Barriers and challenges to wind energy development in Poland: research summary

Jagoda Mrzygłocka-Chojnacka[1], Marcin Surówka[2] and Andrzej Zyguła[2]

[1]Wrocław University of Science and Technology
Poland

[2]Krakow University of Economics
Poland

***Abstract*— Wind energy, as a key sector of renewable energy, plays an important role in Poland's energy policy and supports the objectives of economic decarbonization. The aim of this article is to identify the main barriers and challenges affecting the development of wind energy in Poland. The study applies a systematic literature review focusing on four main categories of constraints: legal, social, technical, and economic. Publications from 2021–2025 available in the Google Scholar database were analyzed. Using two search queries, 120 records were initially identified. Following a detailed screening process, 37 publications meeting the qualitative and thematic criteria were selected for further analysis. The review results indicate that the development of wind energy in Poland is limited by a number of interrelated factors. In the legal sphere, the most significant issues include regulatory instability and lengthy administrative procedures. Social barriers are mainly associated with limited local acceptance and insufficient mechanisms for stakeholder participation in investment processes. Technical constraints relate primarily to the limited capacity of transmission infrastructure and challenges related to balancing electricity generation. Economic barriers include investment risks, financial uncertainty, and difficulties in obtaining capital. The findings highlight the need for stable regulatory frameworks, simplified administrative procedures, and stronger involvement of local stakeholders in decision-making processes supporting the development of wind energy.**

Keywords— renewable energy, wind energy, barriers, challenges.

I. INTRODUCTION

In the face of the escalating challenges posed by climate change, the development of renewable energy sources (RES) has become a strategic priority in the energy policies of many countries, including Poland. Wind energy, as one of the most dynamically advancing technologies within the RES sector, occupies a central position in the process of decarbonizing the economy and meeting the ambitious objectives of the European Green Deal. Despite its growing technological maturity and the gradually increasing social acceptance of renewable energy, the Polish wind sector continues to encounter numerous barriers that considerably constrain its development and delay the pace of the energy transition.

For years, wind energy in Poland has been the subject of debate, scientific inquiry, and controversy. While persistent structural obstacles identified in the earlier phases of sectoral development remain unresolved, recent years have witnessed the emergence of new challenges stemming from dynamic shifts in the legal, regulatory, and economic environment. These multi-dimensional barriers highlight the complexity of the sector and the difficulty of aligning national policies with both societal expectations and supranational climate commitments.

Given the scope and complexity of these issues, as well as the rapid transformations taking place in the energy sector, the primary aim of this article is to provide a comprehensive review of the scientific literature addressing the barriers and challenges to the development of wind energy in Poland. The analysis is limited to studies published between 2021 and 2025 and focuses on four key domains most frequently identified in the literature (Wiącek & Malinowski, 2023; Sikora & Zimniewicz, 2023): legal, social, technical, and economic. This structure allows for a multifaceted assessment of the contemporary constraints shaping the trajectory of the wind sector and offers insights into the factors that most significantly influence the pace and scale of wind energy development in Poland.

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II. Research methods

The aim of this analysis was to identify the barriers and challenges associated with the development of wind energy in Poland. A problem-oriented approach was adopted, focusing on four key areas: legal, social, technical, and economic.

To achieve this objective, a systematic literature review was conducted (Orłowska et al., 2017; Booth et al., 2016), drawing on publications available in the Google Scholar database. Given the dynamic growth of the wind energy sector and the considerable interest in this issue among both academic and expert communities, which has resulted in a substantial body of literature, the review was limited to publications published between 2021 and 06.2025.

To further refine the scope of the search, two queries were formulated in Polish, containing the following terms:

1) "barriers" and "development" and "energy" and "wind = wiatrowa" and "Poland";
2) "challenges" and "development" and "energy" and "wind = wiatrowa" and "Poland".

In both cases, the search examined the occurrence of all keywords in any part of the publication text. The first query yielded 65 results, of which 7 did not have an electronic version available. The second query yielded 120 results, 12 of which were not fully accessible. Additionally, 40 records were eliminated as duplicates of the first query. After this preliminary selection, the database comprised 126 records.

Subsequent content analysis of the selected publications revealed that 94 records, although formally matching the search criteria, were of limited relevance to the research topic and were therefore excluded. Ultimately, 32 publications were retained, two of which were collective studies that drew on more than one source. As a result, the final database consisted of 37 publications, which formed the basis for drawing conclusions regarding the barriers and challenges to the development of wind energy in Poland.

