a specific topic.

However, once again, obstacles to the success of the project were highlighted: the high cost of its installation, dissemination and maintenance. The use of solar energy panels is high, compared to the traditional aerial cabling system already

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installed. Nevertheless, with the hope that development can continue, but in a sustainable way, it represents more than great financial gains.

The production of voltaic energy in Brazil is still a major challenge. Although growth in the sector has been observed through Cleantechs, it is a relatively new technology and has not yet reached the level expected in relation to specific technologies. According to Mendonça (2017, p. 07), “to understand all the nuances of the complex relational dynamics between startups and large companies, seeking to leverage synergies and mitigate divergences, [...]”, which can constitute a valuable path to innovation in the Brazilian energy sector.

Maria Valdete da Silva Bolsoni, Valdecira Aparecida da Silva Moreira and Valdicéia by Cássia da Silva Balbinot (2018, p. 83) argue that, “in some situations technology or worldviews can be decisive [...], that is, the help of science and technology, contribute favorably to the construction of the self-sustainable planet”.

For that, “[...] the regulatory environment, the research environment and the business environment must converge to form a Corporate Venture Capital model adapted to the Brazilian reality.” finishes Mendonça (2017, p. 07). In this sense, one of the main points presented by specialists in the area concerns the use of silicon as one of the raw materials for capturing this type of energy, not yet implemented in Brazil. Thus, as Silva points out (2015, p. 06):

> About 80% of photovoltaic cells are manufactured from crystalline silicon; 20% use thin films. In turn, crystalline silicon is obtained from quartz, which must be purified to the solar degree, which requires 99.9999% purity. Brazil has high purity quartz deposits, but has not yet developed the technology necessary to obtain solar-grade silicon.

In Brazil, “[...] the ecosystem of energy startups is still quite incipient. Considering Brazil's prominence in the field of renewable energies and sustainable development, this finding becomes even more intriguing”. (Mendonça, 2017, p. 06). The same author also adds that a reason for this scenario "[...] can be found in the characteristics of the investments of the last years of the resources of the P&D ANEEL, recently disclosed in the IX Citenel." Thus, according to the scenario envisaged, “[...] it was shown that research carried out in the sector is generally more focused on the first

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stages of technological maturity, causing few technologies to actually reach the market". (MENDONÇA, 2017, p. 06).

The country does not master this technology, and for this reason, it ends up being an obstacle in the projects of the plants, such as the increase in investment costs and the process of supplying the material, which needs to be imported. At this point, adds Fernandes (2018) that "it is also necessary to consider two practices that must be overcome: the high level of import of components and, many times, of completely finished projects, [...]", and end up harming the Brazilian technicians in relation to their experience in the subject. Still with Fernandes (2018):

> Another point to be discussed is the training of Brazilian professionals who can take the lead in the production of **photovoltaic energy**. Despite the efforts of universities in training specialists to meet the demand, there is still a lack of engineers with experience in the area of electrical generation, which is new and is in the expansion phase. About the formation of an experienced designer, in addition to the knowledge acquired in the academic experience, it takes time for practical learning in the execution of specific projects. For that, must be a counterpart in investments that allow the evolution of this professional in real projects.

The production of voltaic energy is shown to be advanced in some parts of the globe, which according to Silva (2015, p. 08) "Technological development occurred mainly in Germany, the United States, Japan and, in the background, in Italy, Spain and Norway. [...] ". The same author also adds that, "[...] studies for technological development in the photovoltaic industry are concentrated in China, the current leader in the production of photovoltaic panels." The countries that have the greatest potential when applying energy capture technology are the United States and Spain, although they use technological research and pilot plants related to solar thermal technology.

Sector data account for the amounts invested:

> According to data from StartSe, there is great interest in investments worldwide. On average, US $ 300 billion a year is spent on renewable energy. China occupies a share of US $ 100 billion, Europe is responsible for US $ 48 billion and the Americans are investing US $ 44 billion. In Brazil, investments are around US $ 7 billion. According to the data analysis, it is a promising market for entrepreneurs who are focused on specific technologies for the area. (FERNANDES, 2018).

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Mendonça (2017, p. 06) believes that “by linking these points, it is possible to see that the insertion of startups in the context of the Brazilian energy sector can be a great opportunity for several stakeholders.” Within governments, the possibility of formulating public policies “[...] is a means of inserting the country in global innovation chains, as well as increasing the impact and externalities of research funded and subsidized in previous years, [...] ”. These hypotheses cause:

> [...] developed patents and technologies reach the market more quickly. For researchers and research institutes, it is a way to monetize the knowledge generated through spin-off startups, enabling new models for research self-financing. In addition, for startups themselves, it is a great opportunity to access greater volumes of capital and networking necessary for their growth, fundamental, especially, for them to cross the moment between research and the market known as "death valley". (MENDONÇA, 2017, p. 06).

