POLICY PAPER

STRATEGIES FOR OFFSHORE WIND INDUSTRY IN BRAZIL

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CEBRI
Rethink Tank

ABEEólica
ONSHORE OFFSHORE
ASSOCIAÇÃO BRASILEIRA DE ENERGIA EÓLICA E NOVAS TECNOLOGIAS

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This study was completed prior to the promulgation of the Law nº 15.097, from January 10th, 2025, that regulates the exploration of the offshore wind energy potential in Brazil. The analysis, data and perspectives presented here contribute to the recommendations and planning of the "planned offer", when the Federal government auctions for the implementation of projects in specific areas, and of "permanent offer", that happens with the solicitation of authorization in order to exploit the seabed to implement the project.

It is recommended that future studies dive deep in the analysis on the directives and the effects of the Law nº 15.097/2025, incorporating the new legal conditions to the debates and to the decision making, focusing on: i) increased demand for energy, with the development of more data-centers, for instance, known for their intense energy demand; ii) in Hydrogen hubs and, and iii) in the National Integrated System (SIN).

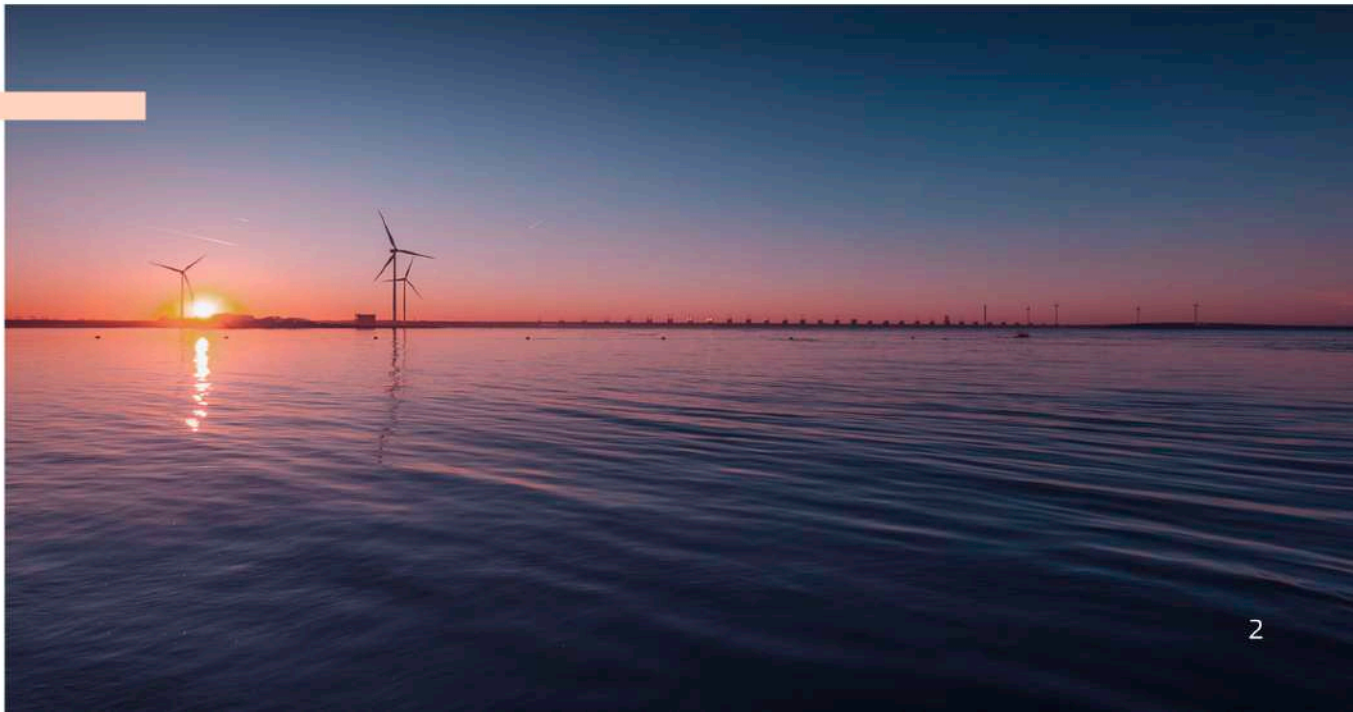
Summary

1 Executive Summary

Offshore wind energy has seen remarkable growth in recent years, driven by the increasing demand for renewable energy sources and the need to reduce carbon emissions. This has led some countries to invest significantly in infrastructure and technology to harness the potential of offshore winds, resulting in a substantial increase in installed capacity. The sector has benefited from technological innovations, such as larger and more efficient turbines, as well as government policies that encouraged investments and partnerships between the public and private sectors.

However, the 2023 crisis brought considerable challenges to the offshore wind industry, affecting supply chains, financing, and regulations. In response, countries utilizing this technology implemented various measures to mitigate the crisis's impacts. This included strengthening support policies for the sector, diversifying supply sources, and increasing international collaboration for knowledge and resource sharing. The actions taken during this critical period demonstrated the need for the creation of public policies to promote the sector's resilience due to its relevance in the global energy transition.

The Policy paper was developed addressing the following topics:(i) Context; (ii) Global Scenario; (iii) Directions to accelerate; (iv) Market pathways; (v) Strategic actions.



Context

The offshore wind energy market is growing, driven by the need for energy transition and carbon emission reduction. Despite the 2023 crisis in some countries, global capacity now stands at approximately 75.2 GW. Projections suggest that installation and operational costs will continue to decline due to various factors, with public policies playing a crucial role in advancing this energy sector.

Offshore wind projects require intensive capital investment; however, operational costs benefit from economies of scale. The value of this chain has a multiplier effect, extending beyond financial gains to GDP, fostering socioeconomic development, and benefiting the environment. This policy paper discusses lessons learned by leading and emerging countries, along with public policy mechanisms used to overcome industry challenges. Innovation Norway, together with CEBRI, hosted an event at the Norwegian Embassy, "Offshore Wind Energy: The Next Steps for the Industry," focused on challenges and opportunities for Brazil.

This policy paper aims to present international experiences and lessons based on discussions from the workshop "Offshore Wind Energy: Next Steps for the Industry," held on October 14, 2024. The panels addressed the barriers to implementing offshore wind energy in Brazil. Key topics included the viability of offshore wind energy, experiences from established markets, lessons learned from Norway, and how Brazil could benefit from developing this industry.

Additionally, the workshop covered environmental licensing and potential market pathways to drive the sector forward.