III. Legal Barriers and Challenges to Wind Energy Development

One of the principal barriers to the development of wind energy in Poland lies in the legal framework. The so-called 10H rule, introduced by the Act of 20 May 2016 on Investments in Wind Farms, has remained controversial for many years. This provision prohibited the siting of wind turbines at a distance of less than ten times their height from residential buildings and protected natural areas. In practice, it led to an almost complete suspension of new onshore wind investments (Talarek, 2022; Jasiński, 2022; Przygodzka, 2023; Tokarski & Superson-Polowiec, 2021; Kawecka-Wyrzykowska, 2022; Brzezińska-Rawa, 2024). According to expert estimates, this regulation excluded more than 99% of the country's territory from potential use, rendering the development of onshore wind energy nearly impossible (Sikora & Zimniewicz, 2023; Czyżak et al., 2021; Kawecka-Wyrzykowska, 2022; Swoczyna, 2023).

A significant breakthrough in this area was expected to come from the amendment to the Act on investments in wind farms, adopted by the government in March 2025. One of the most important elements of the new regulations was the repeal of the 10H rule. The amended legislation established a minimum distance of 500 meters from residential buildings and were intended to significantly shorten shorten investment implementation timelines (Perzyński, 2025). Ultimately, however, the amendment was vetoed by the President of the Republic of Poland.

It is important to emphasize that both the original provisions and subsequent amendments to the Act have had not only spatial but also significant regulatory and financial implications. As Przygodzka (2023) observes, repeated changes to the legal definition of a wind farm have affected property tax rates, reducing municipal revenues without ensuring adequate compensation. Bartoszewicz-Burczy (2022) further argues that the volatility of legal regulations constitutes a major barrier for investors. This regulatory instability undermines investment security and confidence in the durability of policy solutions, thereby generating uncertainty about future support mechanisms.

Although the attempt to repeal the 10H rule constituted a step in the right direction, numerous regulatory challenges still remain. These include complex and time-consuming administrative procedures as well as the absence of clear guidelines and standards, which results in divergent interpretations of the law by public administration bodies (Talarek, 2022; Bujny, 2024; Gerej-Gula, 2023; Seroka, 2022; Pinkas, 2021; Bartoszewicz-Burczy, 2022). Bujny (2024) also highlights the shortage of qualified administrative staff, particularly in the area of offshore wind energy, which contributes to extended application processing times.

Further challenges arise from environmental protection and spatial planning regulations (Woźniak, 2025; Jasiński, 2022; Seroka, 2022; Śleszyński, 2024). According to Bujny (2024), environmental procedures are exceptionally lengthy, with environmental impact assessments (EIAs) often lasting many months or even years. With respect to spatial planning, Woźniak (2025) notes that municipalities are now required to prepare a general plan, a new mandatory document that must designate areas for wind farm development. However, many municipalities are not yet prepared to undertake this task, and the statutory deadline for plan adoption by the end of 2025 is often considered unrealistic. Furthermore, as of 31 December 2025, existing studies on the conditions and directions of spatial development will cease to apply. In practice, the absence of a general plan will preclude the issuance of development conditions for new wind farm projects.

From a regulatory perspective, the insufficient quality of expert studies on the landscape impacts of wind investments also remains problematic. Antolak (2023) emphasizes that landscape assessments are often prepared selectively and inadequately, with their overall quality being unsatisfactory. The absence of mandatory and standardized methodologies contributes to spatial disorder and impedes the evaluation of the actual impacts of investments. Fogel (2024) further notes that the current legal framework concerning landscape protection remains insufficient.

IV. Social Barriers and Challenges to Wind Energy Development

Social factors play a crucial role in the siting and implementation of investments in the wind energy sector. A lack of public acceptance constitutes one of the most significant barriers, which can effectively prevent the realization of projects, even if they are technically feasible and economically justified (Jasiński, 2022). Resistance from local communities is a complex and multifaceted phenomenon, arising from both objectively measurable impacts and subjectively perceived threats, such as noise, landscape degradation, and potential health risks (Sobieraj, 2023; Przygodzka, 2023; Jasiński, 2022).

