




THE RESILIENCE OF THE ELECTRIC SECTOR AFTER COVID-19 AND THE IMPACTS ON THE PHOTOVOLTAIC SOLAR ENERGY MARKET

La resiliencia del sector eléctrico tras la COVID-19 y las repercusiones para el mercado de la energía solar fotovoltaica
A resiliência do sector eléctrico após a COVID-19 e os impactos para o mercado da energia solar fotovoltaica

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Fecha de recepción: 20 de mayo de 2021.

Fecha de aceptación: 15 de julio de 2021.

ABSTRACT

INTRODUCTION. The Brazilian electricity sector and parts of society are experiencing the impacts of COVID-19, which spreads throughout the world, paralyzing all or part of its activities. The reduction in electricity consumption leads to an analysis of the stability of the Brazilian energy matrix that serves different social segments. **OBJECTIVE.** The objective of this work was to carry out an analysis of the electric power generation sector and its standardization, the perspectives of its post-Covid-19 behaviour and the role of renewable energy sources, in particular the photovoltaic industry. **METHOD.** An analysis was made of the electric power generation sector and its standardization, the prospects for its post-Covid-19 behaviour and the role of the solar photovoltaic systems. **RESULTS.** Scenarios evaluated: updating of the regulatory framework for the Brazilian electric sector, the solar energy market photovoltaic, electricity consumption and the solar photovoltaic systems as a complementary source in this climate change scenario. **DISCUSSION AND CONCLUSIONS.** It is concluded that sustainable transitions on the planet, associated with economic growth, promote human development for a low carbon community.





Keywords: Brazilian electric sector, solar energy market, photovoltaic industry, Covid-19 impact.

RESUMEN

INTRODUCCIÓN. El sector eléctrico brasileño y parte de la sociedad están experimentando los impactos del COVID-19, que se extiende por todo el mundo, paralizando todas o parte de sus actividades. La reducción del consumo de electricidad lleva a analizar la estabilidad de la matriz energética brasileña que atiende a diferentes segmentos sociales. **OBJETIVO.** El objetivo de este trabajo es realizar un análisis del sector de generación de energía eléctrica y su normalización, las perspectivas de su comportamiento post-Covid-19 y el papel de las fuentes de energía renovables, y en particular, del sector fotovoltaico. **MÉTODO.** Se realizó un análisis del sector de generación de energía eléctrica y su normalización, las perspectivas de su comportamiento post-Covid-19 y el papel de los sistemas fotovoltaicos. **RESULTADOS.** Escenarios evaluados: actualización del marco regulatorio del sector eléctrico brasileño, el mercado de la energía solar fotovoltaica, el consumo de electricidad y el sistema solar fotovoltaico como fuente complementaria en el contexto del cambio climático. **DISCUSIÓN Y CONCLUSIONES.** Se concluye que las transiciones sostenibles en el planeta, asociadas al crecimiento económico, promueven el desarrollo humano para una comunidad baja en carbono.

Palabras claves: Sector eléctrico brasileño, mercado de la energía solar, industria fotovoltaica, impacto de Covid-19.

RESUMO

INTRODUÇÃO. O sector eléctrico brasileiro e parte da sociedade estão a sofrer os impactos da COVID-19, que se está a espalhar por todo o mundo, paralisando todas ou parte das suas actividades. A redução do consumo de electricidade leva a analisar a estabilidade da matriz energética brasileira que serve diferentes segmentos sociais. **OBJECTIVO.** O objectivo deste trabalho é realizar uma análise do sector de produção de energia eléctrica e a sua normalização, as perspectivas do seu comportamento pós-Covid-19 e o papel das fontes de energia renováveis, e em particular, do sector fotovoltaico. **MÉTODO.** Foi efectuada uma análise do sector de produção de energia eléctrica e a sua normalização, as perspectivas do seu comportamento pós-Covid-19 e o papel dos sistemas fotovoltaicos. **RESULTADOS.** Cenários avaliados: actualização do quadro regulamentar do sector eléctrico brasileiro, do mercado solar fotovoltaico, do consumo de electricidade e do sistema solar fotovoltaico como fonte complementar no contexto das alterações climáticas. **DISCUSSÃO E CONCLUSÕES.** Conclui-se que as transições sustentáveis no planeta, associadas ao crescimento económico, promovem o desenvolvimento humano para uma comunidade com baixo teor de carbono.

Palavras-chave: Sector eléctrico brasileiro, mercado de energia solar, indústria fotovoltaica, impacto Covid-19.





INTRODUCTION

The occurrence of crises that affect the world requires an analysis of the facts, their causes and consequences, and sometimes leads people to changes in habits and behaviors that may be permanent. The Covid-19 pandemic has been imposing reflections on what, how it is occurring and how it would be preferable to invest time, money and choices. Furthermore, suppose the reflection is conducted with clarity. It is essential to look for scenarios or issues, which mirror investors in the solar energy sector, entrepreneurs or prosumers (producers and consumers) and public administration, aspects pertinent to these eventualities, such as *i)* What will happen to the solar energy market when the pandemic crisis passes? *ii)* What will be the new opportunities for the sector? *iii)* What are the teachings of pandemic coping? and, *iv)* What resources on the planet can use to implement photovoltaic technology?

