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SOLAR ENERGY IN CEARÁ: EXPANSION PERSPECTIVES AND POTENTIALITIES FOR THE TOURISM SECTOR

Energia Solar No Ceará: Perspectivas de Expansão e Potencialidades no Setor Turístico

Energía Solar en Ceará: Perspectivas de Expansión y Potencialidades para el Sector Turístico

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ABSTRACT

The study explores the development of the photovoltaic solar energy market in the state of Ceará, considering its integration into regional production arrangements and energy transition policies. The analysis examines the articulation of this sector with local economic dynamics, establishing a connection with strategic tourism sectors. The study begins with an overview of Ceará's current context, emphasizing its potential for both solar energy generation and economic development, and highlighting the importance of integrating these sectors to promote more sustainable and balanced development, benefiting local communities and the environment. The research adopted a mixed-methods approach, combining quantitative and qualitative analyses on solar energy production and its application in tourism enterprises. The article details the growth of the solar energy market in Ceará, presenting data on installed capacity, investments made, and ongoing projects. The synergy between the sectors is illustrated through examples of initiatives that combine hotel tourism and sustainability. The results show that the integration of this market has the potential to generate significant benefits. Solar energy not only contributes to reducing energy costs in businesses, but also attracts tourists interested in sustainable practices. The study also addresses the challenges faced, such as the need for adequate infrastructure and public policies that encourage this integration.

Keywords: Photovoltaic Solar Energy; Sustainable Tourism; Regional Development.

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RESUMO

O trabalho explora o desenvolvimento do mercado de energia solar fotovoltaica no estado do Ceará, considerando sua inserção nos arranjos produtivos regionais e nas políticas de transição energética. A análise contempla a articulação desse setor com dinâmicas econômicas locais, estabelecendo relação com os setores estratégicos do turismo. O estudo inicia com uma introdução ao cenário atual do Ceará, enfatizando seu potencial tanto para a energia solar quanto para a economia do estado, destacando a importância de integrar esses setores para promover um desenvolvimento mais sustentável e equilibrado, beneficiando comunidades locais e o meio ambiente. A pesquisa utilizou uma abordagem mista, combinando análises quanti-qualitativas sobre a produção de energia solar e aplicação em empreendimentos turísticos. O artigo detalha o crescimento do mercado de energia solar no Ceará, apresentando dados sobre a capacidade instalada, investimentos realizados e projetos em andamento. A sinergia entre os setores é ilustrada por meio de exemplos de iniciativas que combinam turismo hoteleiro e sustentabilidade. Os resultados mostram que a integração desse mercado tem potencial para gerar benefícios significativos. A energia solar não só contribui para a redução de custos energéticos em empreendimentos, mas também atrai turistas interessados em práticas sustentáveis. Também são abordados os desafios enfrentados, como a necessidade de infraestrutura adequada e políticas públicas que incentivam essa integração.

Palavras-chave: Energia Solar Fotovoltaica; Turismo Sustentável; Desenvolvimento Regional.

RESUMEN

El trabajo explora el desarrollo del mercado de energía solar fotovoltaica en el estado de Ceará, considerando su inserción en los arreglos productivos regionales y en las políticas de transición energética. El análisis contempla la articulación de este sector con las dinámicas económicas locales, estableciendo una relación con los sectores estratégicos del turismo. El estudio comienza con una introducción al contexto actual de Ceará, enfatizando su potencial tanto para la generación de energía solar como para el desarrollo económico del estado, destacando la importancia de integrar estos sectores para promover un desarrollo más sostenible y equilibrado, en beneficio de las comunidades locales y del medio ambiente. La investigación adoptó un enfoque metodológico mixto, combinando análisis cuantitativos y cualitativos sobre la producción de energía solar y su aplicación en emprendimientos turísticos. El artículo detalla el crecimiento del mercado de energía solar en Ceará, presentando datos sobre la capacidad instalada, las inversiones realizadas y los proyectos en curso. La sinergia entre los sectores se ilustra mediante ejemplos de iniciativas que combinan turismo hotelero y sostenibilidad. Los resultados muestran que la integración de este mercado tiene potencial para generar beneficios significativos. La energía solar no solo contribuye a la reducción de costos energéticos en los emprendimientos, sino que también atrae a turistas interesados en prácticas sostenibles. También se abordan los desafíos existentes, como la necesidad de una infraestructura adecuada y políticas públicas que fomenten esta integración.

Palabras clave: Energía Solar Fotovoltaica; Turismo Sostenible; Desarrollo Regional.

1 INTRODUCTION

The increasing integration of renewable energy technologies has provided significant impacts on various economic sectors, including tourism in the hospitality sector. In the state of Ceará, the adoption of solar energy not only contributes to the diversification

of the energy matrix, but also strengthens the local economy and stimulates sustainable tourism. The combination of favorable weather conditions and robust public policies positions Ceará as a leader in the development of renewable energy, especially solar and wind.

