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Energy transition or adaptation of fossil capitalism? “Renewable” megaprojects and territorial conflicts in Brazil

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Article

Energy transition or adaptation of fossil capitalism? “Renewable” megaprojects and territorial conflicts in Brazil

Transição energética ou adaptação do capitalismo fossilista? Megaprojetos “renováveis” e conflitos territoriais no Brasil

¿Transición energética o adaptación del capitalismo basado en los combustibles fósiles? Megaproyectos “renovables” y conflictos territoriales en Brasil

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Abstract

The renewable energy transition is widely regarded as essential for mitigating climate change. In this context, this study seeks to examine whether the so-called "green" energy transition represents a structural socio-economic transformation or whether it merely constitutes an adaptation of fossil capitalism aimed at preserving its inherently unsustainable model of production. The research, of an analytical and explanatory nature, is grounded in a critical review of the literature and in the analysis of institutional documents, with the objective of problematizing the "green" energy transition.

In the Brazilian case, hydroelectric power and wind farms are adopted as empirical examples that reveal the contradictions inherent to this process. The findings indicate that the renewable energy transition operates predominantly as a strategy of adaptation within fossil capitalism, whereby the discourse of sustainability is mobilized to legitimize the expansion of energy enterprises that continue to generate socio-environmental impacts and territorial conflicts.

Therefore, the study contributes to the field of Critical Geography by highlighting the limits of the "green" energy transition within the dynamics of contemporary capitalism.

Keywords: Climate change; Energy transition; Renewable energy; Fossil capitalism.

Resumo

A transição energética renovável é considerada fundamental para mitigar as mudanças climáticas. Por isso, buscou-se analisar se a transição energética "verde" representa uma mudança socioeconômica estrutural ou se constitui apenas uma adaptação do capitalismo fossilista para assegurar seu modelo de produção insustentável. A pesquisa, de caráter analítico e explicativo, baseou-se em revisão crítica da literatura e em documentos institucionais, visando problematizar a transição energética "verde". No Brasil, a hidroeletricidade e os parques eólicos foram tomados como exemplos empíricos das contradições desse processo. Os resultados indicam que a transição energética renovável opera predominantemente como uma estratégia de adaptação do capitalismo fossilista, sendo o discurso da sustentabilidade mobilizado para legitimar a expansão de empreendimentos energéticos que seguem produzindo impactos e conflitos territoriais. Portanto, o estudo contribui para o campo da Geografia Crítica ao evidenciar os limites da transição energética "verde" no capitalismo.

Palavras-chave: Mudanças climáticas; Transição energética; Energias renováveis; Capitalismo fossilista.

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Resumen

La transición energética renovable es considerada fundamental para mitigar el cambio climático. Por ello, este estudio buscó analizar si la transición energética "verde" representa un cambio socioeconómico estructural o si constituye únicamente una adaptación del capitalismo basado en los combustibles fósiles para asegurar su modelo de producción insostenible. La investigación, de carácter analítico y explicativo, se basó en una revisión crítica de la literatura y en documentos institucionales, con el fin de problematizar la transición energética "verde". En Brasil, la hidroelectricidad y los parques eólicos fueron tomados como ejemplos empíricos de las contradicciones de este proceso. Los resultados indican que la transición energética renovable opera predominantemente como una estrategia de adaptación del capitalismo basado en los combustibles fósiles, siendo el discurso de la sostenibilidad utilizado para legitimar la expansión de emprendimientos energéticos que continúan produciendo impactos y conflictos territoriales. Por lo tanto, el estudio contribuye al campo de la Geografía Crítica al evidenciar los límites de la transición energética "verde" en el capitalismo.

Palabras clave: Cambio climático; Transición energética; Energías renovables; Capitalismo basado en combustibles fósiles.

INTRODUCTION

The Industrial Revolution, in the mid-eighteenth century, marks the threshold of a new logic of nature's exploitation, oriented toward the maximization of consumer goods production. In this context, the growing demand for energy constitutes a fundamental analytical dimension for understanding the dynamics of the productive system, insofar as it is responsible for setting its mechanisms in motion while simultaneously revealing power relations, disputes, conflicts, and environmental impacts across territories.

Climate change has placed the issue of energy at the center of contemporary environmental debates. According to Mendonça (2021), it is hegemonic to understand that the climate changes associated with modernity stem primarily from human actions, particularly the use of fossil fuels. Nevertheless, the author argues that the debate should adopt a multirelational and multifactorial perspective, given that science does not yet possess instruments capable of determining with absolute precision the predominant role of human interference, even though such interference is not denied.

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Within this context, the so-called “green” energy transition has been presented as the principal strategy for mitigating the severe effects of extreme events associated with climate change. These events have assumed increasingly dramatic proportions across all regions of the planet, manifesting in severe droughts, catastrophic floods, devastating mass movements, as well as intense heat and cold waves.

