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THE ILLUSION OF ECONOMIC GROWTH COMING FROM WIND FARMING FOR ENERGY PRODUCTION IN RIO GRANDE DO NORTE

A ilusão do Crescimento econômico advindo da exploração eólica para produção de energia elétrica no Rio Grande Do Norte

La ilusión de crecimiento económico a partir de la exploración eólica para la producción de energía en el Rio Grande do Norte

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ABSTRACT

The wind power exploitation in municipalities of Rio Grande do Norte, such as Serra do Mel and João Câmara, for electricity production has promoted socioeconomic and environmental changes in the region. Wind power growth should not be classified as development. The issue is characterized by the fact that the negative impacts of wind installations contrast with the reality. The discourse, which assured the overcoming of local inequalities through job creation and income generation, did not materialize. The objective of this study was to verify the existing dissociation between economic growth and local development in the context of wind power exploitation. The research was developed through a mixed methodological approach, conducted by consulting articles, dissertations, and theses, referring to land commodification and accumulation by dispossession. Data related to the Gross Domestic Product, tax revenues, and municipal contributions of Serra do Mel and João Câmara were collected after the installation of wind farms. Although an increase in municipal revenue was observed, it did not translate into public policies, as, for example, the number of families registered and benefitting from the Bolsa Família Program remained unchanged, corroborating the occurrence of the investigated hypothesis. We conclude that local vulnerabilities are used merely as instruments of persuasion by wind companies to secure land leases with exploitable wind potential. The improvement in municipal revenue, especially in the initial phase when there is a higher demand for local labor, does not represent the overcoming of vulnerabilities, with a high dependence on assistance persisting, thus indicating a lack of socioeconomic development.

Keywords: Energy transition; Wind potential; Rio Grande do Norte; Economic growth; Local development.

RESUMO

A exploração eólica em municípios do Rio Grande do Norte, como Serra do Mel e João Câmara, para produção de eletricidade promoveu alterações socioeconômicas e ambientais na região. O crescimento eólico não deve ser classificado como desenvolvimento. O problema se caracteriza pelo fato de os impactos negativos das instalações eólicas contrastarem com a realidade. O discurso, que assegurava a superação das desigualdades locais a partir da geração de empregos e renda, não se efetivou. O objetivo do presente trabalho foi averiguar a dissociação existente entre crescimento econômico e desenvolvimento local no contexto da exploração eólica. A pesquisa se desenvolveu através de uma proposta metodológica mista, realizada através de consultas a artigos, dissertações e teses, alusivas à mercantilização da terra e à acumulação por despossessão. Foram coletados dados alusivos ao Produto Interno Bruto, arrecadação de impostos e contribuições dos municípios de Serra do Mel e João Câmara, após a instalação de parques eólicos. Apesar de se verificar aumento na arrecadação municipal, não se reverteu em políticas públicas, uma vez que, por exemplo, o quantitativo de famílias cadastradas e beneficiárias no Programa Bolsa Família permaneceu inalterado, corroborando a ocorrência da hipótese investigada. Concluímos que as vulnerabilidades locais são usadas apenas como instrumentos de persuasão pelas empresas eólicas para conseguirem o arrendamento de terras com potencial eólico explorável. A melhoria na arrecadação municipal, principalmente na fase inicial, quando há maior demanda por mão-de-obra local, não representa a superação das vulnerabilidades, se verificando elevada dependência assistencial, inexistindo, portanto, desenvolvimento socioeconômico.

Palavras-chave: Transição energética; Potencial eólico; Rio Grande do Norte; Crescimento econômico; Desenvolvimento local.

RESUMEN

La explotación eólica en municipios de Rio Grande do Norte, como Serra do Mel y João Câmara, para la producción de electricidad ha promovido alteraciones socioeconómicas y ambientales en la región. El crecimiento eólico no debe ser clasificado como desarrollo. El problema se caracteriza por el hecho de que los impactos negativos de las instalaciones eólicas contrastan con la realidad. El discurso, que aseguraba la superación de las desigualdades locales a partir de la generación de empleo e ingresos, no se materializó. El objetivo del presente trabajo fue averiguar la disociación existente entre el crecimiento económico y el desarrollo local en el contexto de la explotación eólica. La investigación se desarrolló mediante una propuesta metodológica mixta, realizada a través de consultas a artículos, disertaciones y tesis, alusivas a la mercantilización de la tierra y a la acumulación por desposesión. Se recolectaron datos relativos al Producto Interno Bruto, la recaudación de impuestos y las contribuciones de los municipios de Serra do Mel y João Câmara, tras la instalación de parques eólicos. A pesar de haberse verificado un aumento en la recaudación municipal, este no se tradujo en políticas públicas, ya que, por ejemplo, la cantidad de familias registradas y beneficiarias del Programa Bolsa Família permaneció inalterada, corroborando la hipótesis investigada. Concluimos que las vulnerabilidades locales son utilizadas únicamente como instrumentos de persuasión por las empresas eólicas para obtener el arrendamiento de tierras con potencial eólico explotable. La mejora en la recaudación municipal, especialmente en la fase inicial, cuando hay una mayor demanda de mano de obra local, no representa la superación de las vulnerabilidades, evidenciándose una elevada dependencia asistencial, lo que implica, por tanto, la inexistencia de un desarrollo socioeconómico.