The Wind and Solar Atlas of Ceará highlights the vast photovoltaic potential of the state, with more than 10,000 km² of areas suitable for solar and wind exploration, favoring the creation of hybrid projects that share infrastructure and become economically more competitive. Such a complement in power generation provides a more stable and continuous supply, which is essential to meet growing energy demands, including those coming from the tourism sector.

The management policy adopted by Ceará includes long-term development plans, such as "Fortaleza 2040"[1] and "Ceará 2050"[2], which aim to promote sustainable and inclusive growth. Support for micro and small companies, as well as the presence of a consolidated production chain, strengthens the business environment and encourages the improvement of new technologies and energy solutions structured and based on sustainability.

In this context, tourism in Ceará directly benefits from solar energy initiatives. The availability of clean and renewable energy not only reduces the carbon footprint of tourism developments but also attracts tourists interested in sustainable practices. Examples of this are the practice of kitesurfing in Cumbuco and Ilha do Guajiru in Itarema, which stand out for their ideal conditions for water sports, in addition to promoting sustainable tourism. According to Setur (2024), 60% of tourists interested in sports and adventures seek Ceará to practice kitesurfing, attracted by environmental awareness and the appropriate structures for the practice of this sport. Additionally, robust energy infrastructure can support the expansion of resorts and other accommodations, contributing to economic growth and job creation in the region.

The promotion of the tourism sector in Ceará is supported by investments in infrastructure and marketing campaigns that highlight the natural beauty and the state's attribution to economic, social and environmental sustainability. Initiatives such as the implementation of solar energy systems in hotels and inns, as well as the development of eco-friendly tourist itineraries, have attracted a growing number of environmentally-

[1] The Fortaleza 2040 Plan is a plan for the city of Fortaleza with strategies to be implemented in the short, medium and long term (with the year 2040 as a horizon).
[2] Ceará 2040 is a collaborative strategic planning platform, focused on the sustainable development of the state, built with the active participation of the population.

conscious tourists. The training of professionals in the tourism chain to deal with sustainable practices is also a priority and a *sine qua non* condition for the tourism trade, ensuring that visitors have experiences aligned with environmental preservation.

The study analyzes the impact of the solar energy market on tourism in Ceará, aiming to observe the promotion of sustainable development and generation of socioeconomic benefits. The objectives include evaluating the state's solar potential and its applications in tourism, investigating the economic and environmental effects of solar energy on tourism enterprises, and examining public policies that encourage this integration. The basic assumption of the research is the combination of an exploratory-descriptive approach; combined with a technical premise of documentary research and analysis of statistical data from the solar and tourism energy sector in the state of Ceará.

The results include the identification of Ceará's solar potential, highlighting how it can benefit tourism and other sectors of the economy, the socio-environmental evidence of the adoption of solar energy, such as the reduction of operating costs, job creation and reduction of carbon emissions. An observance of public policies that have proven effective in promoting the integration of solar energy into the tourism sector was also carried out, identifying government actions that favor this synergy and contribute to the sustainable development of the region.

It is important to note that, although tourism is cited as one of the benefited sectors, the research focuses mainly on the structural role of solar energy in regional development, but this growth goes beyond tourism. The creation of direct and indirect jobs in the installation and maintenance of solar systems, combined with the strengthening of a local production chain, contributes to the reduction of socioeconomic disparities. In this sense, it should be said that access to solar energy in remote and rural areas of the state has promoted improvements in the quality of life of communities, facilitating economic and educational activities. Thus, Ceará positions itself as an example of how the synergy between renewable energy and regional development can generate comprehensive and sustainable benefits.

2 THE RISE OF SOLAR ENERGY IN CEARÁ

In the transition from the 1980s to the 1990s, the economy of Ceará began to prioritize tourism as a strategic segment for state development. The expectations were explicit: to foster business and generate employment and income through the promotion of

the state as an attractive destination for lovers of the sun and beach tourist segment, marking the beginning of tourism as a great market business. Currently, the solar energy generation sector has also shown promise, attracting investors and benefiting the tourism sector with sustainable initiatives.

According to Ipea (2017), the instruments and resources of the explicit federal regional policy were mostly allocated to the North and Northeast regions, with the objective of attracting foreign private enterprises. To this end, fiscal and financial incentive mechanisms were intensively used, aiming at reducing the costs of installing productive capital in these areas.