Following this Introduction, there are six other sections: 3. Global Scenario and Prior Context, 4. Directions to Accelerate Offshore Wind Development in Brazil, 5. International Experience: Successful Cases Integrating Non-Price Criteria Into Auctions, 6. Market Pathways for Offshore Wind: Challenges and Opportunities, 7. Knowledge Transfer Between Norway and the World: Decarbonizing Oil and Gas Platforms at North Sea, 8. Strategic Actions and Guidelines for the Bases of Offshore Wind in Brazil.

Global Scenario and Previous Context

This Policy Paper aims to contribute with the implementation of offshore wind energy technology in Brazil, drawing international lessons to transfer to the local industry. It comprises public policies implemented by several leading countries that have promoted this technology on a large scale.

The global installed capacity of offshore wind energy currently stands at approximately 75 GW, highlighting the potential for expansion (Figure 1).

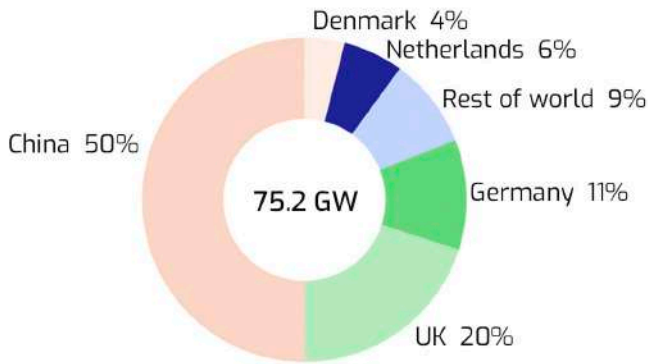


Figure 1: Total installations offshore.
Source: Global Wind Energy Council (2024).

According to the report "Renewable Power Generation Costs in 2023" published by International Renewable Energy Agency (IRENA), the global weighted average costs (LCOE) of offshore wind energy reduced 63% between 2010 – 2023 (Figure 2). Important measures such as financial incentives, simplified licensing processes and long-term power purchase agreements have been crucial to this growth.

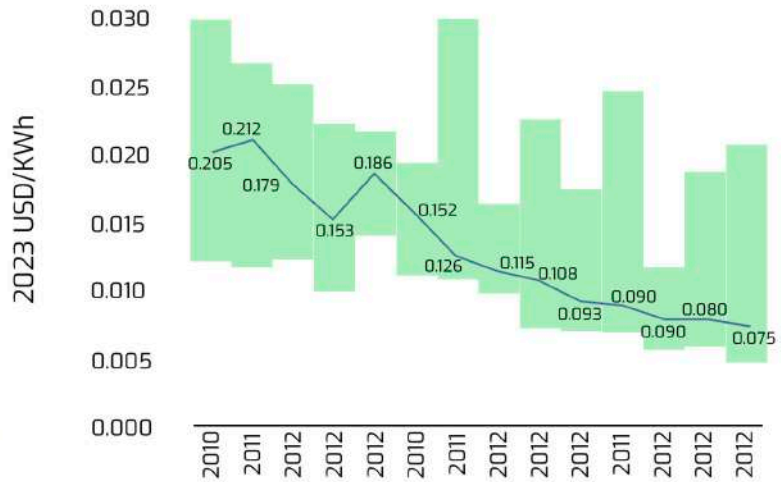


Figure 2: Levelised cost of electricity.
Source: IRENA (2024).

According to the International Energy Agency (IEA, 2023), "a robust regulatory framework and adequate financing are crucial for the expansion offshore of wind energy, especially in developing countries". This document highlights the factors that contributed to the global recession in the offshore wind sector in 2023 and the measures taken to resume growth.

Despite technological advances, offshore wind faces significant challenges. Recently, auctions in Germany took six years between contract award and signing, exposing manufacturers to price flutctuations and supply chain risks. Volatility in energy costs and prices of critical materials, along with logistics and financing costs, are impacting previously viable projects, a trend evident in both the U.S. and Europe.

Denmark was a pioneer in the sector with the first offshore wind farm, Vindeby, installed in 1991, comprising eleven 450 kW turbines. Other farms will follow, such as Horns Rev I and Nysted, generating 160 and 166 MW, respectively. Currently, Denmark has an installed capacity of approximately 1.7 GW (GWEC, 2023). According to Jensen (2022), "Denmark's success in the offshore wind sector is the result of public policies and strategic investments". In 1995, the Danish government assigned a committee to grant electricity concessions and identify specific areas for the installation of wind farms. The "Offshore Wind Action Plan", launched in 1997, promotes large-scale projects.

In Germany, the first concession for an offshore wind farm was granted to Alphaventus, which began operatingin 2009. Germany currently has an installed capacity of approximately 8.3 GW. Key policies developing for this growth include the "Energiewende", the transition to renewable energy, and a feed-in tariff system that guarantees fixed prices for the electricity generated. According to the International Renewable Energy Agency (IRENA, 2023), "government support and well-structured policies are crucial for the expansion of wind energy". Projects in territorial waters are governed by federal law, while those in the Exclusive Economic Zone follow additional regulations.

The UK commissioned its first offshore wind farm, North Hoyle, in 2003, with a capacity of 60 MW. Three rounds of installations took place in 2001, 2003 and 2010. The UK currently has a total installed capacity of approximately 14 GW, establishing it as a leader in the sector. The IEA (2023) notes that "incentive policies, such as the Contracts for Difference scheme, have been crucial to growth". Key policies include the "National Policy Statement for Renewable Energy Infrastructure" and the CfD scheme, which provides financial certainty and incentives for innovation.

Norway has excelled in the renewable energy sector, setting an ambitious target of 30 GW in offshore wind capacity. As a pioneer in floating turbine technology, the country launched pilot projects in 2009, establishing itself as a global leader in this field. A key milestone was the installation of Hywind Tampen, the world's largest floating wind farm, showcasing the feasibility and innovation of Norwegian solutions. With concession rounds scheduled for 2023/2024, Norway reaffirms its commitment to expanding clean energy generation, aligning with global sustainability goals.

The Netherlands also stands out in the offshore wind sector, with an installed capacity of approximately 3 GW, making it one of the European leaders in wind technology. The country has launched the "Wind in the North" plan, which aims to significantly increase offshore wind capacity by 2030, moving 11 GW. The Dutch government has implemented a combination of capacity auctions and a fixed tariff system that encourages investment in the sector. In addition, the Netherlands has invested in port and logistics infrastructure, supporting the development and maintenance of offshore wind farms.

The US ratified the Paris Agreement in 2021, calling for a 50-52% reduction in greenhouse gas emissions by 2030. In 2022, the Departments of the Interior, Energy and Commerce set a joint target of deploying 30 GW of offshore wind energy by 2030, currently installed capacity is approximately 42 MW. Denmark, the UK, Germany and the US are all creating regulations to provide legal certainty for companies in the sector.