However, concomitantly, the extraction and use of fossil fuels have intensified. Murphy (2024) argues that the substantial investments in wind and solar energy, as well as improvements in their efficiency, are offset by the high demand generated by fossil-fuel-dependent activities, thereby hindering effective climate change mitigation. It is therefore not coincidental that, according to the author, 80% of global energy consumption remains concentrated in fossil fuels. Wang and Azam (2024) and Alipour et al. (2024) further emphasize that continuous global population growth and the expansion of national economies have led to an unprecedented increase in the demand for energy and natural resources, particularly fossil fuels.

Considering this contradiction, within the framework of capitalist sustainable development, the strategy adopted has been to promote the “green” transition. From this perspective, sources such as wind, solar, and biomass energy are presented as capable of reducing CO_2 emissions and, in the future, leading a transformation of the global energy matrix (Lange, 2024; Shang et al., 2024). However, these sources also generate environmental impacts and territorial conflicts, even though their advantages are the ones most widely publicized.

In Brazil, large hydroelectric projects and wind farms are examples of enterprises considered sustainable, yet this premise can be readily challenged even through a preliminary examination. Thus, it becomes essential to make explicit the contradictions of the so-called “green” energy transition within a structurally unequal world, including inequalities in access to energy as an essential service.

Given this context, the central objective of this study is to analyze whether the renewable energy transition represents a structural transformation in the patterns of economic production and social reproduction, or whether it merely constitutes an adaptation of hegemonic fossil capitalism aimed at perpetuating the logic of massive extraction of natural resources to sustain an unsustainable model of consumption.

In this regard, it is essential to understand the environmental impacts and territorial conflicts materialized in the production of so-called renewable energy sources, such as wind and hydroelectric power, taking the Brazilian case as an empirical reference. This approach allows for an analysis of the scalar interrelations of the phenomenon, as well as the power relations embedded in the process.

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METHODOLOGY

This is analytical and explanatory research, focusing on the multiple nuances and implications of the theme under investigation. It is grounded in an extensive literature review, based on articles indexed in databases such as SciELO and Elsevier, using keywords including “energy transition,” “fossil capitalism,” and “renewable energy.” The selection sought to encompass authors who both support and challenge the existence of a renewable energy transition, thereby enabling the articulation of convergent and critical perspectives.

The selection of references prioritized scientific articles of recognized relevance across different fields of knowledge, considering their adherence to the theoretical debate and to the research problem addressed.

In addition to academic literature, technical reports from international organizations, such as the World Economic Forum and the United Nations Environment Programme (UNEP), were analyzed to contextualize the global dynamics and identify the challenges and inequalities associated with the issue of energy and the “green” energy transition. News articles from online platforms and specialized media outlets, such as Folha de S. Paulo, Valor Econômico, and BBC News, were also consulted and used critically, to complement academic data with up-to-date information on events discussed in the text.

To illustrate the contradictions inherent in the energy transition, Brazilian examples were mobilized, including hydroelectric projects in the Amazon and wind farms in selected localities of the Northeast. Graphs and a summary table were also employed to support and contextualize the analyses.

These cases were not treated as comparative case studies; rather, they were approached as analytical exemplars, mobilized in light of the theoretical references, with the objective of demonstrating how local territorial dynamics express structural contradictions of the energy transition at a global scale, particularly with regard to territorial conflicts, inequalities in access to energy, and environmental impacts generated even by energy enterprises considered sustainable.

As a temporal framework, the study primarily focuses on the first two decades of the twenty-first century, a period in which climate change centered on human action consolidated itself as a global emergency and, consequently, the renewable energy transition became firmly established at the core of political, economic, and environmental agendas on a global scale.

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ENERGY TRANSITION: RENEWABLE ENERGIES AS PROTAGONISTS OR APPENDAGES OF THE HEGEMONIC FOSSIL-BASED MODEL?

The so-called “green” energy transition has progressed slowly on a global scale. According to a report released by the World Economic Forum (2024), this slow pace is associated with economic instability, escalating geopolitical tensions, and challenges related to technological change. Investment in the sector remains highly concentrated in wealthier and more technologically advanced countries, in addition to China.

By contrast, so-called emerging and developing countries depend on external financing to expand investments in energy infrastructure. Brazil ranks 12th globally, standing out as a country that has achieved relative prominence in the production of renewable energy, particularly in the hydroelectric sector, in biofuels, and in the rapid expansion of solar energy, which has attracted new investments (International Monetary Fund, 2024).

From a more superficial or phenomenological perspective of the phenomenon, as discussed by Deshaies (2020) and Jiusto (2009, apud Cataia; Duarte, 2022), the energy transition is grounded in the premises of low CO_2 emissions, the use of renewable energy matrices, the production and consumption of clean energy, and, consequently, the reduction of negative impacts on the global climate, combined with the promotion of economic and environmental sustainability. In this sense, the dissemination of the term “energy transition” has been closely associated with the discourse on global warming.

Within this framework, Seibert and Rees (2021) argue that the Green New Deal represents the pathway outlined by dominant thought to achieve sustainable development. The Green New Deal, introduced by members of the Democratic Party in the United States in 2019, proposes directing public investments “[…] toward sustainable economic activities, with the aim of reducing the use of fossil fuels and the emission of harmful gases into the atmosphere that currently drive global warming” (Costa; Peres, 2021).