Palabras clave: Transición energética; Potencial eólico; Rio Grande do Norte; Crecimiento económico; Desarrollo local.

1 INTRODUCTION

The absence of genuine local development driven by wind power exploitation constitutes the central hypothesis of the present study. The economic growth observed in the municipalities of Serra do Mel and João Câmara, where wind farms have been established, appears to be disconnected from any meaningful local socioeconomic development.

In the course of data collection for his dissertation, Barros (2018) conducted interviews with residents of the Açucena Settlement, located in the municipality of João Câmara, in the state of Rio Grande do Norte. The author emphasizes that the community members unanimously signed land lease agreements for the installation of wind turbines for energy production.

Although the company did not install the number of turbines initially agreed upon, at the time, each family received approximately one thousand reais, following the division of the amount resulting from the application of 0.85% of the gross annual revenue generated per turbine.

The Assentamento Açucena began with the granting of land credit by Banco do Nordeste, which financed the acquisition of plots. It was the responsibility of the local residents who acquired the land to make annual payments of approximately R$ 20,000 to cover the cost of the purchase.

Given the virtual absence of alternative sources of income, the settlers believed that the existence and continuity of the Açucena Community depended on the revenue generated from leasing their land for the installation of wind turbines. As one resident interviewed stated, “if it weren’t for the wind power, we wouldn’t be here anymore. It was a salvation, allowing us to pay for the land” (Barros, 2018, p. 126).

In Açucena, numerous concerns have been raised regarding the contractual terms, including fear of retaliation should residents seek to renegotiate the agreed-upon clauses, as well as the occurrence of socio-environmental and economic impacts, unfulfilled promises, and privately administered assistance policies. This reflects a typical context of wind energy exploitation in Rio Grande do Norte, with such factors underpinning and legitimizing the social impacts examined in this research.

More broadly, an analysis of the economic benefits stemming from wind energy development in Rio Grande do Norte — when correlated with the associated economic, social, and environmental impacts — reveals signs that the temporary and immediate

alleviation of certain vulnerabilities faced by local communities fosters a sense of transient fulfillment. This sentiment, built upon pillars of fear and beneficent cohesion, is strategically leveraged, and appropriated by wind energy companies as a persuasive discourse.

Accordingly, the present research focused on the methodological category related to the commodification of land, characterized by the appropriation of new areas through the use of coercive and persuasive techniques and mechanisms, as the sole objective of wind energy exploitation in the municipalities of Rio Grande do Norte—ultimately commodifying natural assets such as wind (Traldi & Rodrigues, 2022, p. 58).

The research was conducted using a mixed-methods approach, drawing upon selected sources including academic articles, books, dissertations, and theses. In addition, data were collected on the Gross Domestic Product as well as tax and contribution revenues of municipalities in the state of Rio Grande do Norte—particularly Serra do Mel and João Câmara—mainly after the installation of wind farms in their territories. The aim was to measure the trajectory of these indicators over the years, given that these municipalities are among the pioneers in the state in generating electricity from the exploitation of local wind potential (FIERN, 2024).

During the same period, the study analyzed the trends in the number of families registered with and benefiting from the Bolsa Família Program in the aforementioned municipalities, correlating this data with local GDP and tax revenue figures. This analysis aimed to evaluate the central research hypothesis—namely, that although economic growth has occurred, it has not been accompanied by local social development (Hofstaetter, 2016, p. 69).

Accordingly, the variation in the number of Bolsa Família recipients is identified as a significant indicator for assessing local development. This is due to the fact that eligibility for Bolsa Família, which is determined based on information from the Federal Government's Unified Registry (Cadastro Único), is directly linked to local unemployment rates (Arrais, 2016). Since the initiation of wind energy exploitation activities typically coincides with an increase in formal employment, it is expected, in theory, that the number of program beneficiaries would decline.

The research focuses on specific case studies; thus, a key limitation lies in the potential lack of generalizability of the analytical results to other regions with distinct socio-economic and environmental characteristics. A broader discussion on the applicability of these findings in diverse contexts may be pursued in future studies.

The issue under investigation is defined by the fact that the negative impacts resulting from the installation of wind farms in Rio Grande do Norte stand in stark contrast to the projected outcomes. The discourse advanced by the energy companies—promising the reduction of local inequalities through job and income generation—has largely failed to materialize. Instead, pre-existing vulnerabilities persist, now compounded by new socio-economic and environmental impacts arising specifically from the economic exploitation of wind resources.

This study aimed to identify the social and economic vulnerabilities present in the municipalities of Rio Grande do Norte where wind farms have been installed, demonstrating that such vulnerabilities are employed as tools of persuasion by companies seeking to lease land with exploitable wind potential.

To this end, and in an effort to locate more specific studies on the subject, a literature review was conducted using specialized academic databases, including SciELO, the CAPES Periodicals Portal, and Google Scholar. The total number of works retrieved was subjected to inclusion criteria (thematic relevance, timeliness, and originality) and exclusion criteria (duplication, lack of thematic relevance, and absence of scientific rigor). These were applied through title and abstract screening, followed by a detailed reading of the selected works.

Although wind energy companies have sought to undermine any potential for social mobilization through a series of promises, the lived reality—marked by long-lasting and adverse impacts, ranging from environmental to socio-economic consequences—is borne exclusively by vulnerable populations. These communities are confronted with the imposition of new social, environmental, and economic demands that affect their very cultural identity and give rise to legitimate forms of resistance (Maia, 2023, p. 119).