Although overall support for renewable energy sources, including wind energy, remains relatively high in Poland (Sikora & Zimniewicz, 2023), specific projects often encounter localized opposition. Survey data confirm this ambivalence: in 2023, as many as 83% of Poles declared their support for the development of onshore wind energy (Sikora & Zimniewicz, 2023), yet 30.8% simultaneously admitted perceiving the proximity of wind turbines as harmful (Woźniak & Kud, 2022). One of the central mechanisms explaining this contradiction is the so-called NIMBY (Not In My Back Yard) effect, which reflects the tendency of individuals to support renewable energy expansion in general, while opposing its direct implementation within their immediate surroundings (Wiącek & Malinowski, 2023; Brzezińska-Rawa, 2024). Since the early 2000s, anti-wind movements have significantly shaped public discourse and administrative practices, organizing protests and contributing to delays in the decision-making process (Bednarek-Szczepańska, 2024). In the broader debate, wind turbines are thus simultaneously framed as symbols of sustainable development and as potential sources of health risks and aesthetic or environmental nuisances (Bednarek-Szczepańska, 2023).

An analysis of social concerns related to wind energy allows for the identification of several key categories. First, there are physical and technical impacts, such as noise emissions, shadow flicker, visual alterations to the landscape, and disruptions to spatial order (Sobieraj, 2023; Latosińska & Miłek, 2023). Comparable challenges are also reported in the context of offshore wind energy, particularly with regard to potential adverse impacts on coastal tourism (Kateryna & Lapshyna, 2023). Second, health-related concerns are often raised: low-frequency noise is cited as a possible cause of sleep disorders, difficulties with concentration, and recurring headaches (Sobieraj, 2023; Przygodzka, 2023; Wiącek & Malinowski, 2023). Third, residents frequently fear financial repercussions, including declining property values in the vicinity of wind farms (Latosińska & Miłek, 2023; Sobieraj, 2023).

Another important source of conflict lies in the lack of transparency in decision-making and the limited opportunities for local communities to exert meaningful influence on investment processes. As Sobieraj (2023) stresses, it is essential to engage local stakeholders in participatory mechanisms and to develop models of shared responsibility that reflect community-specific values and priorities. A lack of fair distribution of benefits may exacerbate tensions, leading to social polarization and prolonged disputes (Brzezińska-Rawa, 2024).

Certain social groups bear disproportionate costs of wind energy development. A prominent example are Baltic fishermen, particularly affected by offshore wind farms. As Bojadżijewa (2024) notes, these investments reduce access to traditional fishing grounds, increase the risk of collisions, and generate electromagnetic disturbances that negatively affect fishing practices. For this reason, the role of the state is crucial: through compensation mechanisms and inclusive policy frameworks, it may mitigate adverse consequences and help ensure that the costs of the energy transition are equitably shared.

In addition to issues of social acceptance and conflict, challenges also arise in the context of social development and the labor market. The renewable energy sector is already experiencing a shortage of qualified personnel, particularly among younger workers. This generational gap poses a serious challenge to the education system and to the effective transfer of knowledge between universities, training institutions, and industry (Sikora & Zimniewicz, 2023). The lack of adequate competencies, coupled with relatively low public awareness of the opportunities and requirements associated with the energy transition (Buksakowska, 2023), may significantly slow down the pace of transformation in the long term. The social dimension of wind energy development is therefore not limited to issues of acceptance or resistance but also extends to questions of education, skills development, and equitable participation in the benefits of the energy transition.

V. Technical Barriers and Challenges to Wind Energy Development

The development of wind energy in Poland, encompassing both onshore and offshore projects, faces a number of substantial technical and infrastructural barriers that constrain the pace, scale, and efficiency of new investments. One of the most pressing challenges remains the insufficient capacity and limited flexibility of the national power system, which is inadequately prepared for the large-scale integration of distributed renewable energy sources (BGK, 2024; Przygodzka, 2023; Palmowski, 2024). The existing system, originally designed to serve centralized, conventional power generation, struggles to accommodate the variability and decentralization inherent in wind energy production.

A particularly acute issue concerns the outdated transmission and distribution infrastructure. The aging condition of the grid has resulted in frequent refusals to issue connection permits for renewable energy installations (Seroka, 2022; Kawecka-Wyrzykowska, 2022; Chamier-Gliszczyński, 2024; Sikora & Zimniewicz, 2023). Between 2021 and 2022, the Energy Regulatory Office recorded more than 9,000 refusals for connection requests (Chamier-Gliszczyński, 2024), compared to only 59 in 2018, underscoring the scale of the problem (BGK,

2024). These figures illustrate not only infrastructural limitations but also systemic bottlenecks that restrict the expansion of renewable capacity.