The Green New Deal is premised on the assumption that a transition toward clean energy can be achieved within a relatively straightforward technological context, structurally transforming the energy bases that sustain contemporary societies, while also contributing to the creation of thousands of “green” jobs.

According to Cataia and Duarte (2022), economic growth based on capitalism cannot ensure an indefinite supply of fossil energy, given that such resources are finite, whereas capital’s expansive demand is continuous. Hence, the need arises for complementary energy sources.

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Concerns regarding the scarcity of fossil resources, particularly oil, have been present since the 1970s. However, it was only when global warming became hegemonic in public and scientific discourse, in the early twenty-first century, that the foundations underpinning the narrative of energy transition were consolidated (Cataia; Duarte, 2022). In this sense, global warming has been conveniently mobilized to diversify the global energy matrix and to ensure the continued predatory reproduction of capitalism.

Within this scenario, it is essential to highlight the contradictions associated with this process. A report published by the United Nations Environment Programme (UNEP), in partnership with the International Resource Panel (IRP) (2024), indicates that high-income countries consume approximately six times more resources and generate up to ten times more climate impacts than lower-income nations.

Thus, the much-celebrated "green" energy transition faces significant obstacles, even in countries with high financial capacity, as their economies remain deeply dependent on fossil-based energy systems. This occurs because, according to Seibert and Rees (2021), renewable energy sources are unable to provide the same quantity and quality of energy as fossil fuels. In this regard, Fressoz (2013, apud Cataia; Duarte, 2022) argues that the energy transition, rather than replacing existing energy matrices, is characterized by the incorporation of new sources into pre-existing ones.

Within this debate, even among authors who advocate for a renewable energy transition, there is no homogeneity of positions. It is common to acknowledge the political, economic, and structural constraints that condition its effective implementation.

For Solomon and Krishna (2011), most energy transitions have historically been driven by resource scarcity, high labor costs, and technological innovation. However, they emphasize that the renewable energy transition proceeds slowly due to the specific political, economic, and cultural conditions of each country.

Despite these limitations, Karanikolas and Vagiona (2016) argue that the transition toward renewable energy is already driving both domestic and international policies. From this perspective, the substantial reduction in fossil fuel use represents one of the greatest technological challenges ever faced by humanity (Veelen; Horst, 2018). In turn, Calvert and Simandan (2010) point out that fossil-based energy systems continue to be favored by political and economic power, which helps explain the slow advancement of renewable energies.

According to Calvert (2015), the transition toward renewable energy sources constitutes a cultural, political, technological, and economic project that requires the reorganization of socio-technical structures and of the relationships between society and nature. However, this pathway

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still appears distant, as it would demand a disruptive process that would ultimately imply the end of capitalism itself.

Kaze et al. (2025), in contrast, argue that a key proposal for achieving a just energy transition is Community Renewable Energy (CRE), characterized as a decentralized model of energy generation, with strong citizen participation, mitigation of environmental impacts, and the potential to generate employment at the community level. Such initiatives are particularly prominent in countries such as Germany and Denmark.

In peripheral contexts, especially in Sub-Saharan Africa, CRE holds strategic potential for expanding access to energy and alleviating energy poverty. However, it faces significant limitations related to national institutional structures, the formulation and implementation of public policies, and economic and technological dependence on central countries (Kaze et al., 2025).

From this perspective, CRE depends to be effective on a series of structural conditions that are far from easily attainable. It is also important to recognize that CRE initiatives do not represent a disruptive alternative to capitalist dynamics; rather, they are embedded within a broader process of decentralization of energy production aimed at enhancing the efficiency of the capitalist mode of production in its metabolic functioning.

In this context, authors such as Overland (2019) argue that renewable energy sources tend to exhibit a more geographically uniform distribution than fossil and nuclear resources. Accordingly, he suggests that economic gains and access to energy may become more evenly distributed among countries, thereby reducing the geopolitical relevance of control over specific locations and resources (such as oil and natural gas).

At the same time, Overland (2019) cautions that the abundance and spatial diffusion of renewable resources require the development of technologies capable of capturing, storing, and transporting them. He emphasizes that the control of such technologies and of intellectual property rights, particularly by large corporate conglomerates and central nations, may give rise to a new phase of international competition.

This suggests that central nations and their corporations will likely continue to hold primacy in this sector. Peripheral nations, given their specific socio-economic conditions and levels of technological development, already face significant challenges in ensuring universal access to energy and will remain dependent on technology transfer for investments in renewable resources. Within this scenario, a critical question emerges: would poorer nations be willing to forgo fossil resources that may exist within their territories and/or are more affordable, in favor of more expensive sustainable technologies?

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In addition to the structural difficulties associated with capitalism's chronic dependence on fossil resources, further challenges arise from geopolitical tensions. The war between Russia and Ukraine, ongoing since early 2022, constitutes a clear example of such tensions, generating widespread concern regarding the global supply of oil and natural gas.