Based on the verification of the hypothesis that there is no genuine local socioeconomic development - only an illusion created by limited and isolated improvements resulting from economic growth driven by the exploitation of wind energy, which is abundant in certain municipalities of Rio Grande do Norte - it is concluded that the economic growth fostered by such exploitation assumes the misleading appearance of regional development.

2 RIO GRANDE DO NORTE: POTENCIALS AND VULNERABILITIES

The Brazilian Northeastern Semi-Arid Region stands out as an area with robust and diverse economic potentials. Agricultural and livestock activities are characteristic and

deeply rooted in the Northeast, intertwined with the historical origins of its settlement. Notably, the cultivation of sugarcane - “the most profitable colonial agricultural enterprise of all time” (Furtado, 2007, p. 106) - and cattle ranching to supply the needs of the meat-salting industry served as illustrative examples of this tradition.

In Rio Grande do Norte, cashew cultivation—cajucultura—is regarded as a classic example of an agricultural potential, notably for its capacity to sustain families and communities in rural areas by distributing income horizontally. Other significant examples include melon, mango, and grape farms, among a wide variety of other fruits and legumes.

For decades, mineral exploitation—particularly the traditional saltworks of Rio Grande do Norte, which export sea salt to several continents—has served as the backbone and economic foundation of many coastal municipalities in the state.

Tourism—centered on the exploration of the region’s natural beauty, which spans from the coastline to the Northeastern backlands and reflects strong local identity, along with its unique gastronomy and cultural expressions - has made this region one of the most visited touristic destinations in the world, driving regional economic growth.

More recently, the region’s exceptional solar radiation and brightness, along with the consistency and intensity of its winds, have created ideal conditions for electricity generation through the exploitation of these renewable energy sources. However, the energy generation potential of Rio Grande do Norte has been accompanied by a misleading and strategically constructed discourse of job creation, income generation, and local development (Pessoa et al., 2022, p. 148).

The emergency energy transition, driven by the exacerbated effects of climate change and embodied in the consequences of environmental disasters, particularly economic ones, has imposed the necessity of replacing fossil fuel sources—such as oil, gas, and coal—which are traditionally polluting, with clean energy sources. This shift has positioned Northeast Brazil as a new hub for exploratory investments from global rentier capital.

The exploitation of wind and solar energy potentials in municipalities of Rio Grande do Norte, with viable and exploitable resources, has revived peasant discourses and struggles regarding how the region's wealth is being exploited, as regional economic potentials cannot be dissociated from local social and environmental particularities.

However, the construction of a misguided perception - rooted in the stigmatization of climatic factors such as prolonged droughts, rocky and low-fertility soils, intense solar radiation, scarcity of fresh water, and vegetation dominated by cacti - has historically

associated the region with poverty and misery, serving as elements of social and economic segregation that have been long challenged and this has been historically challenged and overcome (Traldi & Rodrigues, 2022, p. 183).

These factors have shaped the persuasive discourse employed by wind energy companies, which, alongside the advantages presented, have facilitated the establishment of most agreements, often through promises of transforming the economic conditions of local families.

Low rainfall and prolonged droughts, which render the cultivation of subsistence crops such as corn, beans, and rice unviable - as well as hinder the continuation of traditional economic activities like small-scale livestock farming and cashew nut production - are transformed into instruments of coercion against local communities. These climatic phenomena are reframed as catastrophic events, fostering the idealized imagery of a new reality - “salvation”—supposedly brought about by income from wind energy (Sobrinho Júnior, 2020, p. 49).

3 PERSUASION STRATEGIES

Communities in the municipalities of Santa Luzia, São José do Sabugi, Junco do Seridó, and Picuí, in the state of Paraíba were visited by the Projeto Dom Quixote. Based on the observations made and described, it is possible to infer a prevailing perception of "salvation" associated with the advent of wind energy exploitation and electricity generation. Among the primary beneficiaries, there is an almost unanimous consensus that the arrival of the wind power industry in the region is perceived as “a blessing” (Maia, 2022, p. 32).

This perspective stems from the ideological construction carried out by the exploiting companies, based on preliminary assessments of local needs - primarily shaped by the social vulnerabilities to which populations in wind energy exploitation zones are subjected (Costa, 2024, p. 250).

Private assistance initiatives have become a common practice among wind energy companies. Minor improvements made in collaboration with municipal governments - such as the maintenance and restoration of public infrastructure, including health clinics and schools in rural communities - serve as compensatory measures for the impacts caused by the installation of wind turbines and the resulting operational activities (Silva & Azevedo, 2020, p. 72).

The two main strategies employed by wind energy companies - fully aware of the existing vulnerabilities within local communities - are characterized by the promise of development coupled with a discourse of socio-environmental sustainability (Maia, 2023, p. 117). This notion of development is associated with job creation, vocational training, and the professional qualification of local residents, as well as income distribution through land lease agreements.

Silva and Azevedo (2020, p. 62) note that the extensive hiring of workers from outside these communities by wind energy companies led to widespread disappointment, particularly among the idle youth of rural communities in the municipality of João Câmara, Rio Grande do Norte. These young individuals were largely overlooked, which sparked resentment within the community. As Hofstaetter and Pessoa (2022, p. 165) observe, “for the local population, what remains are mostly the lower-skilled and, therefore, poorly paid jobs, such as construction laborer, cleaner, assistant, or night watchman.”