According to the analysis carried out by the Energy Research Company (EPE) [1], some of the parameters of the projected load review for the next few years may suffer reductions as a result of some effects, namely: *a)* short-term or temporary, with lower consumption of electric energy; *b)* permanent, of medium or long duration in the consumption patterns, with alteration of permanent habits or not, as an effect of the distance or forced social isolation and; *c)* structural elements, which will be carried out regardless of the crisis, however, with deadlines for execution on the agenda that may change [2]. Considering the impacts for the electricity sector [3]–[5], is possible to ponder some questions: What would mediate actions that would mediate the effects of this abrupt collapse for the electricity sector? Would short-term actions be necessary and what would they be? How to resume activities after the crisis? and, what are the indicators for the pricing of the photovoltaic solar system? On the other hand, the concern with the environment and the use of fossil fuels is becoming a partnership that brings a certain discomfort: how to implement a development that generates work and technology based on the use of resources that contaminate the planet. In this sense, it is necessary to reflect on how to achieve human, economic and environmental sustainability in synchronicity, as studies indicate a bi-directional causality between CO₂ emissions and economic growth, leading to an environmental quality cost [5]–[7].

The United Nations in Brazil [8], established the terms of Sustainable Development Goal 7, SDGs, determining, as targets, by 2030: *i)* affordable prices for energy services, universal, reliable, with uninterrupted availability; *ii)* a significant increase in the use of renewable energy in the energy matrix; *iii)* energy services with efficiency twice as high as the global percentage; *iv)* research in clean energy technology and energy efficiency, with international centers; and, *v)* expansion and modernization in technology for energy services and sustainable projects, focusing on less developed countries, island developing and landlocked development.

In this context, the objective of this work was to carry out an analysis of the electric power generation sector and its standardization, the perspectives of its post-Covid-19 behavior and the role of renewable energy sources, in particular, the photovoltaic solar system, in this scenario, of climate, social and economic changes that involve all nations.



METHOD

Regulatory framework of the Brazilian electrical sector

The projection of energy load in the National Integrated System (SIN), 2017-2021, until then, far from imagining the scenario of the pandemic cycle, foresees an increasing demand, for the monthly load, for the maximum demand and the maximum demand instantaneous, in a study carried out by the Energy Research Company (EPE), in the 2nd quarterly review of the projections, illustrated in Figure 1.

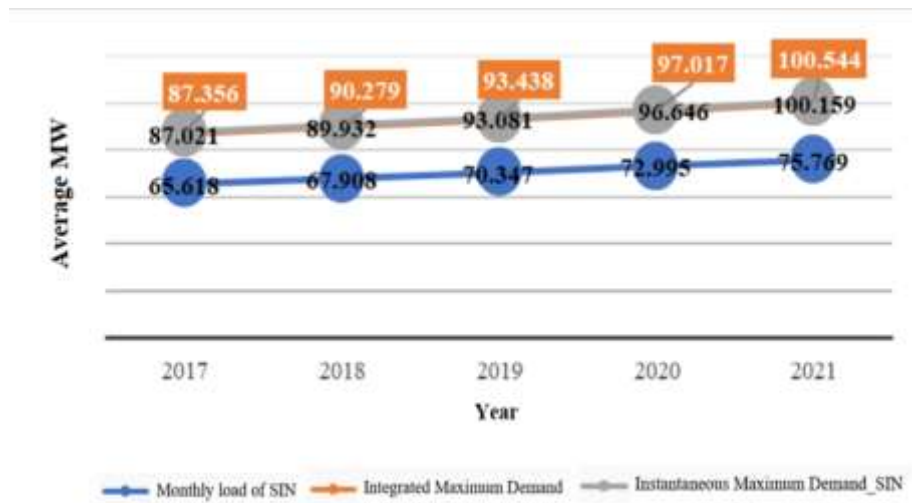


Figure 1. Load projection at SIN, 2017-2021, before the pandemic. **Source:** EPE [1].

Given the uncertainties, the National Electric Energy Agency (ANEEL) expressed its opinion on the over-contracting of the amounts for the use of the Transmission System (MUST), performed by the distributors at the access points and contracting times to the primary network, indicating reanalysis of the device Normative Resolution No. 666/2015, which deals with the portion of inefficiency due to over-contracting of these amounts. The SIN determines that the contracting of electric energy and regulated power is duly registered with the Electric Energy Trading Chamber (CCEE) and the difference between the MUST amount contracted and verified by the measurement is determined in the evaluation of the efficiency of the contract [9], [10].