This change in perspective culminated in impressive economic growth in Ceará. According to the IBGE's Monthly Survey of Services (PMS) (2024), tourism in Ceará has shown considerable growth in recent months. In January 2024, Ceará had a growth of 11.9% in the index of tourism activities, the highest in the country. In April 2024, the state had a growth of 6.8% in the volume of tourist activity, higher than the national index. In June 2024, the state had a growth of 14.4% in the volume of tourist activity, the second highest in the country, compared to the same period in 2023. This result is a direct reflection of the political and corporate governance strategies adopted in recent decades.

In addition to boosting this sector, the Sun has also become an essential source of renewable energy. The conversion of electrical energy from sunlight, although it seems complex, is a technically understandable process. Solar radiation is captured by photovoltaic modules, composed of silicon cells that convert light energy into direct electric current through the photovoltaic effect. This energy is then converted into alternating current by inverters for residential or industrial use, and can also be stored in battery systems for later use.

According to the Government of the State of Ceará (2022), the first commercial Solar Power Plant in Latin America went into operation in 2011. Located in the municipality of Tauá, in the Sertão dos Inhamuns, MPX Tauá started operating with an initial capacity of 1 MW, enough to supply energy to 1.5 thousand families. The park occupies an area of 12 thousand square meters and has 4,680 photovoltaic panels, which absorb sunlight for transformation into electricity. The project conceived by MPX for the solar plant reaches 50 MW.

According to Amaral (2022), the generosity of photovoltaic energy has stimulated significant investments in both residential and commercial areas, where consumers can purchase energy as a commodity. This market benefits large consumers, such as

commercial and industrial complexes, who seek to reduce their energy expenses, which can account for more than 10% of their operating expenses. Ceará has stood out in this scenario, occupying the 10th position in the national ranking of distributed generation, with 398.4 MW of installed power, according to the Brazilian Association of Photovoltaic Solar Energy (ABSOLAR). Fortaleza is in the 6th position among the municipalities, with 95.1 MW of installed power.

2.1 The logistics infrastructure and the growth of the photovoltaic sector

Ceará's logistics infrastructure, exemplified by the Port of Pecém, located in the municipality of São Gonçalo do Amarante and the metropolitan region of Fortaleza, has also played a decisive role in the growth of the photovoltaic sector. In 2021, the port recorded a 26.7% increase in container handling with solar components, such as inverters, modules, and photovoltaic panels. This infrastructure facilitates the import and distribution of the components necessary for the expansion of solar energy in the state. (ADECE, 2022)

The growth of solar energy has directly contributed to the strengthening of tourism, especially in coastal and inland regions. The adoption of photovoltaic systems in inns, resorts and ecotourism enterprises reinforces the state's sustainable appeal, expanding the offer of services aligned with the green economy. At the same time, tourism infrastructure benefits the expansion of distributed generation, creating a mutual relationship between the two sectors in regional development.

Companies from neighboring states, such as Pernambuco, have invested significantly in Ceará, especially in the interior, where there are vast spaces available for the installation of photovoltaic panels. As an example, there is the Apodi Complex, in the municipality of Quixeré, which was the first solar park built in the world by the Norwegian oil company Equinor. (ESTADÃO, 2020)

According to Enel Green Power, the municipality of Quixeré should also receive another solar energy generation park close to 449 soccer fields. The structures are projected to be implemented in a polygonal of 449.41 hectares at the Cerrado Farm. The area will be a photovoltaic solar energy generating unit with a nominal capacity of up to 241 MWp. (ABSOLAR, 2021)

Ceará, with its entrepreneurial potential and vocation for alternative energy sources, stands out as an example of how solar perception and use can transform an economy. The Sun, which was once seen as a villain, is now a symbol of prosperity and innovation,

boosting both tourism and the clean energy sector, solidifying the state as a potential leader in sustainability and economic development.

3 METHODOLOGICAL PROCEDURES

The research used a mixed approach, including secondary data collection and analysis of reports, publications, and statistical data from the solar energy and tourism sectors. The quantitative analysis included the evaluation of indicators of installed solar energy capacity and tourism growth, while the qualitative analysis investigated public policies and the impact of solar projects on tourism enterprises.

The methodology addresses the combination of these elements, both quantitative and qualitative research, providing a broader and more detailed view of the object of this study. The analysis focused on an approach of statistical correlation between the installed capacity of solar energy and the performance of the tourism sector in Ceará. Data from different sources, including reports and market studies, were used to identify patterns and trends in the growth of solar installations in areas of high tourist concentration. The work also involved the comparison of annual data and the projection of future scenarios, considering both the energy infrastructure and the tourism potential.

It is worth highlighting the stage that includes the use of data from the Wind and Solar Atlas of Ceará (2019), as well as the Global Wind Atlas (2024). The Wind and Solar Atlas of Ceará provides comprehensive information on solar irradiation in various locations in the state, allowing the identification of areas with high potential for the installation of photovoltaic systems. This data is essential for the analysis of the installed capacity of solar energy and for understanding the climatic conditions that influence the efficiency of the systems. In addition, the Atlas provides information on average temperature and incidence of solar radiation throughout the year, facilitating comparison with indicators of the tourism sector and the correlation between the availability of solar energy and tourist flow.