Beyond the war, the COVID-19 pandemic disrupted production systems while simultaneously increasing global demand for food and fossil resources, compelling wealthier countries to restructure their commodity supply chains. Geopolitical tensions in the Middle East have introduced additional elements of uncertainty, further intensifying global instability.

In this regard, a notable example of fossil dependence can be observed in the conduct of Joe Biden, President of the United States, whose administration proposed the Green New Deal. However, following the Russia–Ukraine conflict and the imposition of sanctions on Russian oil and gas, Biden acknowledged the need to diversify suppliers, calling for increased domestic production and seeking support from Middle Eastern countries and Brazil to do the same. Even Venezuela, historically subject to U.S. hostility, was approached to expand oil supply (Folha de São Paulo, 2022; Marinho, 2022; Valor Econômico, 2022).

Another emblematic case emerged during the 2024 United States presidential campaign, when then-candidate Donald Trump accused his opponent Kamala Harris of opposing unconventional oil and gas extraction through the controversial technique of hydraulic fracturing (fracking). Harris had adopted an anti-fracking position during the 2019 presidential campaign; however, in the 2024 campaign, she shifted her stance in favor of the technique (Scaff; Rosa, 2024).

Brazil, in turn, continues to pursue the exploitation of unconventional energy resources in onshore sedimentary basins. In 2013, the National Agency of Petroleum, Natural Gas and Biofuels (ANP) held its 12th Oil and Gas Bidding Round, which, for the first time, enabled petroleum companies to explore and exploit the country's unconventional reserves, particularly shale gas.

Nevertheless, resistance from various social actors and groups generated a conflictual scenario, culminating in the suspension of the bidding round's effects by the Federal Court. In addition, several prohibitive laws against fracking were enacted in municipalities located within the auctioned areas, as well as in states such as Paraná and Santa Catarina (Santana, 2022).

Although fracking still appears to be a distant reality in Brazil, the country plans to utilize unconventional resources originating from Argentina. In 2023, the Brazilian government announced investments in the expansion of the Presidente Néstor Kirchner gas pipeline, which transports unconventional gas from the Vaca Muerta Formation (Argentina), with plans for extension to the state of Rio Grande do Sul (Anjos, 2023).

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However, the governments of Argentina and Brazil have also explored alternative routes for transporting Vaca Muerta gas to Brazil. In 2024, during the G20 Summit in Rio de Janeiro, the two countries signed an agreement to expand the importation of Argentine natural gas (Gama; Neder, 2024). In addition to these significant unconventional reserves, the Lula administration has expressed interest in exploring conventional oil and gas resources in the Foz do Amazonas Sedimentary Basin.

It is important to note that the exploitation of unconventional energy resources raises a series of concerns due to the significant environmental impacts and territorial conflicts it generates. Among the main issues are the contamination of surface and groundwater sources, air pollution, induced seismic activity, and the large volumes of sand, water, and chemical substances used in fracking, as well as conflicts involving traditional communities, small-scale farmers, and major agribusiness actors (Santana, 2022).

However, abandoning the use of such energy matrices would entail internal and external economic disorganization, with consequences that remain difficult to foresee. Considering this scenario, Pasqualetti (2011) and Sweeney (2014) argue that large energy conglomerates have been actively engaged in developing technologies to extract all types of fossil resources, thereby opposing a transition in which renewable energy assumes a central role.

Lohmann (2015) contends that conflicts of interest are inherent to the energy question, as the perspectives of public policymakers and fossil capitalism collide with the needs of populations within territories. In this sense, he argues that capitalism treats the energy transition as complementary to the fossil matrix and as "[…] a way of diversifying and intensifying the same type of labor exploitation that fossil capitalism has made universal" (Lohmann, 2015, p. 8 – our translation).

Within this framework, populations remain marginalized from effective participation in the construction of solutions capable of ensuring democratic access to energy; solutions that should be grounded in the specific characteristics of their territories and in the resources available for the local development of energy systems (Veelen; Horst, 2018).

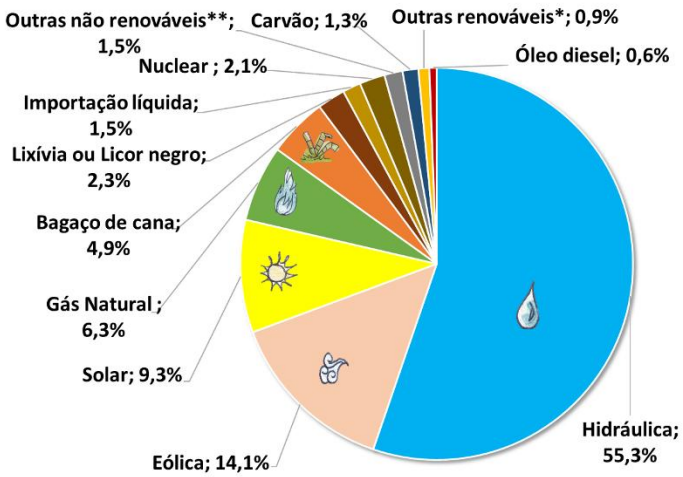
BETWEEN SUSTAINABLE DISCOURSE AND TERRITORIAL REALITY: IMPACTS OF HYDROELECTRIC POWER AND WIND FARMS IN REGIONS OF BRAZIL

From the discussions developed thus far, the Brazilian case is emblematic, as its electricity generation matrix is widely regarded as predominantly sustainable. Figure 1 shows the

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composition of the Brazilian electricity matrix in 2024, highlighting the predominance of renewable sources, especially hydropower, alongside the continued presence of fossil and non-renewable sources, albeit in smaller proportions.