Based on these examples - which are common across all municipalities hosting wind farms in Rio Grande do Norte - it has been inferred that job opportunities are primarily concentrated in the installation phase of the wind turbines. Once the operational phase begins, employment is drastically reduced, and the more specialized positions are typically filled by professionals from other regions of the country, and in some cases, by foreign workers (Traldi, 2014, p. 155).

The promotion of private social policies primarily serves as a tool to mitigate potential “risks” of social mobilization; in other words, they function as “non-market strategies” (Maia, 2023, p. 117). Discontent - often delayed - typically arises from highly unfavorable contractual terms, the repeated failure to fulfill promises made (Hofstaetter, 2016, p. 99), and from the impacts that inevitably emerge, becoming apparent only after the commencement of construction activities for wind farms, transmission lines, and substations.

4 THE MYTH OF WIND DEVELOPMENT

The primary strategy for introducing wind energy into local communities is grounded in a strong discourse of development, which is easily challenged by the realities that emerge from the problems associated with the construction and operation of wind power structures (Silva & Azevedo, 2020, p. 62).

The Northeast region of Brazil, characterized by an abundance of suitable land, high wind energy potential, and low population density, has become the primary locus for wind energy exploitation aimed at electricity production. As a result, it has borne the brunt of the main socioeconomic and environmental challenges, directly experienced by local populations, who report human, cultural, and social losses following the implementation of wind farms (Costa et al., 2024, p. 180).

The Projeto Dom Quixote monitors the expansion of wind farms into the territories of municipalities in the Northeastern Semi-Arid region of Brazil, as well as the development of wind energy exploitation for electricity production across various communities located in the states of Paraíba, Pernambuco, and Rio Grande do Norte.

Wind energy is considered a clean and undeniably renewable source. However, contrary to the dominant discourse claiming the absence of harm or adverse consequences, the installation of wind farms in municipalities of Rio Grande do Norte has revealed negative impacts on local territories, exposing the vulnerabilities of local populations (Hofstaetter & Pessoa, 2022, p. 162).

The analyses and studies conducted under the Projeto Dom Quixote reveal a high degree of tension in the relationships between companies and local communities, stemming from dissatisfaction caused by the lack of tangible development, despite the presence of isolated improvements driven by economic growth (Maia, 2023, p. 106).

At the onset of wind energy exploration investments in Rio Grande do Norte, due to a lack of knowledge regarding the exploratory context, companies took advantage of local economic vulnerabilities and easily persuaded landowners and communities to agree to contractual terms without significant discussion (Maia, 2023, p. 110).

Promises of job creation, regardless of the locality or the state in which the wind farms were established, have resulted in an identical legal scenario: employment opportunities were offered to residents of the surrounding regions only during the initial phase of wind turbine installation, a short-term period after which the workers were dismissed (Maia, 2023, p. 107).

Currently, contractual clauses are discussed more thoroughly, encompassing all stipulated aspects and, when possible, involving communities collectively in the negotiation process. This shift is due to the efforts of certain social organizations that have disseminated knowledge about previous wind energy exploitation in other regions.

Wind energy projects were introduced in municipalities of Rio Grande do Norte with the claim that poverty would be overcome - as is also the case in other Northeastern states,

where populations in exploration zones, whether coastal or in the hinterlands of the Semi-arid region, are composed of economically vulnerable and marginalized groups - by promising to boost the potential of the local economy through income and employment generated by wind energy development (Hofstaetter & Pessoa, 2022, p. 163).

The context of wind energy development in Rio Grande do Norte has revealed and confirmed that the economic growth driven by wind power generation does not necessarily indicate the existence of local development, as reflected in improvements in people's quality of life.

On the contrary, the observed impacts have had negative repercussions on the quality of life of local populations, failing to benefit them and perpetuating high levels of inequality and poverty in the municipalities (Pessoa et al., 2022, p. 151). This context has enabled the communities themselves to reflect on the illusion embedded in the discourse of improved livelihoods and income promoted by the exploiting companies (Hofstaetter, 2022, p. 181).

4.1 The myth that comes from Sustainability

The dissemination - or dogmatization - of the notion that wind energy development entails no environmental or social impacts was rapidly propagated, aiming to portray the areas with viable wind potential in the Northeast as predominantly composed of vast unproductive lands, low population density, and limited biological diversity.

In addition to the indoctrination that wind energy would bring about a true redemption of wind-suitable communities and localities in the Semi-arid region -overcoming social inequalities and poverty through income distribution and job creation - the illusion was consolidated that wind exploitation would occur through clean, sustainable, and impact-free mechanisms.

According to the operating companies, electricity generation from wind would cause virtually no environmental impact (Maia, 2023, p. 50), unlike other sources such as hydroelectric power, despite the construction of large wind farms with massive towers.

Contrary to what had been propagated, the impacts are multiple and varied, both in terms of quantity and intensity, being documented and observed from effects on local fauna and flora to direct harm to people's daily lives and health, affecting their work, leisure, and social interaction routines (Hofstaetter, 2022, p. 180).