In the field of solar voltaic energy, it can be said, according to Rockenbach and Bergmann (2018, p. 05) “the photovoltaic system is made up of photovoltaic modules or panels, which play the role of driving energy into the system.” The author points out that “they can be one or more panels, being dimensioned according to the energy demand, being responsible for the transformation of solar energy into electricity.” In this way, “the panels are complemented by a set of equipment, such as charge controllers, batteries, inverters and protective accessories.” (Rockenbach; Bergmann, 2018, p. 05).

In Brazil, regarding this type of energy capture, according to Rodrigues (2018, p. 19):

> The Sun annually supplies 1.5 x 1018 kWh of energy to the Earth's atmosphere. This is a considerable amount, corresponding to 10,000 times the world's energy consumption in this period. This fact indicates that, in addition to being responsible for maintaining life on Earth, solar radiation is an inexhaustible source of energy, with a huge potential for use through systems for capturing and converting it into another form of energy (thermal, electrical).

Stolf (2016, p. 28) points out that with the publication of Normative Resolution 482/2012, in which the rules of the distribution system to the electric energy systems and also rules of the energy compensation system were introduced “[...] based on the

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net metering model, in which the consumer is allowed to generate energy through solar panels, entering a compensation system". It therefore constitutes a more specific starting point in regulating the deployment and use of solar energy.

Data presented through Stolf's research (2016, p. 27), in 2016 "the number of generation systems distributed in Brazil, considering all possible sources established by normative resolution 482, is 8,406. Of this total, 8,310 (98, 86%) correspond only to the generation of voltaic energy [...]". Thus, the trend that is observed is that the expansion of this type of Cleantech is a reality that is increasingly present today.

3 ELECTRICITY COMPENSATION SYSTEM IN BRAZIL

Among the techniques for harnessing solar energy, the use of photovoltaic panels stands out where the light energy is directly converted into electrical energy. This form of energy generation has recently been regulated in Brazil through Normative Resolution no. 482, published in April 2012, which establishes the conditions for access and regulates the electric energy compensation system.

In this sense, according to Fernandes (2018), "[...] there are already some investments in pilot plants for research purposes with the participation of national and foreign companies." However, the same author points out, "[...] it is still necessary to expand the number of these initiatives. When it comes to solar modules, there is an initial movement, albeit timid, in resources for research at universities. "

According to data collected on the website of the National Electric Energy Agency - ANEEL (2019):

> Brazil surpassed the mark of one gyga watt of installed power in micro and distributed mini-generation of electric energy. This is a major step forward, largely provided by ANEEL regulation (Normative Resolutions 482/2012 and 687/2015). Thanks to these actions, the consumer can generate his electricity from renewable sources or qualified cogeneration and supply the surplus to the distribution network of his locality.

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It is important to mention that the compensation system occurs in the on-grid voltaic model, which are those that operate in conjunction with the power grid and, thus, enable energy compensation. In the of-grid model, photovoltaic systems, whose free translation into Portuguese is equivalent to the expression “disconnected from the grid” (for not being connected to the electricity grid), “[...] are those that operate without any connection to the grid electricity distribution network of the local concessionaire.” (SANTANA, 2016). This type of funding does not require authorization from the electric energy concessionaires because they are isolated solar energy systems.

However, in the process in the on-grid voltaic model, connected to the electrical network and which enables energy compensation, as explained by Santana (2016), it has the following characteristics:

> The main distinction of these systems is the energy exchange carried out between them and the electric grid, providing discounts on the consumer's electric bill. In these systems, the photovoltaic modules capture sunlight, transforming it into continuous electric current, which is then transferred to the **Grid-Tie inverter**. This turns it into alternating current and sends it to the light board, where it will be used to power connected electrical equipment, **such as air conditioning, for example**. The energy generated and not consumed, is injected into the electricity grid and lent free to the distributor, returning to the consumer in the form of energy credits, which are used to **discount the electricity bill** related to what was consumed from the grid. (emphasis added).