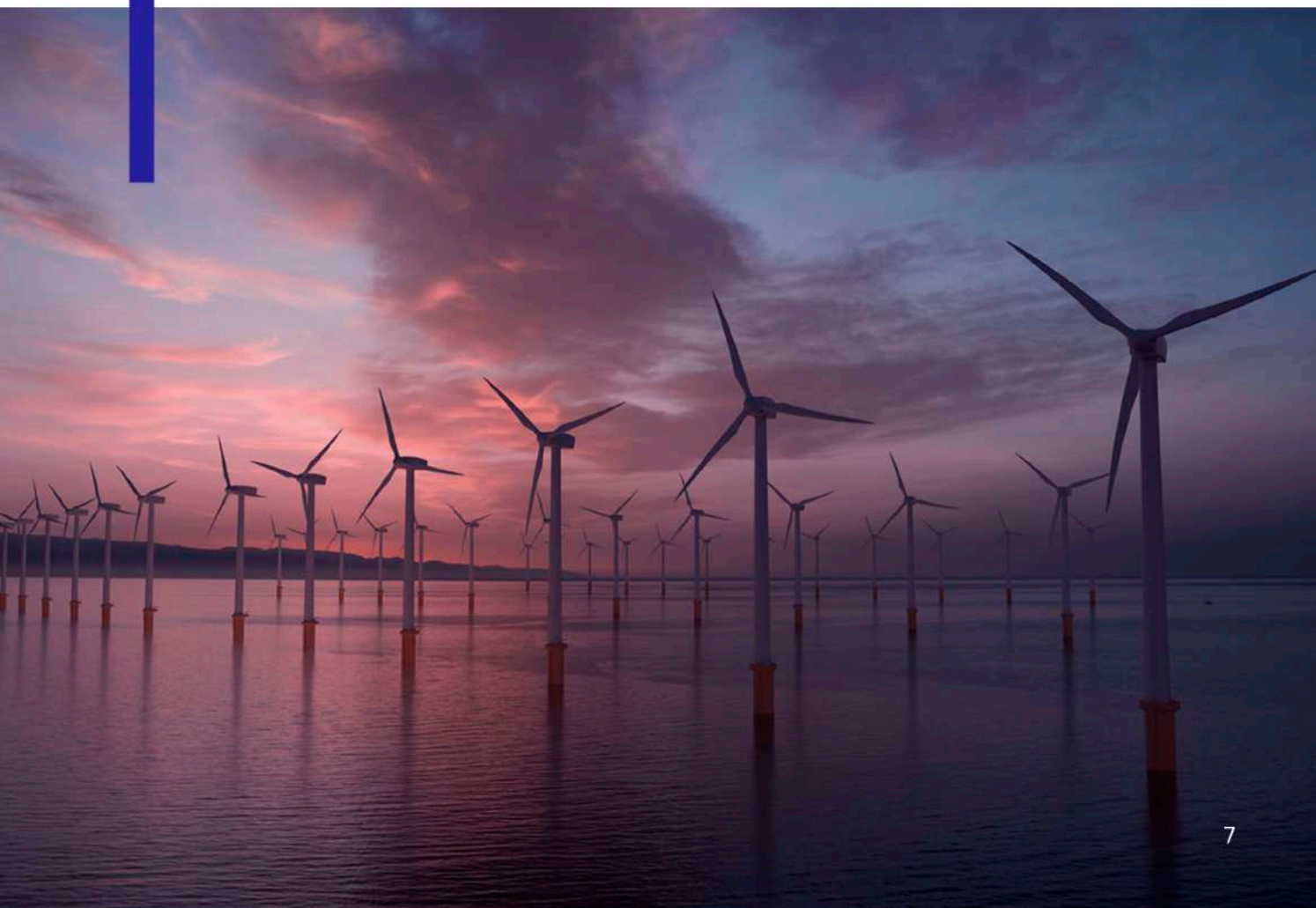
The offshore wind crisis in 2023 significantly affected the United Kingdom (UK), the United States (US), and Germany. In the UK, the fifth allocation round (AR5), based on the Contracts for Difference (CfD) model, offered guaranteed prices for renewables adjusted according to the market. However, the strike price did not cover the high costs, resulting in a lack of proposals for offshore wind projects. In the US, the first offshore wind auction faced inflation, high capital costs, and supply chain issues, leading to renegotiations and cancellations. Logistical costs and geopolitical tensions further increased financing costs, highlighting the need for adjustments to make future projects viable.

To address the crisis, the UK government has taken technologica and policy 1 measures, including a new auction scheme that prioritizes sustainable projects and direct subsidies for technological innovation. In the US, measures such as expanding tax incentives and specific subsidies for offshore wind projects are being adopted to facilitate access to financing. These initiatives are essential to revitalize the sector and ensure competitiveness.

The Energy Research Company (EPE) has published technical notes and

strategic documents on offshore wind energy in Brazil, addressing fundamental aspects of sector regulation and development. Key topics include the compensation due for the cession of maritime areas to the Union, analyzed based on international methodologies adapted to the Brazilian context, and the definition of limits for the area that can be ceded for offshore projects, aiming for effective regulation and avoiding conflicts over the use of marine space.

These publications are part of an ongoing effort by EPE, in partnership with the Ministry of Mines and Energy (MME), to establish a robust regulatory framework for offshore wind energy, including the "Roadmap for Offshore Wind Energy in Brazil." The first version of this roadmap was launched in 2020 and focused on the sector's challenges and opportunities. In 2023, an updated version was released, incorporating recent regulatory changes, such as those outlined in Law No. 9,636/1998 and Decree No. 10,946/2022. These studies assess the viability of offshore wind energy, identify barriers to its development, and provide recommendations to attract investments and ensure security for planners and investors.



Directions to Accelerate the Development of Offshore Wind in Brazil

It is important to highlight that Decree No. 10,946/22, which establishes a policy to encourage offshore wind energy, and Ordinance No. 52 of the Ministry of Mines and Energy (MME) responded positively to the sector in 2022, signaling to investors Brazil's interest in this market. Bill No. 576/2021, currently being processed as an urgent matter in the Senate, aims to complement and strengthen this legal framework. While the decree centralizes the guidelines and standards needed for the sector, the bill seeks to create a legal framework able to favor the capital-intensive investments demanded. Such certainty is important because it is a long period between the signature of the contracts and the actual generation of energy.