Figure 1 – Brazilian electricity matrix, 2024



Source: Energy Research Company (EPE, 2024). Brazilian electricity matrix (*including firewood, biodiesel, and others; **fuel oil, coke oven gas, and other secondary sources). Available at: https://www.epe.gov.br/pt/abcdenergia/matriz-energetica-e-eletrica. Accessed on: Dec. 1, 2024.

Despite discourses that emphasize the need for large-scale projects to ensure energy security and the consequent democratization of access to energy for the entire population, historical evidence demonstrates the occurrence of impacts and territorial conflicts in areas where energy sector enterprises are implemented, particularly those related to hydroelectric power.

The case of hydroelectric dams constructed on the Amazon is especially illustrative. Fearnside (2019) highlights the social conflicts associated with these projects, particularly those involving Indigenous peoples, in the construction of the Tucuruí, Balbina, and Belo Monte dams. In addition, populations are displaced to enable dam construction, while others are affected downstream from the reservoirs. Further impacts include the proliferation of disease vectors, such as mosquitoes, and mercury methylation processes, both of which severely affect public health. The economic orientation of these dams toward supporting mineral commodity processing, such as aluminum production, constitutes another impact that affects society.

A notable example is the Belo Monte Hydroelectric Plant, in the state of Pará, whose construction began in 2010 and was approved by the federal government prior to the completion of the Environmental Impact Assessment (EIA), despite opposition from the Brazilian Institute of Environment and Renewable Natural Resources (Ibama) (Guimarães, 2024). As a result, the project has been marked by low productivity and irreversible environmental impacts in the

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Middle Xingu River region, including alterations in river flow, disruptions in fish reproduction and food chains, and profound changes in the livelihoods of riverside populations and Indigenous communities.

According to Castilho (2019), the Belo Monte project led to the displacement of more than 20,000 people. It also generated impacts on the urban dynamics of the nearest city, Vitória do Xingu, due to the large influx of migrants. This process contributed to increased criminality, as the city expanded without adequate infrastructure and public services.

The Tucuruí Hydroelectric Plant, also in Pará, provides another example of how the Brazilian State has promoted such projects to meet the demands of the mineral sector's economic power. In this case, the plant was implemented without the proper Environmental Impact Assessment and Report (EIA-RIMA). The local geomorphological conditions were unfavorable, requiring the creation of a vast artificial reservoir whose environmental impacts are irreversible—a situation similar to that of the Balbina Hydroelectric Plant, in the state of Amazonas, which was constructed to supply the city of Manaus but exhibits low energy generation capacity (Fearnside, 2019). Thus, these enterprises, often labeled as "clean," generate energy primarily destined for distant areas, thereby reinforcing territorial inequalities.

Regarding greenhouse gas (GHG) emissions, Zaparolli (2019) points out that hydroelectric plants, especially those built in forested areas, may emit significant amounts of greenhouse gases during their initial years of operation; reductions in such emissions, depending on local conditions, may take decades to materialize.

It is also essential to emphasize that economic actors and groups directly involved in the construction of large-scale projects, often financed with public resources and benefiting from close relationships with the State, engage in lobbying to ensure that governmental policies in the territories align with their interests, as well as those of political agents who control the state apparatus, even when such alignment occurs at the expense of environmental degradation and low energy efficiency.

According to Castilho (2019), there has been an increasing participation of private companies in energy generation in the Amazon, including firms such as Engie Energia and Enel. The author also highlights the entry of large agribusiness actors into this sector, such as Itamarati Norte S.A. Agropecuária and Cinco Estrelas Agropecuária, driven by the high energy demand of irrigation systems and, above all, by the highly profitable nature of the energy sector for generating companies.

The Belo Monte project itself has a shareholder composition involving multiple companies, notably Eletronorte, Eletrobras, and Chesf. The estimated cost of the project exceeded R$38

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billion, of which R$12 billion was contributed by shareholders, while the remainder was financed by the National Bank for Economic and Social Development (BNDES), with a repayment period of 30 years. A significant portion of the energy generated is allocated to specific sectors: 10% to two shareholders with energy-intensive industries in the North and Northeast regions, Sinobras and the mining company Vale, and 20% to the free market, composed of 630 large consumers who pay prices lower than those in the regulated market (Castilho, 2019).