The distinction between the two types of capture of solar voltaic energy allows us to conclude that both can store energy when there is surplus production. In that case, when there is surplus, depending on the system, you can then have different destinations. In on-grid mode, it will be injected into the power grid; if of the off-grid type, stored in a battery bank. According to Rodrigues (2018, p. 16) “The on-grid system depends on the network to function, so if the network goes down, it will be immediately turned off and not functioning as a backup system.”

Part of this process of production of voltaic energy started to be regulated, as already mentioned in this work, through Normative Resolution nº 482, issued by the National Electric Energy Agency - ANEEL.

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To make it possible to have access to this type of solar energy, any consumer actively registered with the Ministry of Finance by a CPF or CNPJ may obtain a concession to "[...] connect their own electricity generating system, from renewable sources. [...], in parallel with the distribution networks of the concessionaires. " By the general lines of the aforementioned resolution, the process appears to be accessible to anyone with an interest.

According to Rockenbach and Bergman (2018, p. 02) in the case of the surplus energy produced, "[...] the return to the local electrical distributor takes place, with the installation unit being compensated in the form of credit to reduce the tariff post the invoice next month. " The mentioned benefit "can be used by the consumer unit itself or by another unit of the same ownership." (ROCKENBACH; BERGMAN, 2018, p. 02).

It is important to note that only captive consumers of the distributor can subscribe, excluding, therefore, free, special or partially free consumers cannot be part of the Electricity Compensation System.

This is already a major cut in the possibility of joining the system, because, as will be seen below, the sector has grown and along with it the amount of accumulated energy, causing instability between the sectors involved and culminating in public consultation no. 10 for review of the standards that are currently in effect.

3.1 VALUES FOR COMPENSATION FOR THE ENERGY RETURNED ON THE NETWORK ON SOLAR PANELS

Normative Resolution no. 482/2012, as amended by n. 517 of the same year, when governing the process of injection and consumption of energy in the electric grid, it also created the electric energy compensation system, based on the reduction of consumption and use of the remaining balance to obtain credit, which can be converted into a discount in the amount to be paid to the concessionaire. The billing of this energy, according to the respective regulation, can generate up to 95% in the electricity bill.

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In order for this energy to be invoiced, as provided for in the aforementioned resolution, it is defined that, for consumers in group A[1] (high voltage - equal to or greater than 2.3 kW), at least the amount related to demand contracted. (ANEEL, 2012). For consumers in group B[2] (low voltage - less than 2.3 kW), the cost of availability of access to the network must be charged, as there is the possibility of generation to completely supply the active consumption of electricity, with no excess billing to be charged. (ANEEL, 2012).

With regard to taxes levied, in the case of consumers who have a distributed micro or mini-generation system of electricity, there is an exemption from taxes on the electricity injected by the system into the distributor's network, that is, this is a great advantage for those who produce their own energy. (SANTANA, 2016). This implies saying that "[...] all the energy that the photovoltaic solar system generates and that is not consumed instantly, goes to the distribution network." At the end of the month, the energy returns to the consumer without charging some taxes.

Cabello and Pompermayer (2013, p. 17) point out an important point:

> The financial viability will be verified if the amount spent to install the panels turns out to be lower than the expenses that the consumer incurs with the purchase of electricity from its distributor. For this, the average cost of energy generated by the photovoltaic system will be calculated, considering the investment in equipment and installation, the costs of operation and maintenance, the useful life and the cost of capital (discount rate), as well as the productivity of the system, which depends on the insolation of the place where it is installed.

[1] Depending on information collected on the ANEEL website, Group A comprises the "group consisting of consumer units with a voltage supply equal to or greater than 2.3 kV. Or served from an underground secondary voltage distribution system, characterized by the binomial tariff and subdivided into the following subgroups: a) subgroup A1 - supply voltage equal to or greater than 230 kV; b) subgroup A2 - supply voltage from 88 kV to 138 kV; c) subgroup A3 - supply voltage of 69 kV; d) subgroup A3a - supply voltage from 30 kV to 44 kV; e) subgroup A4 - supply voltage from 2.3 kV to 25 kV; and f) subgroup AS - supply voltage below 2.3 kV, from an underground distribution system. " (BRAZIL, 2019).
[2] Still with information collected on the ANEEL website, it appears that Group B is equivalent to the "grouping composed of consumer units with voltage supply below 2.3 kV, characterized by the monomial tariff and subdivided into the following subgroups: a) subgroup B1 - residential; b) subgroup B2 - rural; c) subgroup B3 - other classes; and d) subgroup B4 - Public lighting. " (BRAZIL, 2019).