A fundamental difference between the referenced decree and bill is that the second makes for a stronger legal framework, better suited to a regulatory instrument (BRASIL, 2022), since less exposed to changes in government. This is a practice well aligned with successful international experience of the sector. In this structure, sub-legal instruments are able to complement the legal framework, allowing both, for the democratic process to be observed through the legislation and, where fit, adjustments that contribute to the system are implemented.

Within this context of sub-legal regulations that can help with the advancement of offshore wind, the publication of the regulatory framework and the creation and provision of Maritime Spatial Planning (MSP) data are great examples. Although the MSP performs several functions, its importance is particularly highlighted in determining a maximum limit for the transfer of maritime areas, preventing companies from holding large extensions just for speculation, without fully exploiting the potential of the area.

International experience emphasizes the importance of a single portal (One-stop-Shop) to simplify bureaucracy and reduce the number of agencies involved in processing offshore area transfer processes. This approach not only reduces costs and legal uncertainty, but also increases transparency in operations. In Brazil, administrative processes related to the oil and gas sector, initiated by the ANP, are managed through the SEI. Likewise, IBAMA uses the SEI for digital environmental licensing processes (IBAMA, 2023). Therefore, implementing a single portal for offshore wind energy becomes a logical and necessary measure to optimize these processes.

Legal Certainty is a fundamental pillar for attracting investment in the offshore wind industry. A clear and stable regulatory framework provides confidence to investors, ensuring that property rights and contracts are respected over time. Therefore, it is crucial that Brazil establishes specific regulations for the licensing and operation of wind farms, creating a regulatory environment that minimizes uncertainty and risks arising from sudden policy changes (Brazil, 2022).

The agility of the environmental licensing process is another key factor for the success of the offshore wind industry. Predictability of demand for renewable energy is crucial for planning and investment in the wind sector. Brazil must establish clear long-term goals for the expansion of renewable energy, creating regular and transparent auctions that provide a stable timeline for developers.

Thus, the main steps for the development of offshore wind energy include the publication of the regulatory framework and the creation and provision of Maritime Spatial Planning (PEM) data. Although the PEM fulfills several functions, its importance is particularly highlighted in determining a maximum limit for the transfer of maritime areas, preventing a developer from holding large extensions just for speculation, without fully exploring the potential of the area. A method that avoids wasting offshore wind potential is highly detrimental. After this period of definition and regulation, it will be possible to carry out environmental licensing by IBAMA, either at the initiative of the developer or through auctions promoted by the Federal Union.

Furthermore, marine spatial planning is essential to demarcate areas suitable for the installation of offshore wind farms. "Marine spatial planning is essential, but it's crucial that areas are studied concurrently as planning develops, given that this tool requires ongoing updates. Thus, the absence of a marine spatial plan should be addressed through locational studies for future project development, as outlined in the document Integrated Environmental & Social Sensitivity Mapping | Guidance for Early Offshore Wind Spatial Planning" (WORLD BANK, 2024b).

Incorporating criteria beyond price into offshore wind energy auctions is vital to ensure the quality and sustainability of selected projects (non-price criteria). In addition to cost, it is necessary to assess factors such as environmental impact, social impact, technological innovation, and commitment to local content. This practice can avoid issues of poor project quality and promote public accessibility of renewable energy initiatives (GWEC, 2024).

Predictability of renewable energy demand is crucial for planning and investment in the wind sector. Brazil should set clear long-term targets for the expansion of renewable energy, creating regular and transparent auctions that provide a stable timeline for developers.

International experience, especially in countries such as Denmark, Germany, the United Kingdom and the United States, highlights the importance of a robust regulatory framework and public policies that encourage innovation and sustainability in offshore wind energy. Brazil can benefit from adopting similar practices, avoiding challenges faced by other countries, such as logistical crises and price volatility (GWEC, 2024).

Finally, it is essential to engage different stakeholders in the decision-making process to ensure that the needs and concerns of all parties are considered. Creating a technical team comprised of representatives from the public sector, private sector, and civil society can facilitate dialogue and collaboration, resulting in more informed and comprehensive decisions.

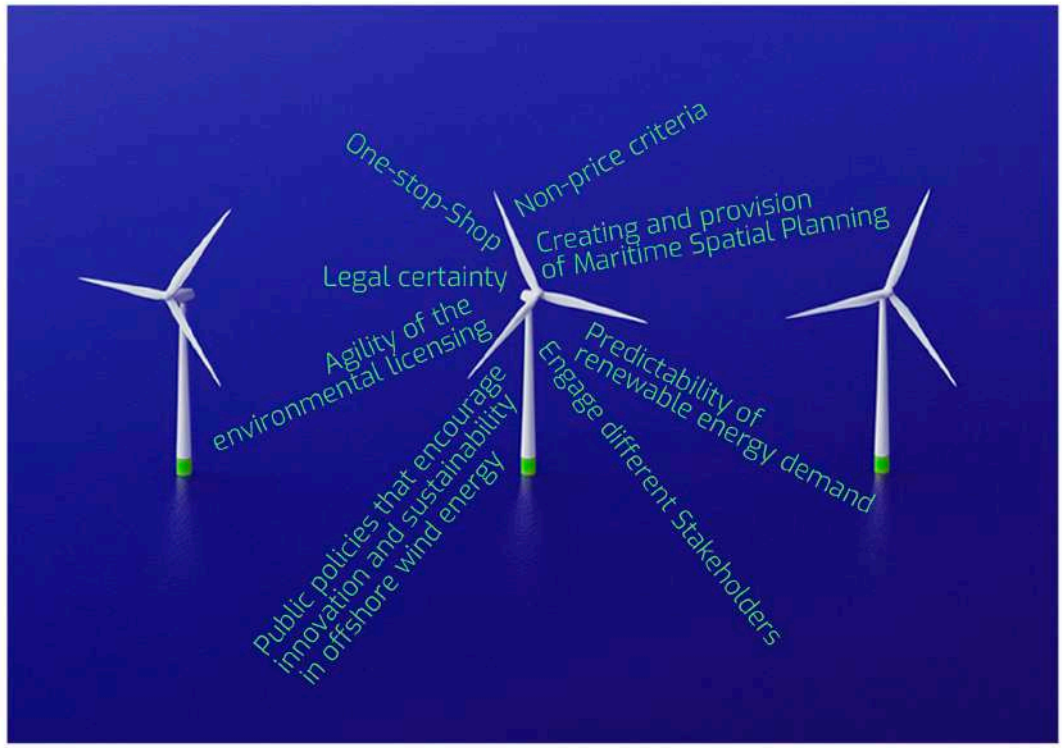


Figure 3: Guidelines to Accelerate the Future Development of Offshore Wind Power in Brazil

Source: Developed by the authors.