Despite the prominence of the hydroelectric sector, planning and strategies for energy resource exploitation remain grounded in a fossilist and extractivist mindset. The prevailing discourse maintains that the country's existing and potential reserves cannot be neglected, as they are essential for ensuring the diversification of the national energy matrix, energy security, and, ultimately, national development.

Considering the arguments presented thus far, it becomes evident that, although structured upon fossil-based foundations, capital increasingly mobilizes renewable energy enterprises, such as wind and solar farms, as showcases of sustainability and as emblematic elements of the renewable energy transition. However,

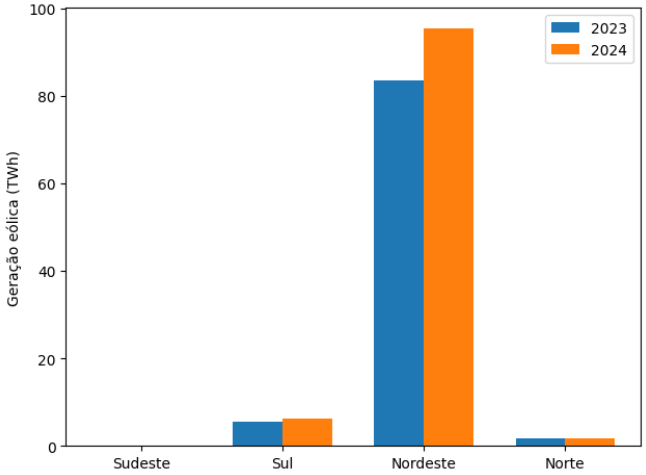
> The new geographical forms and global imperatives brought about by the energy transition are framed as "green energy," "clean energy," "alternative sources," and other denominations that seek to construct a positive psychosphere, yet without abandoning the continued use of highly polluting energy sources such as coal and oil (Cataia; Duarte, 2022, p. 768).

The wind energy sector is a particularly illustrative example of the contradictions inherent in so-called "clean" energy. Although considered renewable, wind energy production has generated significant impacts, especially in areas inhabited by populations that have often occupied these territories for centuries and that are now targeted by the sector.

In 2024, the Northeast region accounted for 92% of wind energy generation in Brazil, according to data from the Brazilian Wind Energy Association (ABEEólica, 2025). The data presented in Figure 2 and Box 1 clearly demonstrate the dynamism and expansion of the sector in this region.

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Figure 2 – Wind Energy Generation by Region – Brazil (2023–2024)



Source: ABEEólica (2025). Organization: Authors (2026).

Box 1 - Brazilian states with new wind farms in 2024

State	Total Installed Capacity (MW)	Number of Wind Farms
Bahia (BA)	1,953.9	48
Piauí (PI)	364.8	8
Rio Grande do Norte (RN)	313.5	9
Rio Grande do Sul (RS)	302.4	3
Paraíba (PB)	116.0	3
Ceará (CE)	112.5	3
Pernambuco (PE)	91.2	2
Total	**3,254.3**	**76**

Source: ABEEólica (2025). Organization: Authors (2026).

According to Izá Pereira (2024), the expansion of wind energy projects in Brazil results from dynamics operating across different scales. In an initial phase (1998–2009), this expansion was associated with nationally driven demands; in a subsequent period (2010–2022), it became increasingly propelled by the interests of international capital, which, in the context of economic crises, sought to diversify its investment portfolios.

Wind turbines installed across various localities in the Northeast region have generated processes of deterritorialization, land conflicts, and the loss of access to communal lands. According to Machado and Serrano (2023), they have also led to health-related issues, including depression, insomnia, and hearing loss. Faustino, Tupinambá, and Meirelles (2023), in turn, emphasize the environmental impacts in ecologically fragile environments, such as dune systems.

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Dantas (2021) notes that such conflicts may arise either prior to or following the installation of wind farms, whether because of resistance from local communities or due to the failure of companies to fulfill previously established commitments.

This conflictual scenario is marked by a clear asymmetry of power. Within this dynamic, once wind farms are installed, communities often become dependent on corporate actors for land management, previously conducted according to traditional knowledge systems and practices (Faustino; Tupinambá; Meirelles, 2023).

Madeiro (2022) reported negative impacts affecting communities in the states of Pernambuco, Ceará, and Rio Grande do Norte, including damage to roads, houses, and water cisterns caused by heavy truck traffic, as well as restrictions on access to and circulation within areas that were previously communal. These impacts are compounded by noise pollution, which generates discomfort and adverse effects on residents' mental health, forcing many to abandon their lands.

On the other hand, Mendes (2019) identified certain positive impacts in the municipality of Camocim, Ceará, such as improvements in housing conditions, access to electricity, the construction of access roads to the community, and the provision of school transportation. However, the author emphasizes that these benefits were only achieved due to the collective mobilization of the community, which sought compensatory measures through legal action in response to the impacts experienced. Regarding negative impacts, in addition to those identified by Madeiro (2022), Mendes also highlights damages to artisanal fishing, due to reduced surface freshwater availability, fears of accidents, and the emergence of intra-family conflicts.