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The authors also assert, “This cost is then compared to the tariff paid for electricity. Indirectly, consumers' income patterns and current habits were also considered. ” (CABELLO; POMPERMAYER, 2013, p. 17). Thus, even from the point of view of the tariff the photovoltaic system becomes viable, it is important to know if the expenditure that the consumer has with energy during the life of the equipment would in fact justify such a large investment.

The federal government grants exemption from the totality of the PIS (Social Integration Program) or PASEP (Program for the Formation of the Civil Servants' Patrimony) and COFINS. At the state level, all 24 states and the federal district receive an exemption from the ICMS tax rate for energy that returns to the electricity grid, that is, for that which is injected into the electricity grid. In this sense, it is stated that there is no need for these benefits to be requested from public electricity service concessionaires, because, according to Santana (2016), “once the photovoltaic solar energy system is installed and properly regulated, exemptions are now automatically granted.”

By way of information, according to data from ANEEL (2019):

> The states that most adhered to micro and mini-generation, exceeding 10,000 consumer units, were Minas Gerais (16.7 thousand generation units and 212.3 MW of installed power), Rio Grande do Sul (12 thousand units, 144.4 MW) and São Paulo (14.5 thousand units, 117.4 MW). In all, there are 82.9 thousand generating plants in the country, with 114.3 thousand consumer units that receive credits for the energy generated.

Although there is a high cost to implement the unit, long-term gains can represent a good investment, especially when it comes to companies. The consumer will be able, in the case of several consumer units; to choose which one will make the compensation, pointing out their order, only will not be able to exclude the generating unit, which should be the first to be compensated.

In real values, the amount to be calculated for compensation will depend on the rates applied by each of the concessionaires, and, as said, the electric bill will not zero, there will always be values that relate to the maintenance of availability service to consumer units.

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3.2 ANALYSIS OF REGULATORY IMPACT (AIR) OF THE REVISION OF NORMATIVE RESOLUTION No. 482/2012 AND LATER CHANGES

Since the advent of Resolution no. 482/2012 of ANEEL, the microgeneration compensation system (with installed power less than or equal to 100 kW) and mini-generation (greater than 110 kW and less than 1 MW) distributed obeyed the mechanism based on the compensation of 100% of non-energy consumed and returned to the electricity grid, in the proportion of 1 to 1 Megawatt (ANEEL, 2019). In this way, there is a free loan of the energy generated for the distributors, and later compensated on the consumption of the active electric energy that there may be.

Every three years, ANEEL reviews Normative Resolution no. 482/2012, so that the current revision (2019) should come into force 2020. However, the effects will only be put into practice in 2025, depending on the content and complexity of the decisions, but which can be offset by the 25-year guarantee, who may have to install distributed energy in 2019.

ANEEL devised a revision schedule for Normative Resolution 482/2012, to be started in the first half of 2018 with the advent of Public Consultation no. 10, and in the second half of the same year, the holding of Public Hearing no. 001, with extension until 2019. In the second half of 2019, the Agency's Board of Directors (ANEEL, 2018) also schedules a public meeting for approval of new rules.

The regulatory impact analysis was analyzed in the scope of commercialization, regarding tax exemption, measurement, legal restrictions and economic viability, while also being concerned with the exchange of credits between distributors, which is based on the application of the ICMS, allocation of network costs and complexity.

It is important to mention that this return through the electric power network has zero cost for the consumer unit that previously generated the energy captured through renewable sources (hydraulic, solar, wind, biomass or qualified cogeneration), in parallel with the distribution networks of the concessionaires. This system works like a battery, which stores the energy returned so that it can be returned in up to 60 months

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(amendment of the 36-month term provided for in Resolution No. 482/2012 by Resolution No. 687/2015) according to the demand of the consumer (ANEEL, 2019).

Regarding the modifications of Resolution no. 482/2012, asserts Costa (2018, p. 22):

> Three years after the publication of REN ANEEL No. 482, REN ANEEL No. 687 of November 24, 2015 changed REN ANEEL No. 482 and Modules 1 and 3 of PRODIST. Its main change came in article 1, changing the limits of microgeneration, which have an installed power of less than or equal to 75 kW and those of mini-generation with an installed power greater than 75 kW and less than or equal to 3 MW for water sources, or less than or equal to 5 MW for qualified cogeneration or for other renewable sources of electricity. Another considerable modification, in REN ANEEL, no687, is the definition of new modalities of distributed generation [...] The publication of REN ANEEL n. 786 of October 17, 2017 changes REN no 482, of April 17, 2012 in relation to the limits of energy production, already changed also by REN ANEEL no 687, increasing the maximum installed power from 3kW to 5kW for sources water resources.