Eight key factors are deemed to be relevant for the development of the offshore wind sector: non-price criteria, creating and provision of Maritime Spatial Planning, predictability of renewable energy demand, engagement of different stakeholders, public policies that encourage innovation and sustainability in offshore wind energy, agility of the environmental licensing, legal certainty, one-stop-shop. The understanding here is that there is no precedence between these factors and that their adoption creates a virtuous cycle of mutual reinforcement between all.

It is important to build a favorable environment for offshore wind energy in Brazil, promoting sustainable development and investment security. It's relevant to highlight that the use of a multi-critetria tool for auctions will further improve the selection process, ensuring that multiple factors are considered and contributing to the overall quality and sustainability of the selected projects.

5

International Experience: Successful Cases Integrating Non-price Criteria into Auctions

Multi-criteria analysis is a structured approach to complex decision-making, especially in industries such as offshore wind energy, where multiple factors must be considered. This methodology allows decision-makers to evaluate and compare different alternatives based on criteria that go beyond financial aspects.

In recent years, the offshore wind sector has experienced serious crises, including rising material costs and supply chain instability. Applying a multi-criteria approach can help mitigate these issues by enabling a comprehensive and flexible analysis of bids. This analysis should consider not only price, but also factors such as sustainability and resilience of the project, as evidenced by experiences in other countries.

The lack of non-financial criteria, as noted by GWEC (2024), has created challenges in the implementation of offshore wind energy projects in the United States. Therefore, the inclusion of non-financial criteria in Brazil's offshore wind energy auction can be crucial. Non-Price Criteria refers to selection standards in bidding and public procurement processes that go beyond the lowest price. This model assesses projects based on various qualitative and strategic factors, including quality, innovation, sustainability, social impact, delivery timelines, and technical capacity. These criteria may include social constraints, environmental protection, technological innovation, and socioeconomic impact, which are essential to ensure the sustainability and predictability of projects. These non-price criteria can be expected in three main categories according to GWEC (Table 1).

Social Impact	Sustainability	System Integration
Encouraging community and stakeholder engagement	Emission limitations in the lifecycle of projects	Different technologies aimed at energy efficiency
Pursuit of community welfare	Affirmative actions for biodiversity and ecosystem preservation.	Transmission or transportation of energy
Public policies for infrastructure improvement.	Environmental and ecological preservation in construction, operation, decommissioning, recycling, and decarbonization	Combined cycle of offshore energies

Table 1: Criteria for social impact, sustainability, and integrated system.
Source: Adaptation of the GWEC 2024 spreadsheet.

GWEC (2024) emphasizes the importance of both financial and non-financial criteria in wind energy auctions. Additionally, countries should look to the dimensions of sociopolitics, environment and economy to include factors as:

Figure 4: Sociopolitical, environmental and economic criteria that can help in defining non-price criteria.
Source: Adapted from (GWEC, 2024).

Offshore Wind Auctions Earlier application of NPC is preferred for markets with a two-stage auction particularly at seabed leasing stage		
Pre-Qualification Stage	**Seabed Lease Bidding Stage**	**Offtake Bidding Stage**
Ensure project feasibility and quality bids. Sets out technical specifications and minimum-level competencies required for participation in an auction. Sets out technical specifications and minimum-level competencies required for participations in an auction.	**Allocate seabed rights based on price and project value.** Qualified bidders enter a competition based on price and, if NPC are applied, project value. It is beneficial to introduce NPC at an earlier stage to allow for project preparation.	**Award offtake contract through a competitive price-based process.** Qualified bidders holding seabed rights enter a primarily price-based competition for offtake agreements.
Supply Chain and Industrial Strategy Unlock supply chain investment and capture long-term local value creation		
It is most effective to foster supply chain development through a wider industrial growth strategy, created in collaboration between government and industry, and aligned with anticipated schedules and volumes for procurement over a long term. This process of consultation, coordination and forward-planning provides visibility and certainty to investors and the wind value chain, unlocking investment and value creation over a long horizon. An industrial growth strategy should build on existing competitive advantages, drive innovation, and complement auction design and criteria.		

Table 2: Offshore wind actions.
Source: Adapted from (GWEC, 2024).

Non-price criteria help select the best projects by focusing not only on energy delivery and price but also on promoting local socioeconomic development and environmental benefits. However, an excess of criteria can complicate auctions and create barriers, so criteria must be clear and aligned with each country's national policy and technological maturity.

The figure below illustrates three criteria: (i) Technical, (ii) Environmental, and (iii) Socioeconomic. Each criterion has three sub-criteria that decision-makers can score to select the best projects.

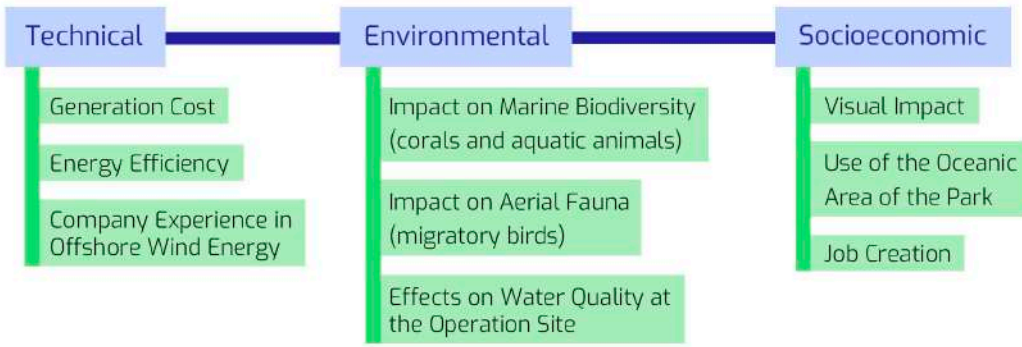


Figure 5: Micro and micro criteria considered by decision makers
Source: Developed by the authors.

5.1 GLOBAL CASES

Several countries already use non-price criteria to boost technological maturity and ensure industrial growth in specific regions. Among these countries are:

Country	Non-Price Criteria
United Kingdom	Technical experience of developers, environmental and social benefits, contribution to the local economy.
Germany	Environmental sustainability, social acceptance, technological innovation.
Denmark	Integration of wind energy with the power grid, environmental impact, contributions to research and development.
Netherlands	Environmental, social, and innovation considerations, plans to mitigate impacts and maximize local benefits.
France	Environmental protection, job creation, and economic development in affected communities.
China	Environmental impact, technology and innovation, regional development, energy security, and community engagement.
Japan	Considerations for disaster resilience, environmental sustainability, and local economic benefits.
Taiwan	Focus on local community engagement, environmental protection, and promotion of renewable technologies.