The atypicality of the moment and the sustainability of the electrical system, taking into account the preservation of the public electricity distribution service, should be evaluated in several shades, especially the solar system [11], [12]. The CCEE's stance should be to seek the maximum effort to analyze the pandemic reality with its degree of complexity and its impacts in the most diverse sectors, with the mitigation of involuntary damages, structuring and reevaluating positive commercialization models for the sector, without preferably, make disproportionate transfers to the consumer account, resulting from the compensation of the seasonal risks [9], [13].



The Energy Development Account (CDE), established by MP 950, provides for the provision of resources, exclusively, through a tariff charge to assist electric energy distributors in the amortization of financial operations linked to the pandemic, ensuring the sustainability of the entire chain and respect for contracts [14]–[16]. However, the energy generated and distributed needs to pay effectively so that the distributors would cover part of the default from consumers of the social tariff (9 million people), prorating the rest with the other actors in the entire chain the captive market and free [2], [14], [15].

The Brazilian photovoltaic market followed Public Hearing No. 1/2019 of ANEEL to review the distributed generation rules, proposing an update of its regulatory framework REN 482/2012 and REN 687/2015. In addition, ABSOLAR (Brazilian Solar Energy Association) informs in a study that the total operational photovoltaic solar power installed in the country is only 5,918 MW, corresponding to 1.6% of the Brazilian energy matrix, whose primary source is water. The world energy matrix consists of 13% of renewable sources for industrialized countries and 6% for developing nations. However, in Brazil, 60.3% of generation comes from hydroelectric plants [11], [16]–[20]. Though, in its analysis, they are opposed to ANEEL to update the regulatory framework, which in addition to not considering such aspects, raises the payback period of the project when it uses a financing rate of 4% per year for economic analysis—not practiced—in the market (1.1% per month) [2], [21]–[25].

The REN 878/2020 established by ANEEL determined for 90 days that requests for inspection and connections are referring to Micro and distributed Mini-generation systems' connections be suspended, classifying such services as non-emergency/essential. Thus, the consumer who made a loan assumes two accounts in this period, the energy account and the system financing account [18], with operational limitations for the sector. Pending legal decisions will have a considerable impact on the sector [26]. However, public services have managed to serve most of the population concerned with guaranteeing their survival, thus not posing themselves as critics and analysts of rules and contracts, celebrated between investors and institutional environments susceptible to renegotiations [6], [26], [27].

There are initiatives to expand options for the consumer, which have been carried out by the legislature. One of them is the Bill of Law that is pending in the Federal Senate, 232/2016, which among other items, proposes a free energy market, with the portability of the electricity bill between distributors, in demands of loads greater than 3,000 kilowatts (kW), extending to all consumers, after 42 months, after its sanction, allowing the choice of its supplier freely. Such a probability would boost the solar sector [20], [22], [28]. The events demonstrate the need to strengthen institutions so that investments in infrastructure, energy, health, security, and education are guaranteed and cannot be driven by small groups' interests, mainly seeking profits from these services. It is essential to emphasize and point out the essential topics for the establishment of the declaration of rights of consumers of clean energy so that in times of doubt, there is a legal basis for claims and resources for possible losses, imposed by interests, sometimes dubious [4], [11], [16], [22], [24], [26].



Post-pandemic photovoltaic solar energy market

The sources of electric power generation, their applicability and the level of reliability made of them are decisive for its choice as an alternative. In particular, the solar heats the Earth, fuels life, and there is the technology that transforms it into electrical energy. Its implementation is associated with public opinion, representing a multidimensional problem in politics, technology, market businesses, reliability and the cost-benefit ratio [11], [12]. Ortega-Izquierdo and Río [11] developed the implementation of renewable sources in European Union (EU) countries and evaluated the cost/benefit ratio of the photovoltaic solar system with water, biomass/biogas/waste, wind and geothermal. They considered the fossil fuel economy, avoided CO₂ emissions and the energy cost of implementing each one. They found that the most significant results are for the fossil fuel economy, comparatively, with avoided CO₂ emissions. The estimated average base for the value of CO₂ per ton was 32 € / tCO₂ about the total invested in the projects, Figure 2.