With the growth of autonomous generating units and the consequent increase in the energy returned to the grid, the compensation, according to the energy distributors, became inadequate, considering that if the alternative energy generating units had the need to use the grid used by all. Nothing would pay for it, while the total cost would be distributed among the rest of the population who do not have micro or mini-stations of distributed energy.

However, although the distributors pointed out that the current compensation format is not adequate because it generates inequalities in payment in the face of the same use, even if occasional by those who have alternative energy generation, both consumers and Cleantechs understand that Resolution no. 482 serves the market, since it allows alternative energy generations and opens space for the sector's growth.

Some studies were carried out by ANEEL and the growth, since resolution 482 was verified, both in the minis and micro units of distributed generation and for energy accumulated and returned to the electricity grid. This type of energy comes not only from solar panels, but also from the wind energy sector as alternative and clean sources.

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The impasse is based on the verification of profits from one sector to another, causing a dispute for the consumer market, added to the fact that there is dissatisfaction of the current model on the part of the distributors that, as said, consider it inappropriate. The expansion of the distributed generation market leads to a retraction in the distributors' market and a decrease in the transfer to concessionaires, and can be seen as a cost for other consumers.

Thus, based on the studies carried out, there is an indication that "[...] the maintenance of the current rules indefinitely can lead to high costs for the other users of the network, who have not installed their own generation." Therefore, depending on the same source, [...] a change in the rules would be necessary after further consolidation of the distributed generation market. ” (BRASIL, 2019).

On the other side of the scale, installers and consumers, who believe that full compensation for the energy returned, are indispensable, since it allows the consolidation of the market, in addition to the benefits of this system for society.

Within the analysis of the regulatory impact that was the subject of a public hearing n. 001/2018 promoted by ANEEL (Public Consultation No. 10/2018), different ways of solving the problem of electricity compensation were researched, according to the findings of the technical team of the referred agency found solutions for the sustainable growth of distributed generation in the country.

According to data collected on the ANEEL website (BRASIL, 2019):

> The public hearing had three face-to-face sessions that were held in Brasília, São Paulo and Fortaleza. The purpose of making subsidies is to analyze different alternatives for the Electric Energy Compensation System, in view of the need to define a way of valuing the energy injected into the network that allows the sustainable growth of distributed generation in Brazil.

The valuation of this energy returned to the grid is the major key element, as it must consider different components of the supply tariff. Based on it, the proposals placed in the alluded audience initially contemplated the indication of the so-called “alternative 0”, in which there would be a compensation of 100% of the energy returned, with full use of the energy returned, as it is being done until then.

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A regulatory problem was the subject of constant complaints from electricity distributors and transmitters. For this reason, in 2018, Aneel published technical note no. 62 in order to define guidelines for dealing with these problems. Thus, the intention was "[...] to propose alternatives for improving the rules applied to the Energy Compensation System [...]", and, thus, "[...] to describe the steps to be carried out in the construction of the Regulatory Impact Analysis." (JESUS, 2019, p. 27).

It was from this Technical Note that the alternatives were raised in relation to the pricing of the current clearing system. In the same way that five billing alternatives were presented to the consumer units participating in the clearing system. Jesus (2019, p. 15) points out that the alternatives "[...] are differentiated by the way they value the energy injected into the network, each considering certain components of the energy supply tariff for such valuation." Nevertheless, according to the same author:

> After analyzing the possible effects of the projections made, Aneel determined which alternatives would have the least possible impacts, both from the point of view of the consumer with micro and mini generation and from the point of view of the consumer without micro and mini generation. Therefore, triggers for the activation of the alternatives were determined, that is, specific moments in which the scenario exchanges alternative zero (current) for a new alternative. [...] Aneel "triggers" called the moments for exchanging alternatives [...]. (JESUS, 2019, p. 16).

The monthly bill, therefore, will be equivalent to the net total consumed per month. This full compensation was fundamental for the success of the micro and mini-generation distributed in the country, but with the increase in this solution, as stated, some points were identified as unfavorable. In alternative one, the consumer with generation would pay for the amount corresponding to the transport for the distribution of energy that was consumed, that is, it would no longer be exempt from the distribution costs that are not currently paid, as there is 100% compensation, which includes the value of the distributors' services. If an average of the tariffs practiced in Brazil today is considered, it would be equivalent to 28% of the value of the kWh used. Thus, considering this percentage that would be paid, it would be equivalent to 72% of the use of returnable energy.