Hofstaetter (2016, p. 100) emphasizes the alteration of local landscapes, as seen in the dunes located in the Distrito de Galos, in the municipality of Galinhos, RN, previously known for the beauty of its bucolic beaches, which were visually changed with the intrusion of the massive wind turbines.

Far from going unnoticed, considering their size and vertical structure, the wind turbines transformed the landscape from the coastline to the hinterland, where the wind is abundant and the geographical space was occupied and used for wind energy generation. These changes are significant and emblematic for the local landscape, affecting, for example, the traditional source of income for the villages in the municipality of Serra do Mel, in Rio Grande do Norte - the cashew, as deforestation of cashew trees was carried out to make way for roads, transmission lines, and substations (Jacinto; Bezerra, 2024, p. 101).

According to consensus among residents of areas near the wind installations, the main health impact factor is the noise from the blades, caused by the wind's force and the turbines' operation, which lead to discomfort and stress, adversely affecting people's well-being.

4.2 The Increase in Revenue and the Falsehood of Municipal Development

Wind companies strengthen their discourse on local development by emphasizing the increase in tax revenue. Undoubtedly, in municipalities with wind farms installed within their territories, tax revenue—composed of fees and, primarily, the Service Tax (ISSQN)—has seen an increase since the onset of wind exploitation.

However, the growth observed in tax revenue resulting from wind exploitation, which began during the construction phase of the wind farms but stagnated at lower levels during the operational phase (IBGE, 2023), does not represent a significant shift in the socioeconomic landscape of the municipalities, despite being classified as an activity with high levels of financial investment (Silva; Azevedo, 2020, p. 65).

The municipality of Serra do Mel, located in the Western region of the State of Rio Grande do Norte, began to incorporate resources from service providers in the wind energy sector into its economic revenue composition starting in 2014. Currently, with a total of 39 wind farms in operation and classified as the municipality with the largest number of wind farms, it is responsible for generating 1,200 MW of regulated power, according to data from the Observatory of Industries of the State of Rio Grande do Norte (FIERN, 2024).

The actual onset of wind energy generation, observed starting in 2016, maintained the growth of the municipality's current revenue, compared to the period before the installation phase, derived from the collection of taxes and fees, with the revenue from these current receipts quadrupling between 2018 and 2023 (IBGE, 2023).

Table 01 – Taxes, Fees, and Improvement Contributions

YEAR	TAXES, FEES, AND IMPROVEMENT CONTRIBUTIONS (R$)
2013	1.010.324,29
2014	1.546.346,89
2015	2.688.287,88
2016	3.238.253,47
2017	3.249.550,82
2018	3.787.882,54
2019	6.654.625,42
2020	13.671.312,25
2021	22.448.818,86
2022	13.946.909,04
2023	15.868.433,82

Source: Public Finances (IBGE, 2023).

Similarly, reflecting the economic foundation of wind energy production, the per capita Gross Domestic Product (GDP) of the municipality of Serra do Mel increased from R$ 10,646.61 to R$ 70,243.25 in 2021 (IBGE, 2021a). Data collected by IBGE (2021b) also reveal that, in 2017, for example, the manufacturing industry—represented during the installation phase of the wind farms in Serra do Mel—led the sectors with the highest value added to municipal revenue. From 2020 onward, during the phase of effective wind energy exploitation, electricity became the leading sector in terms of value added.

At current prices, that is, nominal values at the time, in the years 2020 and 2021, the industrial sector contributed 55% and 73%, respectively, representing increases of 343% and 456% in the added value contribution to GDP compared to 2019, when industry accounted for only 16% of the value added.

Despite economic growth, there remains a clear gap between the wealth generated and the socioeconomic reality of the population in the Municipality of Serra do Mel, as no collective and significant changes have been observed in the local population's socioeconomic conditions.

Moreover, there is an absence of technical information provided by official agencies, such as the Brazilian Institute of Geography and Statistics (IBGE), regarding the exploitation

of any other industrial activity within the Municipality of Serra do Mel that would justify the consolidation of added value in the composition of the Gross Domestic Product (GDP) for the years 2021 and 2022.

Table 02 – Per Capita GDP of the Municipality of Serra do Mel/RN

ANO	PIB (R$)
2010	7.263,16
2011	11.250,22
2012	10.942,62
2013	10.729,77
2014	10.646,61
2015	9.217,11
2016	12.749,16
2017	25.897,17
2018	21.590,96
2019	25.411,50
2020	50.795,43
2021	70.243,25

Source: PIB Interno Bruto dos Municípios (IBGE, 2021).

In this regard, the data related to the composition of the Gross Domestic Product (GDP) and the collect of the tax on services (Brazilian name: ISS), which are components of current revenues reported in the annual financial statements (Municipality of Serra do Mel, 2020 and 2021), indicate that the wind energy is the sole driver of the observed increases in these indicators.

In the Municipality of João Câmara, located in the Agreste region of Rio Grande do Norte, wind energy development began in 2012 with the operations of two wind farms. This activity gradually expanded with the construction of additional farms, totaling 29 operational wind farms by 2018 (Silva; Azevedo, 2020, p. 63). This expantion contributed to changes in per capita GDP, which increased from a nominal value of R$ 4.646,29 in 2009 to R$ 35.911,78 in 2021 (IBGE, 2021c), based on the same set of data concerning GDP, besides the Bolsa Família program, and tax revenue used for the analysis of the municipality of Serra do Mel.