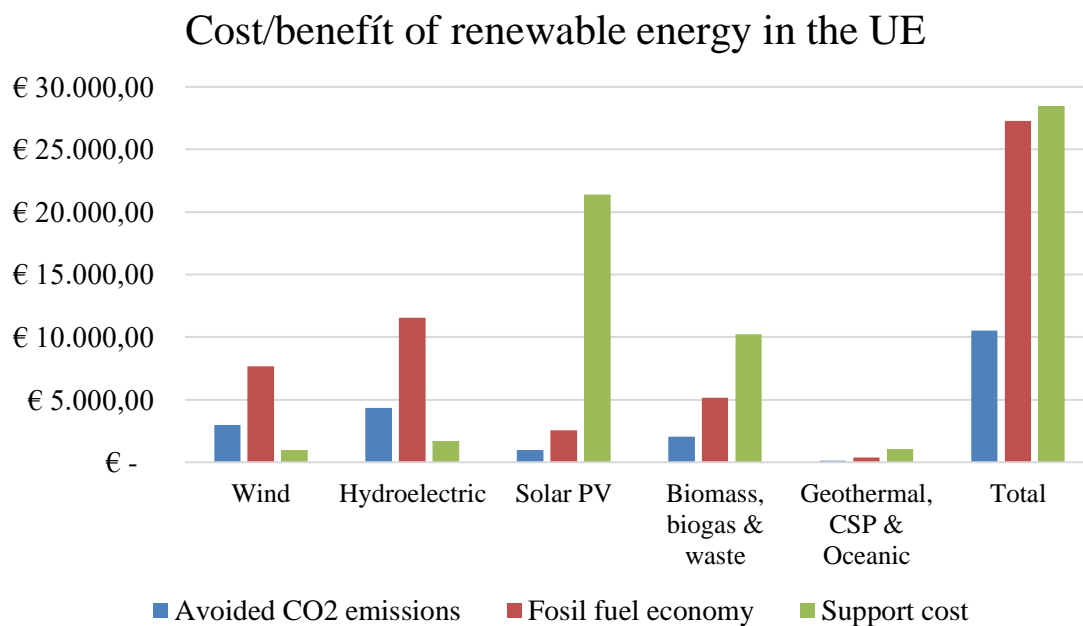


Figure 2. Load Cost-effective insertion of renewable energy in EU countries, considering avoided CO₂ emissions, fossil fuel savings and country cost for insertion of technology. **Source:** Prepared by the authors based on Ortega-Izquierdo and Río [11].

Figure 2 shows a record of the values of CO₂ emissions avoided in the EU. The water source, followed by wind, biomass/biogas/waste, the photovoltaic solar system, reach more interesting balances in Germany. The sequence repeats regarding the fossil fuel economy; however, the most relevant gains occur for photovoltaic systems in Spain and Germany.

The technology of renewable sources, and the market to develop and self-finance, needs to receive contributions [16], [29]–[31]. However, it is necessary to rethink such a model in view that the role of the photovoltaic system and other sources implies relevant technological and environmental aspects [16], [31].

The construction of this management model, the resources destined for operation, maintenance and expansion of energy matrix should occur without having to be surprised by a pandemic outbreak, such as that of COVID-19 or by the failure of the current system, packed by the sin of unpredictability or studies, in scenarios of change, possible, that should be evaluated and planned, considering the insertion of renewable energy sources and highlighted photovoltaic solar, on a large scale [6], [32].