Table 3: Countries that use non-price multicriteria.
Source: Developed by the authors.

In the Netherlands, offshore wind auctions combine financial and non-financial criteria, with about 50% based on non-financial factors to ensure social and environmental benefits. These criteria include impacts on biodiversity, community engagement, sustainable technology use, local economic contributions, and alignment with carbon reduction goals.

In the UK, offshore wind auctions incorporate 30% non-financial criteria, emphasizing social affordability and innovation. This approach ensures projects meet energy needs and gain local acceptance. It has proven effective in attracting investment by encouraging developers to address social issues, leading to more harmonious and sustainable development.

Denmark's offshore wind auction methodology uses criteria with weightings that vary by specific tender. Generally, non-monetary criteria such as environmental impact, technological innovation, and social benefits make up 20% to 40% of the evaluation, while energy price typically carries a greater weight, around 60% to 80%. This balance reflects Denmark's strategy to combine economic viability with environmental and social considerations, promoting sustainable development in the energy sector.

In Japan's auction model, project developers submit proposals to build and operate offshore wind farms, including energy pricing and project capacity details. Projects are evaluated based on energy price, technical feasibility, environmental impact, and regional economic benefits. The government prioritizes proposals that show innovation and commitment to sustainable practices. Auction winners sign fixed-term power purchase agreements, ensuring stable energy prices and financial security for investors.

In Germany, the selection criteria include not only the developers' experience and the project's feasibility but also execution plans, legal security, and environmental sustainability. These non-price-related criteria account for a significant part of the evaluation process, with up to 30% of the score attributed to these aspects. Auction winners receive power supply contracts with fixed tariffs for a specified period, which provides financial predictability and encourages investment in the sector.

In France, the criteria include environmental quality, which encompasses the impact on wildlife and flora; contribution to local development, which considers job creation and support for local suppliers; and technological innovation, which involves the adoption of new technologies to increase efficiency and reduce environmental impacts. Developers submit detailed proposals, which are analyzed by a committee based on these criteria. Projects that achieve the highest scores are selected, prioritizing excellence over merely offering low prices. The awardees then

sign power purchase agreements, which may include fixed prices or adjustments over time, according to the agreed terms.

In Taiwan, government entities define relevant non-financial criteria for projects and services, such as technical capability, prior experience, and environmental impact. Interested companies submit proposals that include both technical and financial components, with the technical part usually carrying more weight, representing about 70% of the total evaluation in offshore wind projects. An evaluation committee analyzes these proposals, assigning scores based on the established non-price criteria, and the final ranking combines the technical and financial scores, selecting the winner based on the total score.

5.2 STEPS AND CONSIDERATIONS FOR THE BRAZILIAN CONTEXT

The experience of UK and other countries, which subsidizes the remaining cost of electricity, highlights the need for Brazil to seek alternatives, as it will not have similar subsidies. Thus, non-financial criteria become even more necessary to ensure the balanced development of the sector. These non-price pecuniary criteria are important for several reasons: promoting environmental sustainability, ensuring the social reach of projects, encouraging technological innovation, stimulating local development, improving the resilience of projects, and benefits for more transparent and accountable governance. For Brazil, the inclusion of socioeconomic criteria is crucial to ensure that offshore wind energy projects meet energy needs and provide direct benefits to local communities and the regional economy.

The Brazilian legislative proposal sets out principles and foundations for energy generation from the use of offshore potential. The principles highlighted include sustainable development, job creation, rational use of natural resources and environmental protection. These principles will be used as non-price criteria in Brazil, due to legal provisions. A comprehensive approach that seeks sustainable development that balances economic vision with social and environmental responsibility.

For Brazil to make significant progress in the development of offshore wind energy, it is essential to adopt a multi-criteria approach that integrates the principles and fundamentals discussed. It is important to mention that this perspective was emphasized by the panelists, especially by the World Bank representative, who highlighted the importance of protecting our projects through solid practices. This strategy not only strengthens the viability of initiatives, but also ensures that Brazil is aligned with best international practices, promoting sustainable and efficient development of the sector.

This can facilitate the auction of areas, allowing developers to submit proposals that consider both price competitiveness and non-price criteria. These criteria can assess social outreach and engagement with local communities, minimizing ecological impacts and encouraging technological innovation.In summary, implementing a multi-criteria approach in Brazil can provide a solid basis for offshore wind energy auctions. This methodology will not only increase the efficiency of project selection but will also contribute to more sustainable and inclusive development, aligned with the needs and expectations of society.

The adoption of non-price criteria in the auction can ensure that Brazil develops a more resilient and competitive offshore wind sector, promoting innovation and social benefits. The flexibility of multi-criteria analysis allows Brazil to respond to future challenges, adapting quickly to changes in market conditions and demand for renewable energy. The auction of offshore wind area in Brazil can incorporate non-pecuniary criteria to facilitate the participation of entrepreneurs and promote a healthy competitive environment. These criteria expand opportunities for entrepreneurs and advances in the development of a more resilient energy sector aligned with the needs of society.

Market Pathways for Offshore Wind: Challenges and Opportunities

Although Brazil's electricity matrix is predominantly clean, efforts are still needed to achieve a transition to net zero by 2050. The development of infrastructure for the offshore wind energy industry is essential to diversify the energy matrix and ensure sustainable electricity for the entire Brazilian population. The integration of renewable sources, combined with incentive policies, is crucial to encourage the adoption of this technology.

The electrification of oil and gas (O&G) platforms and the decarbonization of upstream operations are topics of great relevance, especially for countries like Norway. This country, with a robust supply chain, stands out in the use of floating technology to meet the energy demand of its O&G facilities through offshore wind (OW).

A significant example of this advancement is Equinor's Hywind Tampen project, which demonstrates the transformative potential of offshore wind in decarbonizing operations. In addition, Petrobras is also exploring sustainable alternatives, including the use of offshore wind energy, carbon capture and storage (CCS) and platform electrification.

Brazil, with its vast coastline and abundant natural resources, presents immense potential for implementing offshore wind energy solutions. The adoption of this technology will not only contribute to the decarbonization of O&G operations, but will also offer a viable path to a more sustainable energy future, aligning with global energy transition trends.

Therefore, the integration of offshore wind energy into O&G operations represents not only a significant opportunity for Brazil, but also an effective strategy to reduce carbon emissions and promote sustainability in the sector.