5 THE REAL CONTEXT OF THE WIND ECONOMY IN RIO GRANDE DO NORTE

In his dissertation, Barros (2018) conducted a comprehensive study on the impacts experienced by communities in areas where wind farms were established in the state of Rio Grande do Norte, with particular focus on the municipalities of Serra do Mel and João

Câmara. His findings demonstrate that the anticipated and aspired economic, social, and environmental transformation of these communities - through the advent of wind energy production - did not materialize, despite the economic growth reflected in certain studied indicators.

The aforementioned Author highlights that the local impacts are directly linked to wind energy exploitation, which has led to economic consequences for tourism - due to the alteration of the landscape - as well as for other local economic activities that are typically land-based, such as cashew cultivation, livestock farming, and legume production (Sobrinho Júnior, 2020, p. 88).

The expectations raised by the promise of permanent jobs and income, which were unfulfilled in the subsequent stages following implementation, also led to a contingent of unemployed individuals who were unable to return quickly and satisfactorily to their previous positions (Barros, 2018, p. 118). Furthermore, they failed to secure new positions, forcing them to migrate from rural areas to the nearby urban center, or even to other, more distant municipalities. This migration led to the disruption of their familial ties as they sought a livelihood, during which period they were almost entirely dependent on public welfare policies, particularly the Bolsa Família program from the Brazilian Federal Government.

The real estate market, with speculation and the exponential appreciation of rural properties - reaching up to 500% in some cases (Hofstaetter, 2022, p. 180) - triggered local disputes over land ownership through land grabbing and became one of the major economic indicators of the imbalance in local relations following the arrival of the wind energy industry. Local landowners, who are typically farmers using their land for subsistence production, as well as local inhabitants, many of whom reside on their own properties, are the primary victims of the disturbance to land ownership and dispossession observed.

Contrarily to the sustainability discourse, one of the main arguments of the wind energy industry, the environment suffers from severe negative impacts on the fauna and flora of the Brazilian Semi-Arid region, an extremely unique biome with characteristic resilience to annual, periodic, and prolonged droughts (Hofstaetter, 2016, p. 79).

The deforestation of areas for the construction of wind towers and access roads, as well as the installation of substations and transmission lines, disrupts the caatinga biome and weakens the habitat and natural routines of local wildlife, hindering their access to water and food sources.

The foundations required for the installation of wind towers, which are deeply embedded, reach and impact the water table, thereby affecting the quality of the already

scarce water resources. This water is essential for both the hydration of livestock and the consumption needs of local populations residing in wind exploitation zones (Hofstaetter, 2016, p. 108).

The wind towers, due to their height and the continuous rotation of their blades, cause noticeable disruptions to the migratory cycles of various species, particularly birds that travel across continental distances and use the Northeast region of Brazil as a site for rest and recovery.

The increase in drug consumption, observed following the arrival of wind energy companies and their workforce from other regions of the country, with cultural backgrounds and lifestyles markedly different from those of the local residents, reveals a reality that unfolds in a manner starkly opposed to the narrative promoted by the companies operating in the wind energy sector (Barros, 2018, p. 138).

The increase in the number of single mothers, a social phenomenon triggered by the advent of wind energy exploitation in Rio Grande do Norte, is so extensive and pernicious that it has been given a specific designation: "children of the winds" (Hofstaetter, 2016, p. 77). This phenomenon represents a glimpse into the social vulnerability to which the local youth is subjected, violently deprived of its socio-economic strengths, a situation that unveils the violence of energy exploitation and the fragility of rapid transition.

Studies indicate that illnesses associated with noise, blade movement, and the shadow flicker of wind turbines are components of the anamnesis of “Wind Turbine Syndrome” (Pardal, 2013, p. 16). These factors lead to visual disturbances, particularly among individuals residing behind wind installations, as well as headaches, irritability, stress, insomnia, and other triggered symptoms. Such effects have been observed upon the activation of wind turbines, impacting nearby residents, including those with pre-existing comorbidities or heightened susceptibility.

5.1 Maintenance of public welfare dependency

The benefits offered by companies to local residents do not constitute genuine social development; rather, they are primarily employed as a means to preempt concrete reactions stemming from public dissatisfaction with the issues arising from the implementation of wind energy operations, as experienced by the local population (Traldi & Rodrigues, 2022, p. 249).

Barros (2018) and Hofstaetter (2016) cite data from the Bolsa Família Program as indicative of development for the local population, “reflected in the improvement of people’s quality of life” (Silva, 2022, p. 38). However, this assistance—provided by the Federal Government to low-income families—serves more as a compensatory welfare measure than as a result of employment generation by the dominant economic activity.

The sporadic social incentive actions carried out by wind energy companies are isolated phenomena that do not contribute to genuine local development. These companies exploit the socio-economic vulnerability of residents in communities affected by wind farm installations to construct an illusion of progress, offering basic health and education services that, in fact, constitute fundamental rights of these populations (Silva & Azevedo, 2020, p. 75).

The reliance on welfare programs—particularly those provided by the Federal Government, such as Bolsa Família—remains at levels comparable to those recorded prior to the onset of wind energy exploitation in municipalities of Rio Grande do Norte (Jacinto & Bezerra, 2024, p. 94).