The data generated by the solar irradiation monitoring system is used to map the performance of photovoltaic installations in Ceará. This system offers real-time records of solar radiation, essential for evaluating the performance of solar energy systems and their contribution to the tourism sector. The analysis of the Global Wind Atlas data complements the research by providing information on the potential of wind energy in adjacent regions, allowing a more comprehensive understanding of the available renewable energy sources. This integrated approach to meteorological and energy performance data enables an

accurate analysis of the relationships between renewable energy and the growth of sustainable tourism in Ceará.

The mapping of photovoltaic solar generating plants in Ceará was carried out using QGIS 3.10 software, based on vector data made available by ANEEL (2025) and IBGE (2020). The information was organized in a geographic information system (GIS), using the SIRGAS 2000 datum as a spatial reference, with coordinates in the UTM system, zone 24 South. This standard was adopted to ensure the compatibility of the data and the correct location of the plants in the state's territory.

The results are presented on the growth in the use of solar energy, and its impacts on tourism, on the increase in the installation of solar energy systems in Ceará, especially in coastal regions and tourist areas. Compare annual growth or over a few years, evidencing the incentive or lack thereof, through public policies or investment from the right private sector.

Creswell (2014), describes the use of secondary data, document and report analysis, in addition to the collection of quantitative and qualitative data, can enrich the analysis and offer a more complete view of a specific characteristic. This application of this type of methodology would be very relevant to study the impacts of solar energy on tourism, by cross-referencing data from different sources (solar energy and tourism sectors) and providing an effective perspective.

4 RESULTS AND DISCUSSIONS

4.1 Growth in Installed Capacity and Impact on Tourism

The installed capacity of solar energy in Ceará, although it represents 3.3% of the national total, shows significant potential for expansion, considering the favorable climatic conditions and the high levels of solar radiation in the region. According to data from the Brazilian Association of Photovoltaic Solar Energy (ABSOLAR), this increase, which reached 21,349 MW in October 2022, reflects not only the diversification of the Brazilian energy matrix, but also the need to align with sustainability and energy efficiency guidelines.

Table 01 presents the distribution of installed power from solar sources in Brazil, highlighting the participation of each state in percentage terms. According to Sebrae (2022), the main states, such as Minas Gerais (MG) and São Paulo (SP), lead with 14.8% and 12.8% of the installed power, respectively. Rio Grande do Sul (RS) follows with 10.9%, while

Paraná (PR) and Mato Grosso (MT) contribute with 8.0% and 5.9%.

Table 01 – Representation of the Installed Power (MW) of solar source by state

Ranking	State	Installed Power (%)
1st	Minas Gerais	14,8%
2nd	São Paulo	12,8%
3rd	Rio Grande do Sul	10,9%
4th	Paraná	8,0%
5th	Mato Grosso	5,9%
6th	Santa Catarina	5,6%
7th	Goiás	4,7%
8th	Bahia	4,2%
9th	Rio de Janeiro	4,2%
10th	Ceará	3,3%
11th	Mato Grosso do Sul	3,2%
-	Other	22,4%

Source: ABSOLAR (2022).

With regard to Ceará, it occupies the tenth position in the state ranking, with a share of 3.3% of the total installed power of solar energy in the country. This contribution is low, taking into account the solar potential of the region. In contrast, the sum of the other federative units represents 22.4%, indicating a diversification in solar energy generation in Brazil. (ABSOLAR, 2022)

Table 02 presents the municipal ranking of solar energy generation in Brazil, with Fortaleza occupying the sixth position in installed capacity. This classification reflects the adoption of policies that encourage renewable energy sources, contributing to the diversification of the local energy matrix. The consumption of photovoltaic solar energy in the capital can increase the economic viability of the tourism sector, considering that sustainability is a growing criterion in the choice of destinations by visitors.