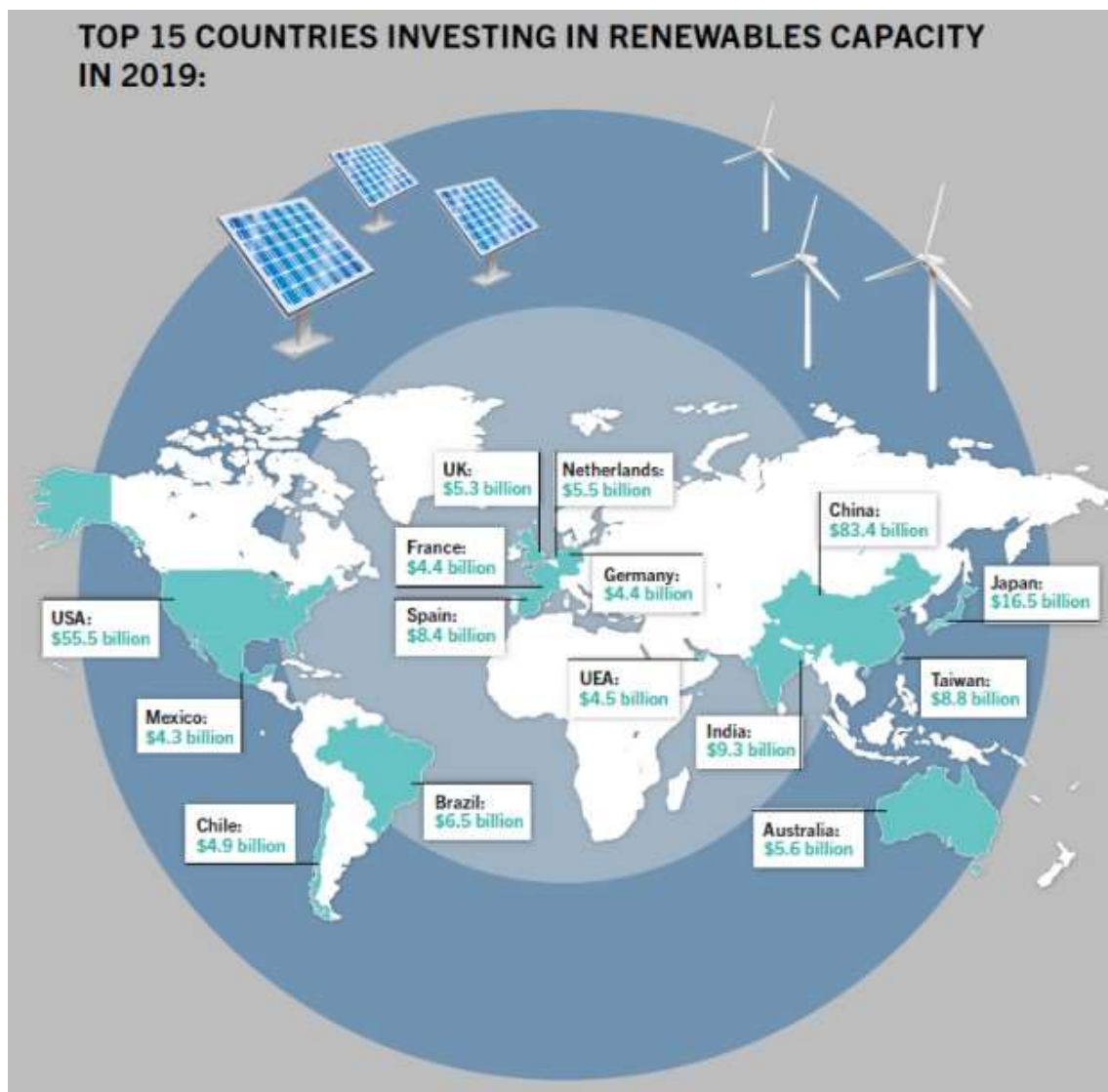


Figure 3. Countries that have invested the most in the implementation of renewable sources in the world. **Source:** Frankfurt School - UNEP Collaborating Center, Bloomberg NEF [33].

The interest in photovoltaic energy has created a favourable environment for businesses, stimulating research in the area, which seeks efficiency and greater efficiency in a generation [34]–[36]. Therefore, sources of environmental financing for the transformation of the electric power industry with smart grid and microgrid operating systems; hydrological resources; the strengthening of existing systems with preventive and corrective improvements with new transmission technologies; plans for a new energy generation mix for the country, integrating the conventional system; technical review of the communications sector for economic growth and the global competitiveness of new products and services, combining functionality, connectivity, portability and energy storage, are needed [30], [37]–[39].

Figure 3 illustrates the 15 countries that most invested in renewable sources in 2019, in a clear movement that drives climate action, prioritizing clean energy in economic recovery plans due to the effects that COVID-19 has on the fuel sector. Fossils, objectives that approximate the Paris Agreement's proposals and targets, Conference of the Parties (COP21). Brazil agreed to reduce CO₂ emissions, increase the share of sustainable bioenergy by 18%, reforest 12 million hectares of forests and have its energy matrix made up of 45% renewable energy by 2030 [33], [40].

IRENA [39] evaluated how many jobs were created by the sector, with the insertion growth of renewable energies in the world, like a positive impact on the planning of low carbon economic growth (Figure 4). Necessary prerequisites, such as telecommunications, electricity, sanitation and transportation logistics, and urban mobility, stimulate the generation of jobs that demand electricity, boosting production and economic growth. The photovoltaic insertion, with the reduction of costs and the opening of the energy market, with the decentralization of the generation and distribution of energy, may lead to other sectors that depend on it, with an integrative approach and to techno-economic models [6], [8], [41].

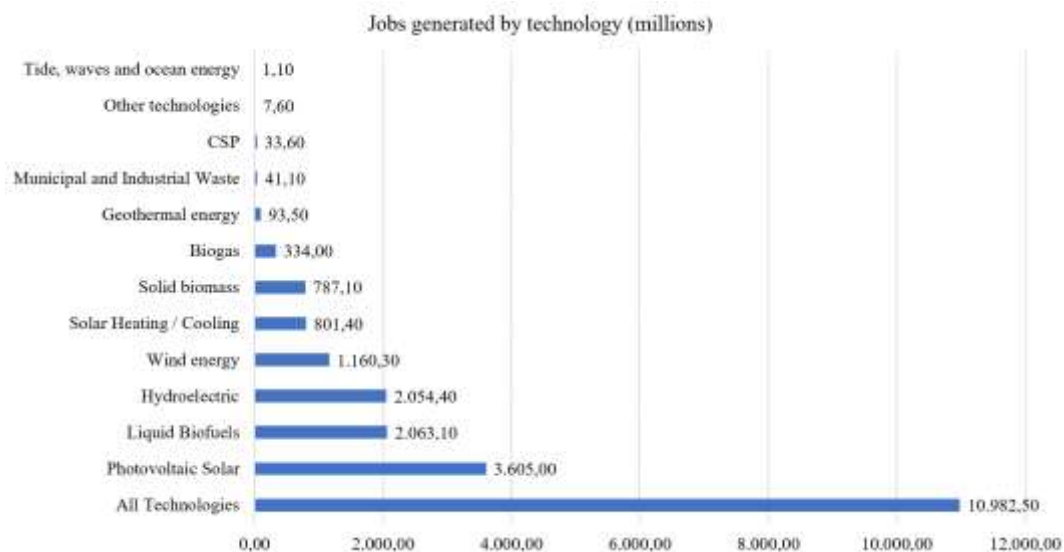


Figure 4. Renewable energy sources in the world and job opportunities. Source: IRENA [39].