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In alternative two, the consumer would start to pay for all energy transport, transmission and distribution at the amount that was consumed, which is equivalent to 34% of the amount of kW / h consumed on average. This implies that the battery would return about 66% of the amount of energy returned.

Alternative three considers payment as the portion of transport and charges, which corresponds to 41% of the value of the kW / h used. It is as if the consumer receives 59% of the energy injected back into the battery (remembering that this energy corresponds to the surplus that generated in the micro or distributed mini-generation).

In alternative four, the costs of distribution and transmission, charges, are added, the consumer would still bear the costs related to the losses caused by the transport of energy, which represents on average about 49% of the value of the kW / h used. Thus, the return would be 51% to the consumer.

In alternative five, in addition to all charges levied on the others, the consumer would still bear the cost of charges relating to all tariff components, except for that relating to the purchase of energy. You will only pay for the net energy consumed at the end of the month. All of these values correspond to 63% of the value of the kW / h used, and, thus, would return 37% of the returnable energy.

However, considering all the alternatives, it is necessary to emphasize that a minimum fee has already been paid for the maintenance of the entire system. Thus, there is a charge even in alternative zero, with the compensation of 100% of the energy injected into the power grid. There is no absence of transfer, even by those who currently inject in the network the surplus energy from their micro or mini power generators.

According to ANEEL, all alternatives were taken into account, the impact on the playback of those who adhere to mini or microgeneration. In addition, it was analyzed that the attractiveness of investment in distributed generation depends on other factors, such as the incidence of taxes and the coincidence between consumption and energy generation.

All of this concerns the minimum fee charged for each consumer group, as, according to ANEEL Resolution 482 (BRAZIL, 2012):

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> For the billing of this energy, it is defined that; for "group A" consumers, the minimum amount must be charged for the contracted demand. Because there is, a possibility that generation will completely supply the active consumption of electricity, with no excess billing to be charged. In other cases, the billing is for energy consumption (active and reactive) during peak and off-peak hours, after having subtracted the energy credits from the compensation system at the same time it was generated.

And, even after compensation, when the energy credit generated by the unit is higher than what it consumed from the electricity grid, this surplus can be used to offset the energy consumption at the next post (time), with the proportion between values of energy tariffs (TE) for the different tariff stations (hours), since 1 kWh (kilowatt-hour) generated at off-peak has a TE value lower than the value of 1 kWh generated at the peak.

The alternative found, until then, has been based on the analysis of regulatory impact for normative alteration, which:

> [...] proposes that the current form of compensation be maintained until the power of distributed micro and mini-generation (GD) installed in each distributor reaches a certain level, both for remote and local systems (when the compensation occurs at the same address where the energy is generated).

The indefinite maintenance of this total compensation format over time, according to the study carried out by ANEEL, would imply an increase in the tariff for those who do not use the distributed generation system, burdening them. However, for those who have the compensation on the spot where it is generated, the total compensation can be maintained for some time, until the mark of 3.4-installed GW is reached.

Having reached this value, ANEEL concluded that alternative 1 should be adopted, in which part of the cost of energy distribution should be passed on to consumers who have distributed micro or mini-generation, with the use of approximately 72% . The total compensation, therefore, will cease to exist, since the total of what was injected into the network will have a reduced return and the remaining percentage will cover the costs of distribution transportation, which are currently not borne by the consumer. (ANEEL, 2019).

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The perspective that is deposited in this analysis is based on a projection made for 2035, in which there is an estimate that the power of 17 GW installed in a micro or mini-generation of distributed local energy will be reached.

In relation to micro and mini-generation of remote energy, which makes the energy compensation in a different place from the one where the energy is generated, if it is kept for a very long period according to the current patterns of compensation. It will cause, in the future, a significant impact on the cost of electricity to other consumers who do not have these alternative sources. For this case, still in the context of the changes that may occur with the proposals placed in Public Consultation no. 10 of ANEEL, there should be a change from alternative zero to alternative one when 1.25 GW of installed power is reached. According to the estimates of the regulatory agency, this mark would occur in 2022, that is, in the next 3 years. (ANEEL, 2018).

In a second moment, when the remote installation reached 2.13 GW of power, there would be a new change to alternative 3 (in which the transmission, distribution and charges on the electricity used are charged), as suggested by ANEEL, after studies on the regulatory impact of the revision of Normative Resolutions no. 482 et seq. In this case, there would be a reuse (compensation) of 59% of the energy injected into the electricity grid.