In the municipality of João Câmara, where the community of Açucena is located, there were 7,750 families registered in the Federal Government’s Cadastro Único as of December 2012, accounting for 24% of the local population. By November 2024, this figure had increased to 9,757 families, which represents 29% of the current population of 33,290 inhabitants (IBGE, 2022; BRASIL, 2024).

This scenario indicates a growing dependence on social assistance programs, which constitute the primary source of income for the poorest families in the municipality. It becomes evident that the economic growth driven by wind energy companies during the main period of wind farm installation in the region has not benefited the impoverished population. In fact, there has been no meaningful job creation for these communities, nor has there been any substantial local socioeconomic development (Hofstaetter, 2016, p. 69).

The reliance on the Bolsa Família program in the municipality of Serra do Mel has shown a consistent upward trend over the years, increasing from 2,682 individuals registered in the Federal Government’s Cadastro Único in 2014 to 11,379 individuals in 2024, a period that coincided with the peak of wind farm installations in the municipality. As of June 2024, a total of 2,901 families were beneficiaries of the Bolsa Família program, encompassing 7,775 individuals and amounting to an investment of R$ 1,953,881.00 (BRASIL, 2024).

Table 03 – Individuals enrolled in the Cadastro Único program in Serra do Mel/RN

Year	Annual average of individuals registered in the Federal Social Registry
2014	**2.682**
2015	**8.233**
2016	**8.354**
2017	**8.443**
2018	**8.543**
2019	**8.747**
2020	**9.020**
2021	**9.403**
2022	**10.475**
2023	**11.108**
2024	**11.375**

Source: Painel de Monitoramento do Cadastro Único (Brasil, 2024).

In a study conducted by Barros (2018), Bolsa Família was already identified at the time as one of the main sources of income in several rural communities across municipalities in Rio Grande do Norte where wind farms had been installed, including Parazinho, São Miguel do Gostoso, Pedra Grande, São Bento do Norte, Galinhos, Guamaré, Macau, Porto do Mangue, and Touros.

6 SUGGESTIONS FOR ADRESSING THE NEGATIVE IMPACTS OF WIND ENERGY GENERATION IN RIO GRANDE DO NORTE

The negative impacts caused by wind energy exploitation in Rio Grande do Norte, regarded as uneconomical factors for the achievement of solid environmental and regional development (Costa et al., 2024, p. 202), must be addressed through mitigation measures that consider the intrinsic vulnerabilities of the region, its population, settlement patterns, and its socio-economic and environmental characteristics.

In order to address the issues presented in this article arising from wind energy exploitation in Rio Grande do Norte, it becomes necessary to provide illustrative examples of constructive proposals, which may include the following:

6.1 Development of Inclusive Public Policies

Wind energy exploitation, whether exclusively or in combination with other sources such as solar energy, as commonly observed in certain municipalities of Rio Grande do Norte, does not provide mechanisms to address the significant problems faced by local

communities, given that the affected populations do not share in the profits generated by the energy industry (Cavalcante, Araújo, & Ferreira, 2025, p. 9).

Therefore, it is essential to develop public policies that ensure the participation of local communities in decision-making processes regarding the installation of wind farms and in the equitable distribution of the resulting economic benefits. This can be achieved by allocating a portion of the profits to social programs in areas such as healthcare - such as oral health initiatives in daycare centers and schools, the strengthening of preventive medicine through community health agents, and improvements in basic sanitation, including the construction of bathrooms with septic systems in local communities.

6.2 Compensation and Direct Benefits

The establishment of compensation mechanisms that ensure affected communities receive direct benefits from the installation of wind farms - particularly through meaningful participation in the revenue generated - is essential for promoting local development.

In this context, for example, the introduction of wind energy in the municipality of Serra do Mel, in the state of Rio Grande do Norte, was preceded by extensive debates and meetings focused on contract negotiations, as the minimally organized local population did not accept the proposals put forth by the company at that time (Traldi & Rodrigues, 2022, p. 230).

Thus, with the participation of the local community, a model of collective contract was developed in the municipality between the companies and interested residents. This model includes compensation to landowners for the portion of land utilized, while the revenue generated by the operational wind farms is shared among all participants in the project, regardless of whether their specific land plot was used.

This type of contract has contributed to positive changes within the community regarding the remuneration structure of land lease agreements. The community's purchasing power has increased, as some of its members - the leaseholders - continue to engage in agricultural activities on their plots while also benefiting from the monthly revenue generated by wind energy production on their land (Jacinto, 2024, p. 95). In addition, the possibility of compensatory investments in areas such as education and healthcare may further enhance the quality of life at the local level.

6.3 Training and Professional Development

One of the most prominent grievances among the population of Rio Grande do Norte is the lack of inclusion of local labor in the wind energy generation process. Employment opportunities are largely concentrated in the installation phase, involving more physically demanding tasks such as masonry, general labor, and transportation, which tend to absorb local workers. However, during the operational phase, due to the lack of technical qualifications, there are no available positions for the local workforce (Traldi, 2014, p. 155).

Thus, the implementation of training and professional development programs aimed at the local population - preparing them to occupy jobs generated by the wind energy industry - can help ensure a more equitable distribution of the resulting economic benefits.

6.4 Ongoing Monitoring and Assessment

The negative impacts resulting from wind energy exploitation in Rio Grande do Norte must be subject to continuous monitoring, with the aim of protecting local communities, preserving the unique cultural aspects of their way of life, and maintaining the region's environmental amenities. When necessary, traditional territories should be readapted to ensure habitability and to prevent population displacement, such as rural exodus (Santana & Silva, 2021, p. 253).