The modernization and expansion of the power grid are therefore indispensable, particularly in the context of the planned large-scale development of offshore wind farms. These projects will require the transfer of substantial amounts of electricity from the northern regions of Poland, where offshore capacity will be concentrated, to the industrial and urban centers in the south (Mazanek & Świat, 2022). According to the investment strategy of the Polish Power Grids, the length of new 400 kV transmission lines is expected to increase by approximately 4,300 km by 2030, a goal that highlights the magnitude of the infrastructural transformation required. Additional obstacles include the insufficient deployment of energy storage facilities (Bujny, 2024) and delays in the rollout of smart meters and advanced balancing systems, which are necessary for stabilizing the grid and enabling real-time management of fluctuating renewable inputs (Bartoszewicz-Burczy, 2022).

In the case of offshore wind development, technical barriers extend well beyond transmission infrastructure. A shortage of port facilities capable of handling the assembly and transportation of large turbine components, combined with the absence of a specialized installation and maintenance fleet, poses a serious challenge to the timely execution of projects. Moreover, the limited number of companies with adequate expertise, coupled with a shortage of qualified engineers and technicians, constrains the sector's capacity to deliver projects on schedule. The scarcity of domestically produced components further intensifies this problem, limiting local supply chain development and increasing dependence on imports (Gerej-Gula, 2023; BGK, 2024; Ballak, 2022).

Technological innovation and digitalization also play a decisive role in overcoming existing barriers. The introduction of advanced digital tools for turbine design, production, and monitoring is increasingly regarded as one of the most important research and development priorities for the industry (OffshoreWindPoland.pl, 2024). Nevertheless, the lack of domestic turbine manufacturing facilities compels investors to rely heavily on foreign suppliers, slowing down project implementation and weakening national industrial competitiveness (Sikora & Zimniewicz, 2023). Logistical challenges related to the transportation of oversized turbine elements, as well as difficulties in servicing and maintenance in geographically demanding regions, further complicate the process (Bujny, 2024).

An additional technological challenge relates to the decommissioning and recycling of used wind turbine blades. Current recycling methods remain costly and inefficient, and the absence of standardized industrial solutions has created a growing environmental and technical issue. Zembrzuski (2023) notes that while there is potential to repurpose blade materials for use in civil engineering and infrastructure projects, effective large-scale processing technologies are still underdeveloped.

Finally, investors point to the complexity and opacity of the connection process, which is often accompanied by high costs and prolonged timelines (Kawecka-Wyrzykowska, 2022; Bartoszewicz-Burczy, 2022; Bujny, 2024). According to some analyses, in extreme cases the entire investment cycle—from the initial planning stage to the commissioning of a wind farm-can take as long as seven years (Bujny, 2024).

VI. Economic Barriers and Challenges of Wind Energy Development

The development of wind energy in Poland—both onshore and offshore—faces a wide range of economic and investment barriers that substantially influence the pace and stability of the energy transition. These barriers, although varying in scale and scope, collectively shape the financial viability of projects and the willingness of investors to engage in the sector.

One of the most critical challenges lies in the high capital intensity of wind projects, particularly offshore developments. As Seroka (2022) observes, offshore wind farms demand exceptionally large capital expenditures from the very outset of the investment cycle. Pinkas (2021) and Pyrka (2021) further underline that without dedicated public support schemes and subsidy mechanisms, such projects would remain largely unfeasible. According to Chamier-Gliszczyński (2024), the construction costs of offshore wind farms are typically 30–50% higher than those of onshore installations. This cost differential arises from a variety of factors, including the need to conduct comprehensive environmental impact studies, accommodate maritime navigation routes and fishing grounds, and manage the highly complex logistics of transporting and assembling large-scale turbine components in offshore environments (Chamier-Gliszczyński, 2024; Trzciński & Próchniak, 2023; Flaszyński, Mitraszewski, & Markowska-Cerić, 2021). In addition, the establishment of adequate port infrastructure and the recruitment and training of specialized technical staff (Mazanek & Świat, 2022) significantly elevate the entry threshold for potential investors.

