# Energy Justice Mapping: Social Impacts of Offshore Wind Farms in NE Brazil

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**Abstract**: The expansion of offshore wind farms in Brazil offers a significant opportunity for energy generation but also presents socio-environmental and economic challenges. Given the scale of these projects, there is a critical gap in the study of the social impacts on coastal communities and their livelihoods, such as fishing. The lack of integration of social, environmental, and economic impact assessments in offshore projects limits the understanding of the social dynamics involved, particularly with the involvement of local communities in impact assessment processes. This research aims to investigate the social impacts of offshore wind farms in Brazil, emphasizing marine and coastal territory mapping as a basis for analysis. Detailed mapping of the impact areas can provide a clearer understanding of the interactions between energy infrastructures, marine ecosystems, and coastal communities, enabling more equitable resource management and helping to avoid conflicts. Furthermore, the concept of energy justice will be central to the discussion, addressing how the benefits of the energy transition can be distributed fairly and how the most vulnerable groups, such as fishermen and traditional communities, are impacted. The research seeks to fill gaps by investigating how these projects may exacerbate or mitigate regional inequalities, considering the distribution of their risks and benefits. The study aims to support sustainable governance of Brazil's seas, ensuring that affected populations have an active voice in the planning and implementation processes of renewable energy, particularly offshore wind farms.

**Keywords**: governance; just energy transition; social participation; communities

## Introduction

Offshore wind energy is poised to play a major role in Brazil's transition to clean power, with the country's northeast (NE) coast identified as a high-potential region, with about 113GW of installed capacity planned (IBAMA, 2025). This rapid push for wind development is driven by climate goals and strong steady winds, but it also raises urgent questions about social impacts on coastal communities. Past experiences in NE Brazil's onshore wind sector show that a purely techno-economic focus can overlook local livelihoods and rights (Gorayeb et al. 2018; Olofsson & Castro, 2024). The transition to renewable energy must address energy justice - the fair distribution of benefits and burdens, inclusive decision-making, and recognition of affected peoples (Ikevuje et al., 2023).

In the context of offshore wind, mapping emerges as a critical tool to integrate local knowledge and spatial planning for just outcomes (Xavier et al., 2023; Balbino, 2024). Coastal areas in NE Brazil host traditional fishing grounds, delicate ecosystems, and indigenous and other traditional communities (Pinheiro et al., 2023), all of which must be mapped and understood before wind farms are sited. Mapping is not only a technical but also a social exercise where local knowledge is essential and territories inserted in the map can determine whether the existence and rights of a community are recognized or ignored. Practitioners and researchers advocate for

participatory mapping and ethnographic approaches to capture local uses of the seascape (Pinheiro et al., 2023; Xavier et al., 2023).

This article explores how mapping and energy justice principles can be harnessed to assess and manage the social impacts of offshore wind farms in NE Brazil. It aims to investigate these impacts, emphasizing marine and coastal territory mapping as a basis for analysis, and explore strategies to ensure that coastal communities—particularly artisanal fishing communities—are not only protected from adverse impacts, but also included and benefited by offshore wind energy development.

**Coastal Mapping for Inclusive Planning**

Proactive coastal mapping is a foundation for inclusive and informed offshore wind planning. Effective mapping incorporates ecological data and the lived realities of local communities. Pinheiro et al. (2023) emphasize that seascape mapping is critical for understanding ecosystem services and managing areas with potential for new uses like fishing grounds, tourism, and wind farm installations.

In NE Brazil's semiarid coast, where resources for extensive surveys are limited, ethnomapping offers a valuable complement to conventional marine mapping technologies. Ethnomapping involves engaging local resource users—particularly artisanal fishers—to map and describe marine environments based on their knowledge and terminology. Pinheiro et al. implemented focus groups with fishers to chart seascape units and fishing spots, integrating this community knowledge with scientific validation. The result was a "seascape ethnomap" identifying nine distinct seascapes vital to subsistence fisheries, remarkably consistent with geological and ecological surveys.

Inclusive mapping also guards against the erasure of communities in formal planning. The case of Praia do Xavier illustrates how maps can become instruments of injustice when controlled solely by developers. In that instance, the wind company's map left the community blank, treating a populated fishing village as empty land, which enabled the project to claim no residents would be affected (Gorayeb et al., 2018). Public archives later revealed the community's existence, contradicting the developer's omission. The community only reclaimed its traditional territory through a collaborative social mapping initiative with a local university.

By mapping fishing zones, sacred sites, navigation routes, and other community values before project siting, conflicts can be anticipated and avoided. Xavier et al. (2023) argue that participatory cartography can facilitate democratic decision-making for offshore wind in Brazil. Government and industry should therefore incorporate ethnographic and participatory mapping in marine spatial planning to ensure that traditional communities are visible stakeholders.