Table 02 – Representation of the Installed Power (MW) of solar source by city

Ranking	City	Federative Unit
1st	Florianópolis	SC
2nd	Brasilia	DF
3rd	Cuiabá	MT
4th	Teresina	PI
5th	Rio de Janeiro	RJ
6th	Fortaleza	CE
7th	Campo Grande	MS
8th	Goiânia	GO
9th	Uberlândia	MG
10th	Manaus	AM

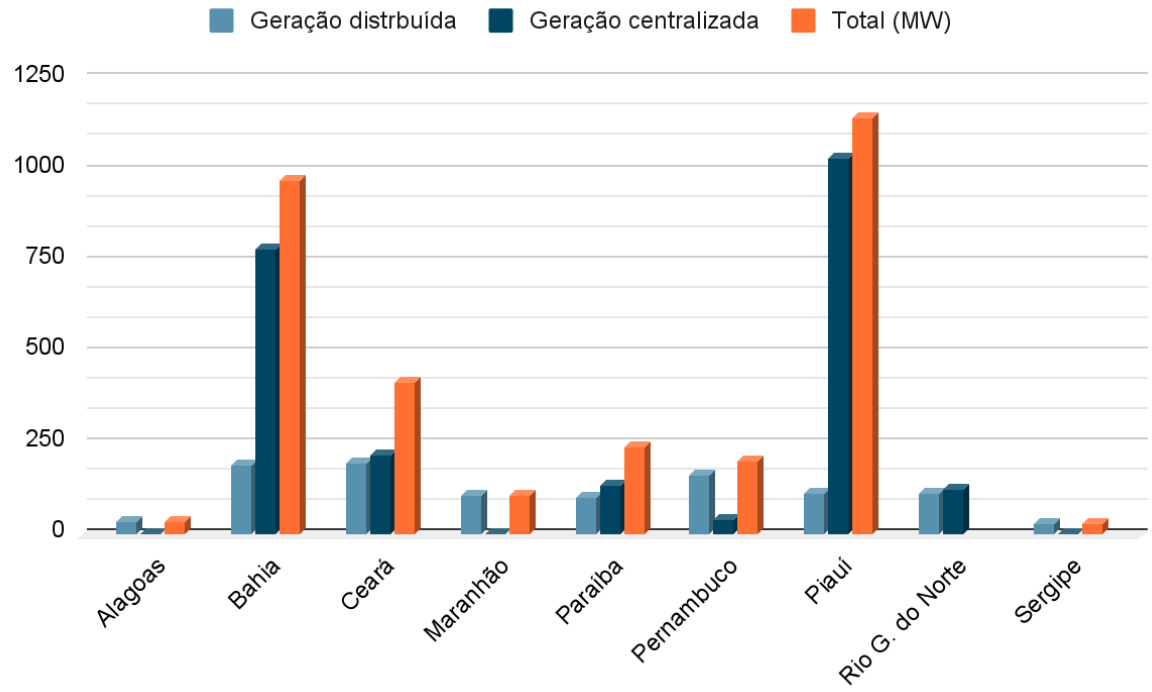
Source: ABSOLAR (2022).

According to the national projection (Figure 01) carried out by EPE (2021), it is expected that, by 2025, centralized solar energy generation will increase from 8 TWh to 11 TWh, and in 2030 it will reach 21 TWh. Distributed solar energy and self-production are expected to grow from 7 TWh to 22 TWh in 2025, reaching 32 TWh in 2030. In this scenario, the state of Ceará stands out, occupying the third place in the national ranking of solar energy production, contributing significantly to the expansion of this source in the country.

These data reflect the growing investment and adoption of renewable energy sources in Brazil, evidencing the importance of Ceará in the national context of solar energy, despite its lower relative participation compared to the leading states. This situation suggests opportunities for the development of public policies and incentives that can increase the installed capacity in Ceará, enhancing its solar resources.