The trend of the photovoltaic solar system's installed capacity, comparatively, between Brazil and the world, is illustrated in Figure 5. It can be observed the increase of its insertion, in the country, more significantly, from 2016, that despite being timid to the world, it represented the triple of the previous year.



Figure 5. The trend of installed capacity of the solar photovoltaic system, Brazil versus the world. **Source:** IRENA [39].

This growth is attributed, basically, to the reduction in technology costs and the increase in the value of kWh, paid by the consumer, via conventional energy source, with an LCOE (Lowest Levelized Cost of Electricity) of 0.3410 \$/kWh in 2010 and 0.1860 \$/kWh in 2018, receiving investments, in this period, in the order of 1,462.1 trillion dollars in the world [39]. However, the use of renewable energy positively impacts the economic system, since with the demand for cargo met, there is a reduction in environmental impacts, climate, social and economic sustainability [42], [43]. Besides, changes in the profile of the consumer stand out, who more consciously sought to acquire more efficient electrical equipment, moving away from energy consumption from non-renewable sources, leading to a 7% decrease in cargo demand, while the economy grew 13 %, in the period between 2009 and 2015, associated with population growth [43]–[45]. In this context, public policies must promote the decentralization of energy supply, expanding the solar market and the number of consumers. In this context, the photovoltaic solar system will play a significant role in the energy transition.



RESULTS

Social, economic and environmental aspects

During the COVID-19 crisis, the world is witnessing a drop in the value of the American oil price (WTI - West Texas Intermediate) traded on the New York Stock Exchange, a reference for the American market and Brent oil, with contracts, being traded for WTI, at values below US\$ 0, indicating a drop in global demand of approximately 30%. What happens is the significant volatility of WTI commodities due to the excess supply of barrels and the lack of physical space for the storage of barrels acquired by operators [46]–[48].

In the market with the non-consumption of fuels, commodities' behaviour reflects the business environment designed by the social distance with the industrial sectors, the productive structures, the retail trade and closed non-priority services, impacting the unrealized trade between cities, states and countries. The behaviour of ADRs (shares of companies outside the US traded in New York) in the Brazilian market fell by 4%. At the end of the year, the forecast for the Brazilian GDP is that it will assume a negative variation of 0.9% to 1.8%, depending on the isolation period of 2 to 3 months, respectively. Table 1 describes the estimate for the segment [48].

Table 1. Projection of Brazilian GDP in 2020, after the pandemic

Inflation for 2020	- 0.14 %
Administered prices	-0.15%
Inflation for free goods	-0.13%
Food inflation	-0.11%
Services	-0.18%
Extrative activities	-38.46
Agricultural GDP	2.5%
Comerce	0.4%

Source: IPEA [48].

Figure 6 shows the analysis of the EPE [1] for the projection of the energy load dimensioned by the Annual Planning 2020-2024, indicating that there will be a drop in energy consumption, comparatively, between 2020 and 2021, 0.9%.

The economic scenarios, broken down by sector, in the PDE (Decennial Energy Expansion Plan 2020) allow data analysis and energy consumption estimates for future markets, respecting the specificity of each of the alternatives. However, with the advent of the crisis, the pent-up demand in the period was postponed for a longer time, thus tending to a not very fast recovery after the pandemic, which will lead to revisions of the PDE for 2024 [49]. In an analysis carried out by the Institute of Applied Economic Research (IPEA), the scenarios for the 2020-2021 biennium estimated and the parameters for the evolution of world trade and influence on the economy, show that the period experienced by humanity is unprecedented over the past 100 years and there is no forecast of how long it will last [48].