Market routes for offshore wind include the export of green hydrogen converted into ammonia or methanol, electricity generation for domestic consumption and power supply for industrial sectors. In addition, direct exports of electricity to neighboring countries represent a viable possibility. To make offshore wind possible, it is crucial to address the challenges related to the distance from the National Interconnected System (SIN) and the technical specificities of offshore generation.Example below illustrates in Europe a case of different offshore energy centers in the North Sea (Belgium, Netherlands, Germany and Denmark) transmission and offshore GH2 production facilities.

Figure 6: Transmission and flow of energy
Source: World Bank (2024).

One of the main markets to be explored is the export of green hydrogen produced from renewable sources and converted into ammonia. This compound is widely used as fertilizer and fuel for vessels. Ammonia can be used in ships with adapted combustion engines, contributing to the reduction of carbon emissions in maritime transport (GWEC, 2024). In addition, renewable ammonia can supply the Brazilian domestic market, helping to reduce dependence on imported fertilizers. Currently, Brazil imports about 80% of the ammonia it consumes, making local production a strategic opportunity to increase self-sufficiency and ensure food security (Brazil, 2022).

The growing demand for energy and the need for sustainable solutions have driven the importance of data centers, which consume a significant amount of electricity. In this context, port infrastructure becomes a crucial factor in attracting offshore wind energy development hubs, as highlighted by Mauro da Prumo in the panel that originated the present document cited throughout the text. Well-structured ports not only facilitate the logistics of installing and maintaining wind turbines, but can also serve as strategic points to connect renewable energy production to the electrical grid. This synergy between port infrastructure and data center technology can boost demand for clean energy, promoting a virtuous cycle of economic growth and sustainability.

Another alternative is to conduct regulated auctions for offshore wind energy, with a long-term horizon. These auctions can provide greater predictability for investors and project developers, facilitating the financing and implementation of new initiatives. In addition, they play an important role in promoting the transition to a low-carbon economy (MME, 2022).

Brazil has specific geographic and climatic conditions for the production of green hydrogen. The use of offshore wind turbines to generate electricity that powers electrolysis systems is a promising strategy. The energy generated by turbines on the northeast coast of Brazil, where winds are constant and strong, can be used to produce hydrogen. This process is sustainable because it generates oxygen and oxygen through the electrolysis of water, resulting in water as a byproduct (ABEEÓLICA; COPPE UFRJ; ESSENZ SOLUÇÕES, 2022).

The growing demand for green hydrogen in international markets, especially in Europe, highlights the potential for commercial partnerships. Germany has already expressed interest in establishing agreements for the import of Brazilian hydrogen, considering Brazil's competitive advantages in terms of production costs and specific climatic conditions (GWEC, 2024). Recently, the country announced annual auctions aimed at producing 500 MW of green hydrogen from offshore wind energy, which not only stimulates the development of the hydrogen sector, but also drives improvements in port and industrial infrastructure. This initiative represents a significant opportunity for Brazil, which can benefit from these new demands and strengthen its position in the global hydrogen market.

In parallel, Bill 412/2024, currently before Congress, aims to regulate the carbon market in Brazil. This legislation sets limits on companies' greenhouse gas (GHG) emissions, allowing those that exceed their emission targets to purchase carbon credits issued that bring their emissions below the limit. For example, an offshore wind farm exceeding its clean production targets could sell credits to a polluting industry failing to reduce its emissions (Brazil, 2022).

This approach creates a financial incentive to implement clean energy technologies and directly benefits offshore wind farms by allowing them to monetize their sustainable generation capacity. In addition to promoting sustainability, carbon market regulation aligns companies' economic interests with the need to mitigate climate change (GWEC, 2024).

In the context of climate finance, the suggestion presented by Jari Vayrynen (Sr. Energy Specialist, from The World Bank) during the event highlights the importance of "Blended Financing" as an essential strategy to boost the development of offshore wind energy projects in emerging markets. According to the report "The Role of Concessional Climate Finance in Accelerating the Deployment of Of-

fshore Wind in Emerging Markets", combining concessional financing with private sector investments can mitigate risks and attract additional capital. This approach not only facilitates access to financial resources, but also promotes sustainability and technological innovation, which are fundamental to the energy transition in these countries. Furthermore, it contributes to achieving global climate goals, strengthening collaboration between different sectors and encouraging creative solutions to the challenges faced.

These initiatives and policies promote sustainable development and position Brazil as a leader in the global transition to a low-carbon economy. By integrating green hydrogen into its energy mix and regulating the carbon market, Brazil can create a favorable environment for investment and innovation, boosting economic growth and environmental sustainability (MME, 2022). It is also necessary to consider an offshore wind energy supply chain, as the pressure on this chain is still fragile. Therefore, prior planning becomes essential to ensure the success of the sector (GWEC, 2024).

7

Knowledge Transfer Between Norway and the World: Decarbonizing Oil and Gas Platforms at North Sea

The energy transition offers possibilities for adaptation depending on the new technologies that are emerging. The decarbonization of oil and gas platforms in Norway is a notable example of innovation and sustainability, especially through the implementation of offshore wind farms. This movement is driven by the partnership between Innovation Norway and the Norwegian government, who have been committed to developing solutions that not only reduce the carbon footprint, but also provide a replicable model for other regions. The experiences gained in this process are valuable, as they demonstrate how the integration of renewable

energies can transform the energy matrix of industries traditionally dependent on fossil fuels.

An emblematic case of this transition is that of Equinor, one of the largest energy companies in the world, which is leading initiatives to electrify its oil platforms using electricity generated by offshore wind farms. The company is already implementing projects that aim to provide renewable energy to its operations, thus reducing greenhouse gas emissions. This approach not only improves the sustainability of operations, but also serves as an innovative business model that can be adapted and applied in different geographic and economic contexts.

Collaboration between the public and private sectors, exemplified by the partnership between Innovation Norway and Equinor, is crucial to the success of these initiatives. Sharing knowledge and experience between countries can facilitate the transition to a more sustainable future, allowing other nations to learn from Norway's best practices. Furthermore, this exchange of learning is fundamental to developing solutions that meet the specificities of each location, ensuring that decarbonization is not just a goal, but a viable and effective reality.

Therefore, when analyzing the decarbonization of oil and gas platforms in Norway, it is evident that the use of offshore wind energy represents a promising route for transforming the energy sector. The Norwegian experience serves as an invitation for other countries like Brazil and companies to adopt similar strategies, promoting a more sustainable future in line with global emissions reduction

Strategic Actions and Guidelines for the Bases of Offshore Wind in Brazil

To establish an environment conducive to the growth of offshore wind energy in Brazil, it is needed to implement clear guidelines and strategic actions. The following recommendations can help to achieve this goal. First, defining clear connection rules for integrating offshore wind farms into the electricity grid is essential. It is necessary to establish transparent standards that guide developers on the technical and regulatory requirements, as well as define timelines and responsibilities for grid connection. This clarity will facilitate project planning and execution, contributing to the efficiency of the sector. For example, in Germany, a grid connection regulation has been crucial for the rapid development of the offshore wind sector, allowing for the efficient integration of new farms into the existing infrastructure (GWEC, 2023).