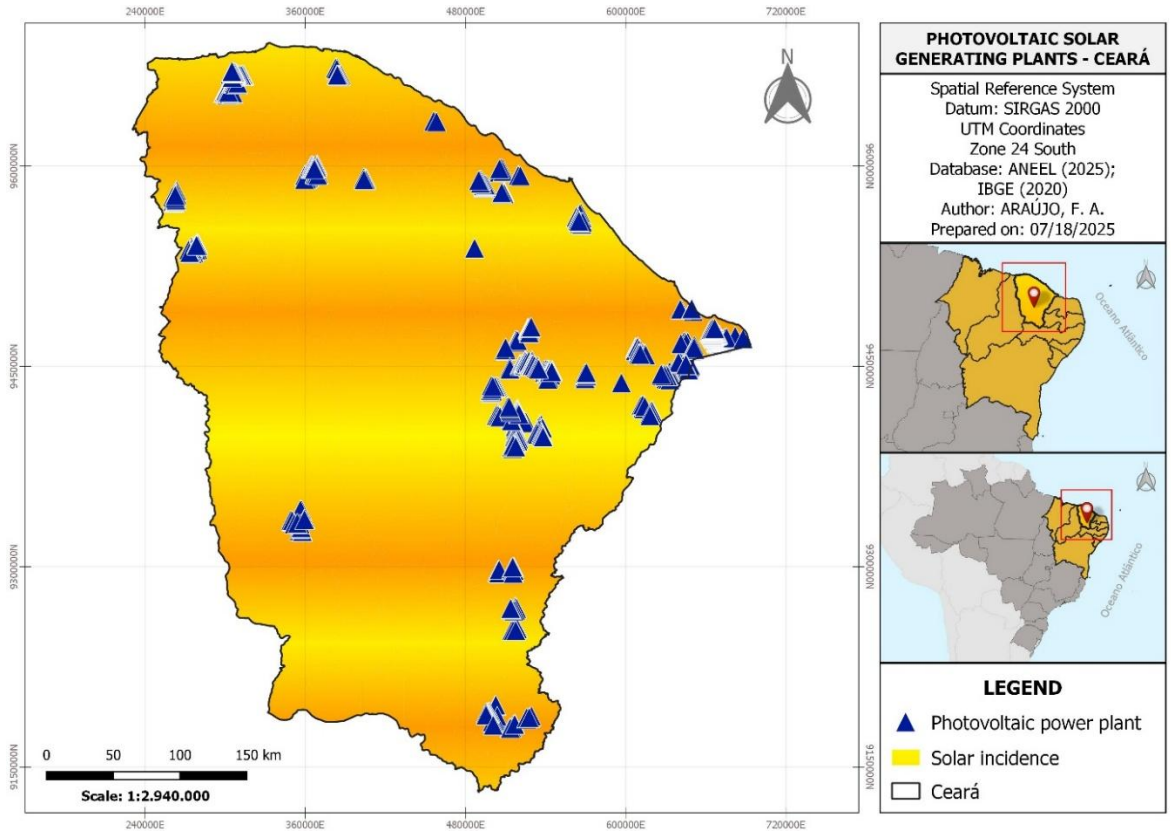
The map presented in Figure 02 shows an updated scheme of the distribution of solar plants installed in the state of Ceará, according to data provided by the National Electric Energy Agency – ANEEL (2025). The generating plants are mostly concentrated in the regions of the Central Sertão and East Coast of the state, where there is a higher level of solar radiation.

Figure 01 – Installed capacity of photovoltaic generation in the states of the Brazilian Northeast



Fonte: elaborated by Silva (2021).

Figure 02 – Map of photovoltaic solar generating plants in the state of Ceará



Source: prepared by the author (2025).

According to ANEEL's 2025 data, the state of Ceará has a total of 783 solar plants in operation or in the design phase, standing out as one of the main photovoltaic energy hubs in Brazil. The municipality of Jaguaretama leads with 88 plants, followed by Icapuí (78), Quixadá (60) and Aracati (55), concentrating most of the projects in the Vale do Jaguaribe region, an area that benefits from adequate infrastructure for renewable energy generation.

The concentration of solar plants in Aracati and Icapuí also results from favorable technical conditions, which ends up boosting regional economic development. The installation of these enterprises contributes to job creation, increases municipal revenue and attracts investments for the sun and sea tourism sector, particularly in the areas of Canoa Quebrada and Praia de Ponta Grossa. The clean energy produced also enables sustainable tourism projects, creating partnerships between the energy and service sectors.

Hotels and resorts that have adopted photovoltaic systems have been seeing a significant reduction in energy operating costs, contributing to financial sustainability and attracting tourists seeking environmentally responsible destinations. According to GR Solar (2024), the adoption of solar energy can offer savings of up to 95% in the electricity bill of the projects. Concrete examples of this practice in Ceará can be seen at the Sítio Escondido inn, in Canoa Quebrada, and at the Hotel Vale das Nuvens, in Guaramiranga, which through the installation of solar panels reported a significant reduction in energy costs, which allowed reinvestments in infrastructure and new activities aimed at guests (IBAHIA, 2022).

The incorporation of these practices in line with ESG (Environmental, Social and Governance) principles has been identified in other tourist developments in the state. According to Rodrigues (2023), the Jaguaribe Lodge & Kite, in Fortim, belonging to the JMC Group, uses photovoltaic systems installed in the parking lot itself as the unit's main source of electrical supply. In the case of Beach Park, in Porto das Dunas, in Aquiraz, socio-environmental management initiatives stand out, such as the implementation of its own treatment plant for the reuse of effluents and the use of solar energy in the heating of saunas and thermal pools (Rodrigues; Coroliano, 2017).

According to Dias (2008), despite the difficulties that nature sometimes presents for tourism, it is actually the great ally of tourism activity in general.

This synergy can result in a significant reduction in the operating costs of tourist establishments and in attracting an audience that values ecological initiatives, highlighting the importance of sustainability in the conservation of natural resources and the strengthening of the sector.