**Energy Justice Principles in Offshore Wind Development**

Energy justice provides a framework to evaluate and guide offshore wind expansion fairly and equitably. Three fundamental pillars are often highlighted (Bennet et al., 2019): distributive justice (who gains and who loses?), procedural justice (who participates in decisions and how?), and recognition justice (whose voices and values are acknowledged or ignored?). In NE Brazil's offshore wind projects, these principles are concretely applicable.

Distributive justice calls for fair sharing of economic benefits with local communities, ensuring costs don’t fall disproportionately on fishing villages or marginalized groups. Procedural justice requires robust community engagement—from meaningful consultation to the inclusion of

community representatives in planning. Recognition justice entails respecting local identities and knowledge: for example, treating artisanal fishers as legitimate stakeholders and recognizing traditional territories and indigenous or *quilombola* rights.

Brown & Sharma (2024) propose the "SEAT" framework, stating that energy initiatives should be Supported, Environmental, Affordable, and Tolerable to ensure justice for all. "Supported" refers to necessary institutional and infrastructural backing so that everyone can reliably access energy. "Environmental" emphasizes ecological sustainability. "Affordable" means energy must be economically accessible. "Tolerable" stresses social acceptance—projects must be appropriate and acceptable to communities.

Crucially, energy justice responds to past injustices in energy development. Brazil's renewable energy expansion was long treated as inherently benign, with regulations assuming wind power caused no socio-environmental impacts. This assumption proved flawed, as wind farms triggered social conflicts over land and resources. Researchers have documented land dispossession, inadequate compensation, and exclusionary decision-making in NE Brazil's onshore wind projects (Olofsson & Castro, 2024). For NE Brazil's fishing communities, offshore wind projects must actively avoid repeating patterns of marginalization. Instead, energy justice principles urge that these communities receive real benefits and empowerment from the projects.

**Socio-Economic Impacts on Fishing Communities**

Artisanal fishing communities are among the most directly affected stakeholders in offshore wind development. These communities depend on coastal and marine ecosystems for their livelihoods, culture, and food security. The introduction of large-scale turbines can bring significant socio-economic impacts—both risks and potential rewards (Glasson et al., 2022).

One major concern is the disruption of fishing activities. Offshore wind farms require exclusion zones or safety buffers, which can limit access to traditional fishing grounds. Even if fishing is not legally banned within a wind farm after construction, many fishers may avoid the area due to navigational hazards or fear of fouling nets on submarine cables and turbine foundations. For small-scale fishers with limited range, losing access to nearshore fishing spots can directly reduce catch and income (Balbino, 2024).

Land-based infrastructure for offshore wind can also cause socio-economic disruptions. Many planned offshore projects will require onshore facilities such as cabling routes, substations, or ports for assembly and maintenance. If these are sited on beaches or coastal lands, they may encroach on areas used by communities for fish processing, boat launching, or housing. In Cumbe (Ceará state), the construction of onshore turbines prevented fishers from accessing the beach, until a court ruled to restore their access route (Chaves, 2019).

Promises of economic benefits such as jobs often accompany renewable projects, but their fulfillment in fishing communities has been mixed. Wind farms do create jobs, mainly during construction and often requiring technical skills or outside labor. Research by Brannstrom et al. (2022) in coastal Ceará found that perceived economic benefits were a key driver of community support for wind farms. Communities that received tangible benefits—such as new brick houses as mitigation for project impacts, or royalty payments to landholders—showed higher acceptance of wind farms.

Socio-economic impacts are not uniform—they vary with each community's context. Factors such as land tenure status, dependency on fishing, alternative livelihood options, and

community organization influence how a wind project's impacts play out (Olofsson & Castro, 2024). Traditional communities in NE Brazil often have insecure land rights and face political marginalization, making them especially vulnerable to displacement or inadequate consultation.

Addressing these socio-economic impacts demands comprehensive social impact assessment (SIA) as part of planning for offshore wind—one that actively involves the communities in question. Impact management plans should consider compensation for any loss of fishing areas, guarantees of local hiring and procurement, and investment in community-defined projects. In this sense, maps can highlight fishing territories and assist in investigating the impacts.

**Participatory Governance and Community Empowerment**

Achieving energy justice in offshore wind in NE Brazil ultimately hinges on the processes of participatory governance. This means moving beyond top-down decision-making to actively involve those impacted in planning, implementation, and oversight. A participatory approach addresses the procedural dimension of energy justice, ensuring that people have influence over projects that affect their lives.

At the heart of participatory governance is the principle of early and continuous engagement. International best practices emphasize the need to inform and consult communities from the very start. To correct past practices, offshore wind projects should establish formal mechanisms for community participation, such as community liaison committees that include representatives of fishing colonies, local government, researchers, and company officials.

Building trust is paramount. Companies must shift from a "decide-announce-defend" model to a "consult-collaborate-consent" model. This could mean holding regular meetings, allowing community observers on project vessels, or adapting project timelines to accommodate community requests, for instance.