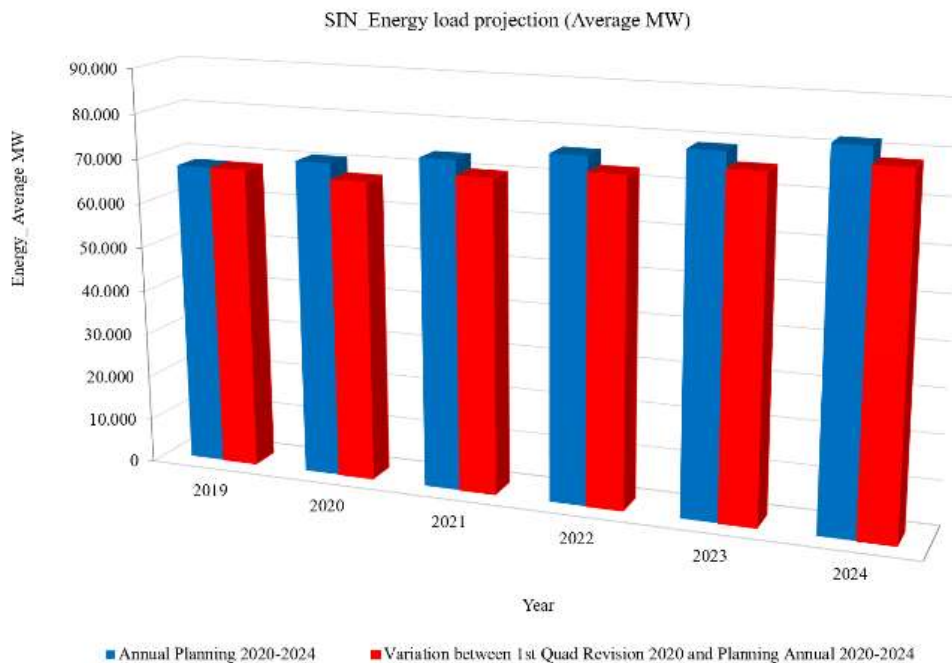


Figure 6. Projection of energy load in the SIN: Average MW. **Source:** EPE [1].

On the other hand, emphasizing its management, ANEEL ensures and certifies control in the quality sector of electricity distribution services and guarantees that the DEC (Equivalent Duration of Interruption per Consumer Unit) indicators. With this measure, the duration of interruptions in the energy supply and the FEC (Equivalent Interruption Frequency per Consumer Unit), which measures its frequency, reached a record in 2019 of minimum time for the system to be unavailable to consumers, an average of 12.77 hours without power.

Thus, it is assessed that the increase in efficiency with the demand reduction may indicate potential energy savings [2], [5]. In the same way, individual and collective efforts to protect people's lives, jobs and income, seeking to restore reliability in the economy, mitigating damage to trade, with social isolation, managing public health policies to combat the pandemic and financial, can lead responsibly to the heating of the various sectors, contributing to the growth of the economy and, consequently, to the rural, residential, industrial energy demand and means of transport [50].

Impacts of the implementation of the post-crisis solar photovoltaic system

Massive investments have made available to save man's life. However, nothing that takes place today will make sense unless resources are also made available for a clean and green transition. The volume of investments aimed at companies to minimize the damage caused by COVID-19 makes it evident that it is possible to make investments available in the creation of green jobs, green companies, in short, in green energy. The need to protect the environment is already noticeable, it is a matter of survival: there is no economy if there is no life that benefits from it [32], [46], [47].



Until now, human beings have had the posture and attitude of domination, of rampant exploiters of natural resources; it is necessary to understand the economy and progress, the self-worth of each creature, the human sense of ecology, the need for debates sincere and honest, the weighty responsibility of international and local politics, the culture of disposal and the proposal of a new lifestyle [8], [41], [51], [52]. The sensitivity analysis should start to consider the adversities of the climate in the financial balance. However, the criteria must be followed by all actors in the process so that, in joint action, it is possible to care for the planet's environment because, like the virus, pollution does not respect borders [8], [32], [53].

Climate change affects everyone, just like the COVID-19 virus, its impacts and effects are transmissible. It is necessary to instruct the whole society for the rational use of water, soil, air, biodiversity, technical knowledge, and investments in the political, social, economic and environmental education areas [6], [32], [53]. A decarbonization process suggests that action plans for the energy transition are carried out quickly. In the Paris Agreement, COP21 (2015) recommended that global warming be kept below 1.5°C, considering the income growth rate of 1.93%, in force during 1971-2015. However, experiences show that society's acceptance is necessary and needs to bear the costs of inserting technology [7], [24], [53]–[55].

According to IRENA [56], after 30 years of useful life, we will have an estimated stock of 78 million tons of raw material discarded worldwide from the solar sector, which indicates that if this material was recovered, it would inject in the economy a value that exceeds US\$ 15 billion, until the year 2050. In addition to financial gains, studies in the economics of cutting-edge recycling technologies for end-of-life silicon photovoltaic modules indicate a 74% reduction in terrestrial ecotoxicity, in the human toxicity potential by 26%, global warming potential by 24% and acidification of water resources by 37% over the entire cycle, with landfill, glass recycling, mechanical recycling and recycling standing out as options thermal [54], [56]–[58].

There is no reference in the history of macroeconomic models that design ideal alternatives for humanity. It is necessary to learn from mistakes, rethink attitudes and build new paths [52], [59]. In this scenario, the Luz para Todos Program is mentioned, in which 245 thousand women started to work another 309 thousand started their studies, reinforcing the social aspect with the insertion of technology, bringing together segments in a task force, as does GWNET (Global Women's Network for the Energy Transition) acting through interdisciplinary networking, for the development of joint actions that boost qualification in the female labour market [7], [8], [34]–[36], [59]–[61]. Also, the incentives instituted by the public authorities are undoubtedly the driving force behind the implementation of renewable energy sources, preparing and promoting their sustainable development in a business environment with less influence from centralized energy production and distribution groups and investors in fossil fuels. However, the involvement of different sectors of society mirrors the understanding, still limited, about technology's benefits [4], [22], [24], [25], [52].