As an example, there are two types of installs for different segments:

1. **The mid-range commercial configuration**: used for simulation of larger roof-mounted PV systems. These photovoltaic installations are larger, usually in the range of 10 to 100 (or more) kWp and are used for commercial electricity production in the distribution network, or to support the building's own consumption. PV modules are typically mounted in row constructions, mounted on flat roofs, so their cooling is better. In addition, the systems are oriented at optimal slope and azimuth with better access for cleaning or maintenance. The installation covers larger areas, the modules can be distributed over multiple roofs, and the interconnection cabling is larger. The AC power generated is usually evacuated to the distribution grid without a transformer, similar to small rooftop systems, commonly used in small enterprises.

1. **The large-scale ground-mounted configuration**: used for simulation of grid-connected PV systems. This option covers large stand-alone installations. The modules are considered to be mounted on fixed inclined constructions. Compared to other previous options, the cooling of the modules is better, the cabling losses are higher, and the power connection to the distribution network is through a medium-voltage distribution transformer (which incorporates an additional loss into the calculation). These systems have usually installed professional monitoring solutions with service groups allowing quick detection and repair of faults, so the availability of the power plant is higher, where in this case, they are most used in large projects. It should be noted that the availability of power plants also depends on the stability of the local distribution network.

The integration of solar energy solutions in the tourism sector, especially in large enterprises, follows different technical configurations of photovoltaic systems, depending on the scale and needs of the project. For medium-sized commercial applications, such as hotels and resorts, roof-mounted systems with powers between 10 and 100 kWp are ideal for electricity production aimed at both self-consumption and connection to the distribution grid. For larger-scale projects, such as tourist complexes that demand greater energy autonomy, the configuration of ground-mounted photovoltaic systems allows the implementation of large autonomous installations, optimizing the performance and cooling of the modules. These solutions, combined with professional monitoring, ensure high availability and energy efficiency, being fundamental for sustainable enterprises.

In this context, the recent financing agreement between Banco do Nordeste and the Beach Park group, which allocates R$ 86.6 million for the development of the Ohana Beach Park Resort in Aquiraz, reflects the potential for synergy between renewable energy and sustainable tourism. According to Banco do Nordeste (2024), the project, which will have 218 housing units and a total investment of around R$ 100 million, is a clear example of how the tourism sector in Ceará can benefit from solar energy and sustainable practices.

Additionally, the growing awareness of the importance of sustainability among travelers has led to an increased demand for accommodations that embrace eco-friendly practices. Solar energy not only promotes a more efficient operation, but also improves the brand image of the enterprises, highlighting their commitment to environmental preservation.

4.2 Challenges and Public Policies

Despite the growth, the integration of solar energy in the tourism sector faces significant challenges. Power transmission infrastructure in remote areas needs to be improved to ensure that all developments, especially those located in less accessible regions, can benefit from the advantages of solar energy (Silva, 2023). In addition, the lack of adequate financial incentives has been an obstacle for many small and medium-sized tourism enterprises that want to adopt renewable energy systems.

Initiatives such as tax exemption and specific credit lines for renewable energy projects are essential to accelerate this integration. The case of the Ohana Beach Park Resort, located in the municipality of Aquiraz, exemplifies the importance of public policies that support the financing of sustainable tourism projects, evidenced by the use of Proatur[3], which is a specific fund for tourism (Banco do Nordeste, 2024). The creation of training programs for entrepreneurs in the tourism sector is also essential, aiming to sensitize them about the benefits of solar energy and the options available for implementation. Such public policies can not only facilitate the adoption of solar technologies but also ensure that tourism growth is sustainable in the long term.

According to Montezuma (2024), the recent processing of complementary bill 14/24 in the Legislative Assembly of the State of Ceará (Alece) represents a significant advance in public policies aimed at promoting solar energy in the state. This project aims to improve

[3] Regional Tourism Support Program, an initiative of Banco do Nordeste (BNB). The objective of the program is to strengthen and integrate the tourism production chain, generating jobs and taking advantage of the region's tourism potential.

the Renda do Sol Program, which encourages the adoption of photovoltaic systems among families, associations and cooperatives. The proposal includes the creation of a mechanism for the State Government to acquire the surplus energy generated by the participants of the program, which not only stimulates the generation of renewable energy, but also provides an additional source of income for the beneficiaries. According to the Federal Government (2024), the future inclusion of housing units from the Minha Casa, Minha Vida and Luz Para Todos program in the scope of the project demonstrates an effective strategy to expand access to solar energy and promote social inclusion.

In addition, the project proposes modifications to the Energy Efficiency Incentive Fund, allowing the savings generated by this fund to be reinvested in the program itself. This approach aims to create an economic development cycle that supports the adoption of renewable energy technologies. The relationship between encouraging the use of solar energy and the growth of tourism in Ceará requires technical analysis to assess how these sectors can interconnect, highlighting the importance of public policies that favor renewable energy and sustainable tourism.