Investment barriers in offshore projects are further exacerbated by spatial constraints linked to competing uses of maritime areas. The necessity to reconcile offshore wind development with fishing activities, tourism, shipping lanes, and military operations creates significant conflicts of interest and complicates spatial planning processes (Lapshyna, 2023; Rapacka, 2023; Palmowski & Kwiatkowska, 2023). Striking a balance between these uses in a sustainable and equitable manner requires sophisticated planning instruments and effective inter-sectoral coordination, which Poland is only beginning to develop (Lapshyna, 2023).

A further obstacle is the high level of regulatory uncertainty, which undermines investor confidence. For instance, frequent amendments to rules governing the minimum permissible distances between turbines and residential buildings (Pilipczuk, 2024), combined with insufficient coordination of spatial planning (Bujny, 2024; Bartoszewicz-Burczy, 2022; Śleszyński, 2024), create an unstable regulatory environment that complicates long-term investment strategies. Financing structures represent another critical challenge. As noted by

Bartoszewicz-Burczy (2022) and Sikora and Zimniewicz (2023), small and medium-sized investors often face limited access to external financing due to insufficient collateral or low creditworthiness. This limitation particularly affects prosumers and small enterprises, which typically lack both the capital base and the specialized human resources required to navigate complex investment procedures.

Economic risks are also heightened by volatility in the prices of raw materials, construction materials, and services. Rising costs of steel, rare earth elements, transportation, and assembly services contribute to significant increases in project expenditures (Sikora & Zimniewicz, 2023). Moreover, unfavorable fluctuations in the EUR/PLN exchange rate raise the costs of imported components, further weakening the financial stability of projects. These macroeconomic factors remain largely beyond the control of domestic investors, amplifying the unpredictability of returns.

Despite these challenges, it is important to note that offshore wind investments, once realized, can generate attractive financial returns, with estimated annual profitability ranging from 12% to 16% (Chamier-Gliszczyński, 2024). However, such opportunities are largely accessible only to major energy companies and multinational corporations, which possess both the necessary financial resources and access to advanced technologies (Sikora & Zimniewicz, 2023). As Trzciński and Próchniak (2023) emphasize, achieving these returns requires not only significant capital but also a high degree of operational coordination. The reliance on just-in-time supply chains and logistics underscores the complexity of these projects, where even minor disruptions can generate considerable delays and additional costs.

VII. Conclusions

The development of wind energy in Poland has long been a complex and multidimensional process that continues to face a wide range of legal, social, technical, and economic barriers. These barriers are not isolated but are closely interrelated, jointly constraining the pace of investment and complicating the implementation of new projects. A review of publications from 2021–2025 enabled the identification and categorization of the most significant obstacles affecting the sector. Legislative restrictions, including the still-applicable 10H rule, proved to be the most significant barrier. Other practical challenges include complex administrative procedures, limited public acceptance, underdeveloped transmission infrastructure, rising investment costs, and the instability of support systems, all of which continue to slow the development of wind energy.

The findings of this analysis suggest that an effective policy framework for supporting wind energy development should rest upon the creation of a coherent, transparent, and predictable legal environment. Such a framework would not only accelerate project implementation timelines but also strengthen investor confidence by reducing regulatory uncertainty. Equally crucial is the introduction of participatory and educational mechanisms, aimed at increasing social acceptance and mitigating local resistance to wind projects. At the technical level, substantial investments are required to modernize and expand power grids, as well as to promote the deployment of advanced technologies that facilitate the balancing of variable energy flows from wind sources. This includes, among others, the development of storage solutions, demand-response systems, and digital monitoring tools.

It should also be emphasized that the present study is limited by its exclusive reliance on secondary literature analysis. This methodological approach, while useful for systematizing knowledge, does not permit a direct assessment of the specific local conditions of individual investments. Moreover, the study does not engage in comparative analysis with other European Union member states, which could have provided a broader contextual framework and facilitated the identification of best practices relevant to the Polish context.

Consequently, further research should be directed toward empirical investigations, with particular emphasis on detailed case studies of wind farm projects in Poland. Future studies would benefit from conducting surveys that capture evolving societal attitudes toward renewable energy sources. It also appears essential to incorporate the perspectives of local governments, grid operators, and other critical stakeholders, whose role in shaping the trajectory of the energy transition remains fundamental. Only through such a multi-actor, evidence-based approach can Poland effectively address the persistent barriers and fully unlock the potential of wind energy as a cornerstone of its sustainable energy future.

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