Accordingly, there is a pressing need to establish a system of continuous monitoring and evaluation of the social, economic, and environmental impacts of wind energy development. Such a system would enable adjustments to policies and practices, thereby ensuring that the interests of local communities are safeguarded.

6.5 Promotion of Sustainable Renewable Energies

The promotion of the diversification of renewable energy sources, such as solar and biomass, considering their suitability to local conditions and generating fewer impacts on local communities, particularly through state intervention, could help reduce dependence on wind energy and its negative consequences (Maia, 2023, p. 79).

6.6 Strengthening of Cultural Identity

Cultural identity, which is reflected in the lifestyle, customs, and traditions of local communities, including quilombolas (descendants of Afro-Brazilian slaves who formed autonomous settlements known as quilombos), peasants, and land reform settlers, is one of the aspects most affected by the introduction of economic activities within or near their territories.

Wind energy exploitation in the state of Rio Grande do Norte has brought negative consequences that directly impact individuals living in communities located near wind farm installations, thereby affecting their cultural identity. One illustrative example of the adverse effects of economic exploitation of wind potential in the region is the social phenomenon known as the "children of the wind," as described by Hofstaetter (2016, p. 77), which highlights the need to strengthen local cultural identity.

Therefore, it is essential to promote initiatives that respect and integrate local culture into wind energy development practices, fostering the appreciation of traditional knowledge and the inclusion of cultural practices within the economic activities generated by renewable energy.

6.7 Transparency and Corporate Accountability

Social responsibility compels companies in the wind energy sector to conduct their operations in Rio Grande do Norte in a manner that shares responsibility for regional development. This includes implementing preventive practices, promoting sustainability, ensuring the realization of human rights, and fostering decent work conditions (Carvalho et al., 2022, p. 12).

These proposed measures, offered here as examples, are intended not only to mitigate the problems identified in this article but also to foster a more equitable and sustainable form of development—one that ensures local communities genuinely benefit from the exploitation of natural resources within their territories.

7 CONCLUSIONS

Development should not be equated with economic growth. The exploitation of wind energy for electricity generation in the municipalities of Serra do Mel and João Câmara, in the state of Rio Grande do Norte, illustrates a pattern of economic growth that is

disconnected from local development. True development encompasses the comprehensive integration of rights and the inclusion of all social actors involved in the economic process, resulting in tangible improvements in quality of life and overall well-being—conditions that are notably absent in the reality of the municipalities under study.

The harnessing of renewable energy sources for electricity production, within the broader framework of the energy transition driven by climate change, has consolidated itself as a global economic process. This trend marks a new frontier of capitalist expansion in regions endowed with abundant natural resources.

Within this context, the redirection of investment flows toward geographic areas with economically exploitable potential—such as high levels of solar radiation or strong and persistent winds in tropical zones, which are essential for the operation of solar power plants and wind farms, respectively—reflects the ongoing accumulation dynamics of global capitalism.

In municipalities such as Serra do Mel and João Câmara, corporate groups involved in wind energy exploitation devise their operational strategies based on preliminary assessments of the socioeconomic vulnerabilities of local populations. These groups promise to overcome such vulnerabilities through the creation of jobs and income generated by wind-based electricity production, which is presented as a catalyst for local development.

Communities are enticed by promises that are only partially fulfilled—particularly in the initial phases—with the aim of preventing resistance to the implementation of wind energy projects. This persuasive process occurs under coercive circumstances, as individuals are subjected to psychological pressure when confronted with their hardships and the supposed opportunities for overcoming them through income derived from land lease agreements, employment generation, and vocational training.

The illusion constructed by these narratives convinces many that the income generated from wind exploitation - through turbines installed on their lands and within their communities - will bring about social redemption and economic salvation. Moreover, the idea that no alternative economic possibilities exist becomes a dominant discourse, upheld as a kind of dogma. This is reinforced by the perception that the Brazilian Northeastern lands are abundant, sparsely populated, and primarily used for subsistence agriculture, rendering them easily adaptable to wind energy exploitation.

The daily life and social fabric of semi-arid communities, such as those in Serra do Mel and João Câmara, have been significantly transformed by the arrival of the wind energy industry. The socioeconomic and environmental impacts of wind energy exploitation have

deeply and negatively altered these communities' ways of life, traditions, and cultures, exacerbating existing inequalities and generating new social demands, such as those ones associated with the phenomenon known as the "children of the wind."

Residents' quality of life has been adversely affected by visual intrusion from the turbines and the constant motion of their blades, as well as persistent noise pollution. Increases in anxiety, headaches, stress, and irritability have been reported by individuals living near the wind farms.

Contrary to the promises made and the idealized visions constructed within the local imagination, the verified impacts - environmental, social, and economic - reveal an irrefutable reality. While economic growth has occurred in municipalities such as Serra do Mel and João Câmara - evidenced by the emergence of jobs, increased municipal revenues, and changes in GDP indicators - such growth, arguably driven by wind energy production, has not translated into genuine development. The promise of reducing local inequalities has not been fulfilled, as the most vulnerable segments of the population remain highly dependent on welfare programs. This is particularly evident in the continued high number of families receiving benefits from the Bolsa Família Program in relation to the total local population.

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