Furthermore, regular public consultation with all relevant stakeholders are recommended, including governments, local communities, industries and non-governmental orga-

nizations. Such interactions are important to address concerns and promote social freedom, strengthening collaboration around offshore wind projects. The United Kingdom, for example, has implemented public consultations that involve local communities, resulting in increased support for wind projects and mitigation of conflicts (IRENA, 2023). The World Bank (2024) also highlights the importance of community engagement as a critical factor for the success of renewable energy projects.

Another suggestion is the establishment of a central authority responsible for coordinating the licensing and regulatory processes. This entity should work to streamline bureaucracy, ensuring that multiple government agencies operate in an integrated manner, acting as a single point of contact for developers and providing support throughout the process. In Denmark, the Energy Authority has been effective in coordinating licensing, resulting in a favorable environment for offshore wind development (Jensen, 2022).

Another example is the Norwegian Energy Agency that has been working to simplify the licensing processes for wind energy projects, promoting a regulatory environment that favors innovation and growth. The implementation of an online portal that centralizes relevant information on offshore wind energy is also a good practice. This portal should include data on regulations, forecast studies, licensing requirements, and financing opportunities, promoting transparency and facilitating access to information. In countries such as the United States, similar measures have been adopted, allowing developers to quickly access essential information, thus accelerating the implementation process (DOE, 2023).

Digitizing the licensing and regulatory processes represents another strategy. Adopting digital platforms for document submission and communication between developers and regulatory authorities will make the processes more agile and efficient, reducing the time and associated costs. Norway has used digital systems to streamline the licensing of its offshore wind facilities, increasing the efficiency of the process and the transparency of information (NREL, 2023).

Finally, the opportunity of upskilling the workforce by way of investing in developing skills across the board is a way of strengthening the case for offshore wind. This investment will ensure the availability of a highly developed workforce

capable of meeting the growing demands of the sector, thus promoting sustainable development and innovation. Scotland, with its training programs focused on skills for renewable energy, and Norway, with its educational initiatives in clean energy, are examples of how workforce upskilling can contribute to the industry (GWEC, 2024).

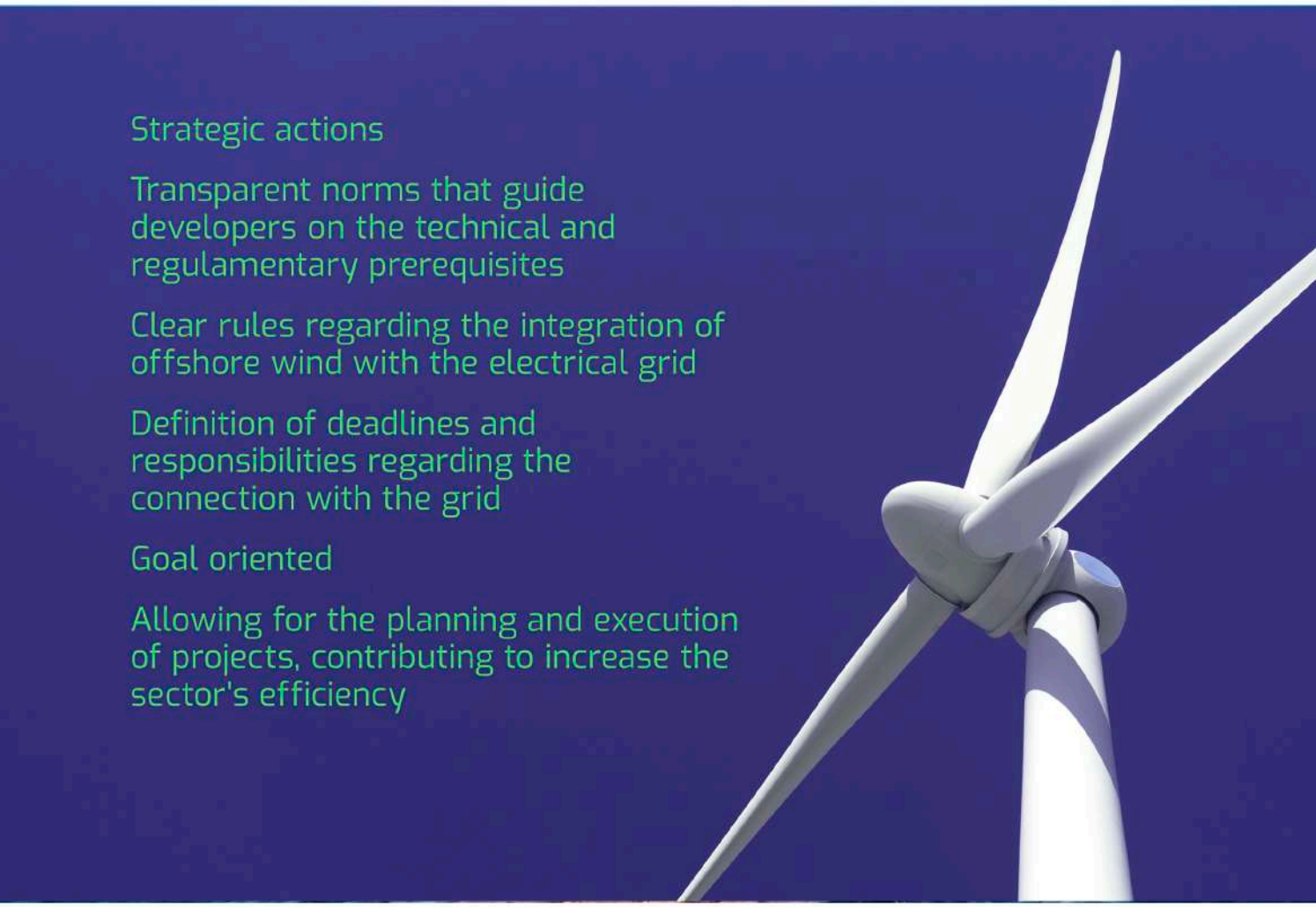


Figure 7: Transmission and flow of energy
Source: World Bank (2024).

Thus, the effective and coordinated implementation of these recommendations can establish a favorable environment for the development of offshore wind energy in Brazil. This will align the country with international best practices and contribute significantly to the global energy transition, ensuring a more sustainable and responsible future (MME, 2022).

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