Experiences in the United Kingdom, Germany and Spain show the importance of public policies and the elaboration of a Brazilian code for electric energy, which guarantees in its regulations, clarity of understanding and reduction of bureaucracy in its regulatory framework, mitigating conflicts of interest, meeting efficiently and competitiveness in the supply of energy to the consumer, leading to social, economic and environmental sustainability — given the principle of equity in the treatment of unequal, observing the natural resources of each region of the country, as well as their demographic and meteorological characteristics [6], [62], [63]. Table 2 highlights the differences between them; the Spanish driving by the elite and the German by large sectors of civil society [52].

Table 2. Comparison between energy transition between Germany and Spain

	Germany	Spain
Economy	Productive, active extroverted accumulation regime, stable context factor	Funded, outgoing passive accumulation regime, unstable context factor
Civil society	Active consent for renewables; active dissent against fossil and nuclear technologies	Passive consent for renewables; passive dissent against fossil and nuclear technologies
Government	Strong legislative power, deliberation, guidance on commitments, high responsiveness	Strong executive power, without transparency, commitment guidance limit, low responsiveness

Source: Haas [52].

However, Pilatowska [7] observed that since 2019, CO₂ emissions from electricity generation in Spain fell 33.3%, compared to 2018, reaching their target for 2030. Result obtained with the end of dependence on coal mineral in the generation of electric energy, promoted by the agreement between countries of the European Union, stimulating natural gas and renewable energy, in substitution to fossil fuel. Towards this trend, some Brazilian experiences and or projects stand out to mean a lot for the insertion of renewable energies through public policies on Brazilian soil. The LPT, *Luz para Todos* Project, extended by decree in Brazil, estimates the accessibility to electricity for more than 2 million Brazilians from rural areas, from isolated regions and the North and Northeast of the country until 2022 [49].

The Ministry of Mines and Energy (MME) [14], published Ordinance No. 244/2020 approving the Operational Manual and determining the basis for the National Program for the Universalization and Use of Electric Energy in the Legal Amazon. Similarly, More Light for Amazon (MLA) aims to serve 70 thousand families living in remote areas





whose subsistence comes from fishing, flour production, the extraction of chestnuts and fruits from the Amazon Forest.

Barriers, challenges, and opportunities will arise from this process, leading to managing and operationalizing the traditional distribution grid. Microgrids have been a studied proposal for integrating distributed energy sources with energy storage systems in the electrical network. Unamuno and Barrena [65], proposed the use of hybrid AC / DC microgrids, associating the advantages of the interconnection of the AC, DC and conventional energy networks. Its scalability would allow implementation in several levels or configurations, used in both low and medium voltage, and scalability and modelling or design. The energy transition should happen because there is a planetary limitation; there is urgency in this new model's sizing, with distributive energy (open source). The transition could bring accessibility and decentralization of energy supply, leading to reduced network overload and transmission losses. In its restructuring process, it may expand the role of renewable energy sources in its energy matrix, with a more significant role in the complementarity model between sources, strengthening the Brazilian market in its process of reframing competitively and efficiently in the post-pandemic period [4], [6], [41], [64].

DISCUSSION AND CONCLUSIONS

Sustainable transitions are long-term transformation processes. They are multidimensional and fundamental, acting as instruments for socio-technical systems, already established, to change and lead to modes of production and consumption protective measures for the environment.

As a result of social withdrawal or lockdown, the photovoltaic solar system's regulatory framework was suspended, auctions postponed, the industrial and commercial load had reduced demand, and instability in the ongoing business plans was generated. Investors, financiers, consumers, and public managers began to reflect on the government policies implemented and the necessary adjustments to map and rethink models in a future market, seeking to predict imbalances in the return of activities after COVID-19.

The Chamber of Deputies and the Federal Senate, as well as other authorities, will have a fundamental role so that the projects that pass through the National Congress are accepted and advance positively so that the legal framework for the distributed micro and mini generation meets the legal requirements necessary for its broad membership in the country.

The economic growth levels reached by the modern world indicate that natural resources have been used to an excessive extent. In this period of critical reflection, environmental sustainability associated with economic growth needs to consider the New Economy proposal so that social well-being is also included in the analysis, as an economic factor that influences life standards. Society has the opportunity to put itself on the path, prioritizing its human development, and, in this way, to evaluate the





demand for renewable energy, which should be essential for this period of energy transition and the future of a low carbon community.

DECLARATION OF INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CONTRIBUTION OF THE PAPER TO THE LINE OF RESEARCH

This article presents an analysis of the current COVID-19 pandemic and its impact on the electricity sector in Brazil, especially on the solar PV industry. In this study, a systematic literature review was carried out on Brazilian regulations, international standards, other research related to the subject of the study, etc. The results of this study will allow further research to be conducted to evaluate how the pandemic has affected different aspects of society.

STATEMENT OF EACH AUTHOR'S CONTRIBUTION

All authors jointly developed each section of this article.

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