According to the same study, the 21 GW installed by 2035 are expected to be surpassed, exceeding the installed powers of the Itaipu, Santo Antônio and Girau hydroelectric plants together, which is equivalent to more than 13% of the potential of the installed generation capacity energy in Brazil in 2018. Therefore, it will represent an advance for the electricity sector, which constantly suffers from the reversals of the lack of rain, the cost of energy distribution and transmission, in addition to the growing demand.

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3.3 ADVANTAGES AND DISADVANTAGES TO DEALERS, DISTRIBUTED GENERATION ENTREPRENEURS AND CONSUMERS WITH REGARD TO ELECTRICITY COMPENSATION RULES

In view of all this information, it is possible to extract advantages and disadvantages to all parties involved in the context of generation, compensation, transmission and distribution of electric energy in the context of the generation of voltaic energy in micro and mini-generations. The problem is because economic losses are observed if the current rules are maintained, and if there is a change in the format that is being articulated, there will be losses in the same way, in different economic agents.

However, it is important to note that:

> The financial return of consumer units that decide to invest in distributed generation is directly related to the price that the consumer would have to pay for energy if he had consumed it on the grid. Therefore, the return is greater for those who pay higher tariffs, which are consumers connected at low voltages, up to 2.3 kV, such as homes, businesses and small industries. (JESUS, 2019, p. 38).

The current rules benefit consumers who have opted to join the generation of voltaic energy, because there is full compensation for the energy generated. Due to the growing demand, power generation companies were able to invest in technology and solidify themselves in the market. In this sense, Costa points out (2018, p. 17):

> In addition to technical and environmental factors, GD presents a favorable economic factor for consumer units. According to REN ANEEL No. 482, consumer units that produce energy can inject the surplus energy produced by them into the integrated network, thus generating a credit that can be used to deduct from the electricity bill. All of this is intended to attract investment and increase the production of renewable energy in Brazil.

Due to current demands, these two sectors are satisfied with the rules contained in Resolution 482/2012, modified by Resolution no. 687/2015 in some points. However, if there are changes based on the alternatives inserted in the

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commands of Public Consultation n. 10 of ANEEL, in all of them there are losses for consumers, which will have reduced their net energy return margin when they need to use it, increasing, consequently, the value of the energy bill.

In other words, the attractiveness of the investment (which is not low) is because, in addition to power generation, there is an opportunity for consumers to compensate for the energy injected into the power grid at a ratio of 1 to 1 kW; therefore, there are no additional costs in this transaction. If there is a drop in values, the entrepreneurial market in the renewable energy sector - and here all of them are considered, and not just those fruits of solar energy generation - may be harmed, as there may be a dropout or a decrease in those interested in joining to that kind of sustainable technology.

Through the studies carried out by Jesus (2019, p. 39):

> ANEEL's regulatory impact analysis took into account the premise that households suitable for local generation would be all those whose caregiver received more than five minimum wages, which resulted in a total of 8 million apt consumer units, according to the 2010 IBGE Census.

On the other hand, energy distributors consider that this scenario is not adequate, since the costs that are not borne by distributed energy generators end up being passed on to those who do not have mini or micro-generators and depend on the electricity grid. In other words, they claim that there are higher costs for the rest of the population, as the cost has to be borne by someone. In another step, consumers of distributed energy are exempt from the cost of the available energy, even if not used.

However, we cannot forget that the use of distributed energy, in general, brings benefits to all those mentioned in this topic, since it decentralizes the total generation of energy, avoids losses in transmission and distribution and makes clean energy available to other consumers. These are the factors that can be quantified, since there are still benefits such as job creation and a reduction in the emission of carbon dioxide, emphasized at all times by those interested in passing on costs to consumers, who have distributed mini or microgeneration.

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The advantages of the distribution companies, in turn, are in the increase of the profit with the transfer of the injected energy through the compensation, since part of that energy would be retained at the source to cover their services. This concern has even been a flag raised by ANEEL itself, which is constantly concerned with the decrease in the size of the distributors' market, threatened, apparently, by the growth of the distributed power generation sector. At the opportunity, according to the contribution of Athon Energia S.A. to public hearing no. 001/2018 of ANEEL (FREITAS, 2018, p. 05-06):

> 6. STRUCTURAL REGULATORY CHOICES. [...] 6.3 Size of the distributors' market. It even caused us an initial surprise to say that one of the biggest concerns of ANEEL, in this regulatory review process, was to preserve the "size of the distributors' market". It seems to us that, with concerns of this nature, in this type of evolutionary context, ANEEL could delay the development of the energy market in Brazil. Should the economic growth expected for Brazil materialize in the coming years? There is a tendency for there to be an increase in the demand for electricity; however, with so many innovations emerging both in international markets and in Brazil, it seems unreasonable to assume that the size of the distributors' market will follow this growth, in the same proportion.