**Conclusion**

The rise of offshore wind energy in Northeast Brazil stands at a crossroads between advancing a low-carbon future and upholding the rights of coastal communities. This article examined how mapping and energy justice can guide development in a socially equitable and sustainable manner. Key findings show that an integrated approach is needed: participatory coastal mapping helps reveal the human and ecological landscape, ensuring communities like artisanal fishers are not made invisible in project plans. Energy justice principles offer a crucial evaluative lens, reminding us that success must be measured not only in megawatts but in fairness and inclusion.

Experiences from NE Brazil's onshore wind projects reveal tangible social impacts: displacement, loss of access to resources, unmet promises, and conflicts. These are not inevitable, but rather stem from gaps in justice and participation. By proactively addressing socio-economic impacts on fishing communities—through compensation, alternative livelihoods, and benefit-sharing—many negative effects can be mitigated. International examples show that with political will, burdens can be offset and local well-being improved.

Central to this is participatory governance. Offshore wind planning that includes communities—and ideally grants some control—is more likely to achieve durable, positive outcomes. Inclusive processes like ethnomapping and consultation embody the principle that a just energy transition is done with people, not to them.

Thus, mapping and energy justice are pillars that determine whether offshore wind becomes a model of sustainable development or a source of new inequities. NE Brazil's strong winds and vast ocean areas offer the chance to generate clean energy and drive economic growth. Grounded in inclusive planning, fair distribution, cultural recognition, and participatory governance, offshore wind can contribute to energy justice—where coastal fishing villages become beneficiaries of the transition, not its casualties.

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**References**

Bennett, Nathan J., Jessica Blythe, Andrés M. Cisneros-Montemayor, Gerald G. Singh, and U. Rashid Sumaila. (2019). "Just Transformations to Sustainability" *Sustainability* 11, no. 14: 3881. https://doi.org/10.3390/su11143881

Brannstrom, C., Leite, N. S., Lavoie, A., & Gorayeb, A. (2022). What explains the community acceptance of wind energy? Exploring benefits, consultation, and livelihoods in coastal Brazil. *Energy Research & Social Science*, *83*, 102344. https://doi.org/10.1016/j.erss.2021.102344

Brown, K. E., & Sharma, B. (2024). A seat at the energy table. *Progress in Energy*, *6*(4), 043006. https://doi.org/10.1088/2516-1083/ad828f

Chaves, L. O. (2019). Modos de vida e conflitos pelo uso dos recursos naturais na Comunidade do Cumbe, Aracati, Ceará - Brasil [Doctoral dissertation, Universidade Federal do Ceará].

Glasson, J., Durning, B., Welch, K., & Olorundami, T. (2022). The local socio-economic impacts of offshore wind farms. Environmental Impact Assessment Review, 95, 106783. https://doi.org/10.1016/j.eiar.2022.106783

Gorayeb, A., Brannstrom, C., de Andrade Meireles, A. J., & de Sousa Mendes, J. (2018). Wind power gone bad: Critiquing wind power planning processes in northeastern Brazil. Energy Research & Social Science, 40(August 2017), 82–88. https://doi.org/10.1016/j.erss.2017.11.027

Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis - IBAMA. (2025). Mapas de projetos em licenciamento - Complexos Eólicos Offshore. https://www.gov.br/ibama/pt-br/assuntos/licenciamento/licenciamento-ambiental/mapas-de-projetos-em-licenciamento/complexos-eolicos-offshore

Ikevuje, A. H., Kwakye, J. M., Ekechukwu, D. E., Ogundipe, O. B., & Esiri, A. E. (2023). Energy justice: Ensuring equitable access to clean energy in underprivileged communities. *Magna Scientia Advanced Research and Reviews*, *8*(2), 211--218. https://doi.org/10.30574/msarr.2023.8.2.0097

Olofsson, V., & Castro, A. (2024). Unjust Winds of Change: The Politics and Narratives of Wind Farms in the Brazilian Northeast. *Iberoamericana -- Nordic Journal of Latin American and Caribbean Studies*, *53*(1). https://doi.org/10.16993/iberoamericana.638

Pinheiro, L., Rodrigues Ximenes Neto, A., Aquino Bezerra Filho, F. A., Rosane Silveira Pinto, C., de Souza Pinheiro, L., Pessoa, P., Lima Filho, R., Balbino da Silva, R., Morais, J., Gorayeb, A., Bramanti, L., & Rossi, S. (2023). Seascape Ethnomapping on the Inner Continental Shelf of the Brazilian Semiarid Coast. *Water (Switzerland)*, *15*(4). https://doi.org/10.3390/w15040798

Silva, R. B. (2024). Cartografia social do mar do Ceará: perspectivas da pesca artesanal e os potenciais conflitos com a energia eólica offshore [Doctoral dissertation, Universidade Federal do Ceará].

Xavier, T., Gorayeb, A., & Brannstrom, C. (2023). Participatory cartography as a means to facilitate democratic governance of offshore wind power in Brazil. In *Energy Democracies for Sustainable Futures* (pp. 185--193). Elsevier. https://doi.org/10.1016/B978-0-12-822796-1.00021-8