In the case of solar energy, the production and disposal of photovoltaic panels have emerged as additional sources of pollution and contamination (Gordon, 2023; Jones, 2024; Anusuya et al., 2023). Electric vehicles and other forms of electrified transport depend on lithium, which is extracted in various regions of the world, generating environmental impacts and territorial conflicts (Mousavinezhad et al., 2024).

Cataia and Duarte (2022, p. 767) further argue that the rapid development of renewable energy, particularly wind and solar, requires the destructive extraction of minerals such as lithium: "Wind and sun are renewable, but 'everything else'—the invisible materialities—all spatial circuits of production and their circles of cooperation within the energy industries are not, especially in the case of predatory extractivism."

Ediger and Berck (2023) also point to the limitations of technologies such as wind turbines and solar cells, noting that they have already reached near the maximum efficiency permitted by the laws of physics. Moreover, these technologies experience efficiency losses over time and face

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significant challenges related to energy storage, thereby limiting their capacity to sustain a fully renewable energy system.

Seibert and Rees (2021, p. 3 – our translation) go further by arguing that the technologies required for "clean" energy generation "[…] are not renewable; their production—from mining to installation—is fossil energy-intensive; and their manufacture—particularly the mining of their metals and the disposal of their waste—involves glaring social injustices and significant ecological degradation." The authors conclude that the Green New Deal "[…] offers little more than a green version of the unsustainable growth-based status quo. Even if feasible, its implementation would merely exacerbate human ecological dysfunction" (Seibert; Rees, 2021, p. 12 – our translation).

It thus becomes evident that so-called renewable energy sources, like all dimensions of capitalist production, require the large-scale exploitation of natural resources, thereby intensifying neo-extractivist practices across vast regions of the planet, particularly in poorer nations and in so-called emerging economies, many of which remain strongly dependent on primary commodities. Accordingly, the fragility of the renewable energy transition within the context of capitalism becomes apparent, despite the enthusiasm with which it is often promoted.

Seibert and Rees (2021, p. 2 – our translation) argue that "Climate change is merely a symptom of systemic destabilization, as the human enterprise has come to overload the ecosphere." Thus, development strategies and policies aimed at promoting "green" energy (and its variants) ultimately constitute a broadly shared illusion, insofar as they "[…] futilely seek techno-industrial solutions to problems caused by techno-industrial society. This self-referential pursuit is doomed to fail" (Seibert; Rees, 2021, p. 2 – our translation).

Within this framework, Loureiro et al. (2023, online) argue that green capitalism invests in carbon markets, energy transition initiatives, and "green" mining, among other strategies, to sustain the claim that the climate crisis can be reversed within the capitalist system. They further note that climate change is treated as the sole environmental problem, to the detriment of other critical issues, such as biodiversity loss, increasing chemical pollution, soil degradation, and ocean acidification.

Thus, capitalism has been compelled to reinvent itself and to appear less destructive, with sustainable development emerging as the strategy through which it seeks to present itself as rational, based on the assumption that production and consumption levels can be maintained through practices deemed sustainable.

In this sense, sustainable development is embedded in a logic whereby "[…] 'nature' is understood merely as a variable to be managed, administered, and governed within the

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longstanding rationalist, bureaucratic, and Enlightenment tradition, in such a way as not to hinder the hegemonic conception of 'development'" (Zhouri, 2004, p. 212).

Montibeller-Filho (2001) and, more recently, Kruse and Cunha (2022) highlight the contradiction inherent in attempting to reconcile development, poverty reduction, and environmental preservation, arguing that social and environmental crises are rooted in the relentless pursuit of profit by the global dominant class. Consequently, progressive environmental degradation constitutes an insurmountable challenge for capitalism.

From this perspective, Loureiro et al. (2023, online) conclude that "It is not possible for the very model that produces environmental impacts and the destruction we currently experience to serve as the protagonist and promoter of solutions to these problems. On the contrary, the proposed solutions generate further contradictions and inequalities."

Contreras et al. (2023, p. 4 – our translation) argue that the implementation of renewable energy infrastructures intensifies the extraction of natural resources, the privatization of land, and the commodification of essential public services such as electricity, thereby "[…] exacerbating longstanding capitalist economic relations of accumulation by dispossession."

The authors further contend that the energy transition, particularly through large-scale renewable energy megaprojects, is grounded in a form of energy colonialism, as it is underpinned by a colonial logic of economic, cultural, and political domination that continues to shape relations between central nations and peripheral countries, as well as internal peripheries within the Global North. Within this framework, peripheral countries remain suppliers of raw materials and energy to central economies (Contreras et al., 2023).

This dynamic reinforces asymmetries of power in relation to Indigenous peoples, peasants, and other communities affected by large-scale energy projects labeled as sustainable. For these communities, the negative impacts of projects disconnected from their ways of life persist, transforming many localities into sacrifice zones, while profits are distributed to distant regions.

> Energy colonialism promotes a biased and paradoxical narrative that seeks to establish that the development of renewable energy is sustainable and benign, or at worst, the "least harmful" way of addressing climate crises while, in reality, it renews the capitalist system based on the extractive destruction of the biocultural commons of rural and Indigenous communities (Contreras et al., 2023, p. 11 – our translation).