Therefore, for distributors, their growth will not keep pace with that of renewable energy companies, be they solar, wind or any other.

The concessionaires, in turn, claim that, in the current model, "[...] who generates their own energy pays a tariff that does not cover the cost of the concessionaire who has to make the distribution network available." There is, therefore, a pressure on the part of the distributors for ANEEL to regulate the collection of extra fees for those who produce their own energy, so that they can remunerate the concessionaire and pass it on to the distributor.

In view of this, it is interesting to the concessionaires that there is a change in the form of compensation, with the setting of new percentages of return with the consequent tariff of the energy used from the electric network, in the percentages already mentioned in this work previously. Maintaining the model as it is, according to them, fails to remunerate them properly, which prevents them from growing in the sector.

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The great truth is that the growth of micro and mini power generation terminals represents an obstacle for the hydraulic power generation sector to maintain itself. According to Jesus (2019, p. 17):

> In the last two years, after REN's revision No. 482/2012, the micro and mini generation grew significantly in Brazil and exceeded the projections made by Aneel. In 2017, the installed capacity reached 68% above the regulator's highest projection.

The advantages for all the economic agents involved (generation, transmission and distribution) are reflected in lower environmental impacts and in the generation of jobs. On the other hand, the disadvantages are materially based on the economic impact that surrounds the situation, which will be borne by the consumer, be it the consumer (the one who produces and consumes electricity) or the ordinary consumer.

4 FINAL CONSIDERATIONS

Throughout the research, the importance of searching for new forms of energy generation that could guarantee the means for a future succession of non-renewable energies was seen. Although clean energies and renewable energies do not have the same definition, but are presented in a complementary way, the conclusion that is reached is that both are fundamental for the search for a balanced environment, far from pollution and degradation.

Thus, the use of clean technologies, such as the generation of energy through solar panels, although still incipient in Brazil, has been gaining more and more space, attracting more and more investments. It was verified that the importance of looking for new means of energy increases the environmental discussions and makes the population turn to the consumption of conscious alternatives in relation to the environment in which they live.

Through Cleantechs, it was possible to combine technology with the goal of sustainable consumption and environmental preservation. The main characteristic of

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which is the fact that this type of startup develops in the midst of issues projected for the future, where an ideal is sought to combine several areas and concepts to achieve satisfactory results within the proposed area. Clean technologies, in free translation, sell the mark of sustainability and concern for the present and the future of the environment, and it turns out to be an attractive option in the concept of preserving the environment.

The reduction of impacts, a concern secondary to the use of clean technologies, is also a factor that influences the decision to opt for the use of solar energy in the voltaic modality, highlighting that Brazil has great potential for generation in practically all year in all the regions of the country.

With regard to compensation, it was seen that, in relation to the initial investment, which is still considered high, one must keep in mind the monthly consumption of the place where the generating unit will distribute the transformed energy. However, this type of thinking, apart from the environmental issue and closer to the economic sphere, deviates from the real intention of using clean energy, although it cannot be ignored. Henceforth, there is still a high cost for implantation, repelling many good intentions, with the aggravating factor that the majority of the population does not have the financial conditions to have access to the service.

For this reason, at this point, its use by the general population is still unfeasible, and in relation to those who are able to have it, the initial investment ends up discouraging them. In addition, there is the fact that, although there is a possibility that there will be generation of solar energy converted into electricity greater than that consumed, and that there may be the injection of energy into the network in the on-grid mode, even so, the account of electricity will never reset.

Although, there are also several incentives from both the federal and state governments with regard to taxes levied on the energy bill. There will still be a charge for the provision of the service by the public service concessionaire, which will pass on the funding costs to the final consumer, distribution and maintenance of the networks, which did not seem unfair, since there is a potential public service.

Even so, what remains to be seen is that there will only be a sustainable consumption of clean energy when there is a possibility that more people will have

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access to this technology. For the time being, the compensation amounts will depend on the rates practiced by the concessionaires, which take into account a number of factors, including geographic position. The likelihood that there will be a cost reduction in the installation is still a distant project, but not impossible. Attracting investments and betting on public policies, perhaps are good options.

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