The processing of this project indicates that the state government recognizes the importance of adapting its policies to the demands for renewable energy and the economic and social needs of the population. The analysis of the repercussions of this initiative on the increase in the installed capacity of photovoltaic solar energy and its impact on the tourism sector is relevant to understand the interaction between public policies and the enhancement of the energy and tourism sectors in Ceará. This technical approach will allow the identification of strategies that can improve energy efficiency and promote sustainable development in both areas.

4.3 Job Creation and Regional Development

The expansion of the solar sector in Ceará has boosted the generation of direct and indirect jobs. According to the State Government's projections, the implementation of the green hydrogen (H2V) plant in the Pecém Complex could generate up to 5 thousand jobs during the construction phase. The state has stood out in the national energy transition, having formalized 39 memorandums of understanding and six pre-contracts with companies that are in the installation phase in the Pecém Industrial and Port Complex (CIPP), where the H2V HUB is located.

According to Amaral (2022), the recent financing from Banco do Nordeste for the

Ohana Beach Park Resort, which is expected to generate approximately 210 direct jobs, also exemplifies how investment in the sector can boost the regional labor market. This increase in the installed capacity of solar energy not only benefits the tourism sector, but also stimulates the development of a local production chain. According to Banco do Nordeste (2024), the forecast of hiring local labor in the municipality of Aquiraz, as part of the Beach Park group's sustainability practices, reinforces the importance of renewable energy and tourism for social inclusion and economic development in the region.

Strengthening the local economy through job creation in renewable energy-related sectors, such as solar equipment installation, maintenance, and distribution, has a positive impact on communities. In addition, the promotion of solar energy contributes to the reduction of socioeconomic disparities in the region, offering new job opportunities and training for the local population. The growth of this sector can be seen as an engine of regional development, aligning with sustainability and social inclusion goals.

Although the expansion of photovoltaic generation contributes to the image of a sustainable destination and can add value to specific tourism products, such as ecotourism and adventure tourism, there is not enough empirical evidence to establish a direct causal relationship between these variables. The increase in the tourist flow observed in recent years is due to a multifactorial set of elements, such as public policies to encourage the sector, improvement of the air network, promotion of destinations, expansion of hotel infrastructure and diversification of the offer of attractions.

5 FINAL CONSIDERATIONS

The integration of solar energy in Ceará's tourism sector has significant potential for sustainable development. The reduction of operating costs, the attraction of conscious tourists and the generation of jobs demonstrate the benefits of this synergy. However, to amplify these impacts, it is essential to strengthen public policies and investments in infrastructure, aiming to consolidate Ceará as a reference in sustainable tourism and renewable energy.

Tourist facilities that use solar energy directly to reduce greenhouse gas emissions, since they efficiently replace energy sources, such as fossil fuels, with clean and renewable energy. This is essential for mitigating the effects of climate change, especially in a state that relies on its natural resources, such as beaches and parks.

Many travelers today are looking for destinations and tourist facilities that adopt the

use of renewable energy and responsible environmental policies. Hotels, inns, restaurants and other tourist establishments that use solar energy are able to reduce their electricity costs. This can increase the competitiveness of these businesses, allowing them to invest in facility improvements, promote sustainable practices, and offer more attractive rates to tourists. In addition, these saved resources can be reinvested in environmental preservation projects and social responsibility initiatives.

The incorporation of solar energy in tourist equipment strengthens Ceará's image as a sustainable destination. This attracts a specific type of tourist, interested in responsible environmental practices such as ecotourism and regional community tourism. With this, the flow of conscious visitors who value environmental preservation is increased, generating income without compromising natural resources for future generations.

Whereas, the lack of specific public policies to encourage the use of solar energy in Ceará directly impacts the tourism sector and the sustainable development of the region. When there are no explicit policies or incentives for the adoption of renewable energy, such as subsidies, facilitated credit lines, or even tax benefits, the initial cost for installing solar equipment remains high. This discourages owners of inns, hotels and other segments.

In addition, without public policies that encourage training and the development of adequate infrastructure for renewable energy, access to solar technology becomes limited to certain sectors. This directly affects the efficiency and competitiveness of companies in the tourism sector, which could benefit both economically and in terms of image by adopting sustainable practices, especially with adherence to the United Nations Sustainable Development Goals [SDGs], for example, such as the use of clean energy.

In the socioeconomic context, the absence of incentives for the use of solar energy can also impact the creation of investments in sectors such as the installation and maintenance of photovoltaic systems, in addition to limiting income generation. Thus, the criteria used for the correlation between solar energy and tourism are complementary in nature, and not deterministic. The approach adopted is based on the understanding that investment in renewable sources, such as solar, represents an element of support for territorial qualification and can reinforce tourist attractiveness when associated with sustainability strategies and environmental enhancement.

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