Therefore, the direct association between so-called renewable energy resources and a clean and just energy transition does not hold. This is because capitalism distorts this premise by reducing territories, populations, and all elements of nature to mere instruments of its reproduction, invariably under the logic of appropriation and violence.

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FINAL REMARKS

Climate change has become the primary concern for the maintenance of life on the planet, with human activities widely regarded as the central cause of its intensification, particularly through greenhouse gas (GHG) emissions resulting from the combustion of fossil fuels. This constitutes the hegemonic perspective prevailing within scientific discourse, the media, and the policy orientations of numerous nations. Nevertheless, critical perspectives persist, viewing this process as only one dimension within a broader context of environmental degradation driven by the dynamics of fossil capitalism.

However, this dominant view has succeeded in establishing the narrative that the transition toward renewable energy matrices constitutes the solution to mitigating the effects of climate change and safeguarding humanity from an imminent collapse. Consequently, investments in so-called clean energy sources, such as wind and solar, have gained significant prominence, albeit predominantly within wealthier nations possessing the technological and financial capacity to foster such sectors. Meanwhile, poorer countries continue to face substantial challenges in ensuring universal access to energy, thereby exposing global inequalities within a process that purports to be both sustainable and inclusive.

Despite these challenges, some authors argue that a “green” energy transition remains achievable, notwithstanding the political, economic, and cultural specificities of each nation, as well as the continued primacy of fossil resources. From this perspective, the “green” energy transition has been driven by policies at both national and international levels and is understood as a process capable of reconciling decarbonization, economic growth, and development. It would, however, require a profound reorganization of socio-technical systems and of the modes through which society–nature relations are structured.

In contrast, other authors interpret renewable sources merely as appendages to the hegemonic fossil-based matrix, serving as a necessary mechanism for the continued reproduction of capitalism according to the predatory logics of production and consumption upon which it is founded. These perspectives argue that the fossil matrix lacks a viable substitute capable of sustaining capitalist reproduction and, therefore, that a complete transition to clean energy sources is unlikely.

Moreover, these authors contend that so-called “clean” energy sources generate significant environmental impacts and territorial conflicts, while remaining dependent on fossil-based inputs throughout their production and installation chains. Nonetheless, the discourse of

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sustainability is mobilized to legitimize the production of “clean” energy and, simultaneously, to obscure the negative impacts generated by “green” enterprises. It is this latter perspective that has guided the analysis developed in this article.

The cases of large-scale hydroelectric megaprojects in the Brazilian Amazon and wind farms predominantly located in the Northeast region reveal the contradictions between the sustainability discourse associated with these energy matrices and the environmental impacts they produce. These projects generate conflicts in territories where local dynamics of social reproduction come into direct confrontation with ways of life that are systematically disregarded by such enterprises.

In this sense, the narrative of the “green” transition emerges as a necessity for capitalism to continue its reproduction, grounded in a dynamic that remains fundamentally predatory. This is because the natural resources required for commodity production are themselves finite, while systemic environmental degradation persists.

Thus, the renewable energy transition, although widely advocated at the global level, does not resolve the central issue. Capitalism, as a system based on expanded accumulation and the continuous expansion of production and consumption, entails a structurally increasing demand for energy and materials. In this regard, regardless of the energy matrix adopted, the logic of capital reproduction remains unchanged, as gains in efficiency or the substitution of fossil sources by renewable ones do not eliminate the need to intensify the metabolism between society and nature.

Accordingly, the so-called energy transition tends to reconfigure, rather than reduce, the exploitation of natural resources, deepening the appropriation of territories, the spatial displacement of environmental impacts, and the degradation of the living conditions of subordinated populations, as a means of sustaining mass consumption and the forms of social reproduction characteristic of contemporary capitalism.

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Declaração de contribuição dos autores:

Alessandro Donaire de Santana: concepção da pesquisa; análise de obras obtidas por meio de revisão bibliográfica e documental; levantamento, sistematização e análise de notícias jornalísticas; análise teórica; redação do manuscrito; sistematização e organização do conteúdo; revisão final.

Margarete Cristiane de Costa Trindade Amorim: discussão teórico-metodológica; revisão crítica do conteúdo; levantamento e sistematização de obras (livros e artigos) que serviram de base para o artigo; aprovação da versão final.

João Osvaldo Rodrigues Nunes: orientação da pesquisa; discussão teórico-metodológica; revisão crítica do conteúdo; levantamento e sistematização de obras (livros e artigos) que serviram de base para o artigo; aprovação da versão final.

Declaração de conflito de interesse

Os autores declaram não haver conflito de interesse.

Declaração de disponibilidade de dados da pesquisa

Todo o conjunto de dados de apoio aos resultados deste estudo foi publicado no próprio artigo.

Declaração de uso de IA

A ferramenta de inteligência artificial ChatGPT foi utilizada para auxiliar na revisão técnico-gramatical do texto e normalização de referências.

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