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THE IMPACT OF SOCIO-POLITICAL FACTORS ON THE PROFITABILITY OF WIND FARMS IN SELECTED EUROPEAN UNION COUNTRIES

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ABSTRACT: Purpose: This study examines wind energy profitability and the impact of social and political attitudes on this sector performance. Methodology/approach: It employs panel data analysis of wind farm profitability across various countries, considering governmental policies and renewable energy targets. Findings: Profitability varies significantly by country, with social acceptance and political support influencing outcomes. Austria and Germany show higher profitability, while Greece and Poland face challenges. Countries with the highest resistance to wind energy also had the highest electricity prices. Research limitations/implications: The focus on profitability may overlook other factors affecting wind energy development, and the analysis is limited to companies solely engaged in wind energy.
Practical implications: The findings indicate that increasing political and social support is vital for wind energy's economic viability. Social implications: Understanding public resistance to wind farms is key for the future development of this energy source. Originality/value: This research highlights the impact of social and political factors on the profitability of renewable energy initiatives.

KEYWORDS: wind energy, profitability, social acceptance, political support, renewable energy

Introduction

Renewable energy is essential for meeting modern energy demands while reducing reliance on depleting fossil fuels. Faced with the inevitable end of the fossil fuel era, the energy sector is increasingly turning towards renewable technologies. However, assessing the profitability of these technologies under real market conditions remains crucial for economists and financiers.

At first glance, renewable energy profitability seems evident, with wind energy generation costing less than fossil fuels. This is supported by numerous studies estimating the Levelized Cost of Energy (LCOE) for wind energy, such as the annual reports produced by the International Renewable Energy Agency (IRENA). Yet in practice, the situation is not so straightforward. Firstly, the renewable energy sector benefits from various forms of support, while the traditional energy sector bears additional costs related to CO2 emissions. Secondly, wind farms are built based on certain economic, legal, and climatic assumptions, which may change over time. For instance, interest rates in Europe increased in 2023, significantly reducing the profitability of wind farm investments. Another recent challenge faced by renewable energy producers, including wind farms, was the high cost of electricity, which led to increased prices for steel and concrete used in wind turbine towers, along with other raw materials required for turbine construction.

A further factor that has recently negatively impacted wind farm profitability is the growing social awareness of the negative effects of living near wind farms. This has limited access to areas with favourable wind conditions, affecting both onshore and offshore farms.

Wind energy faces the well-known challenge of intermittency. In favourable weather conditions, the grid is flooded with energy, but in poor weather, there may be little or none. This shortfall must be compensated by traditional power plants, which must maintain their generators in standby mode. Keeping generators in standby without generating energy is costly but essential. This challenge is becoming increasingly apparent as more renewable energy sources are connected to national grids. As a result, nuclear energy is gaining popularity in many countries due to its predictability and growing perception as a safe energy source.

Although the European Union has adopted the European Wind Power Action Plan, this does not change the fact that, despite increasing budgets for wind farms, many countries remain cautious or even politically reluctant towards their development.

For these reasons, the aim of the research presented in this publication is to assess the profitability of enterprises whose primary income comes from generating electricity from wind. The research hypothesis posits that the political climate towards wind energy, as well as the ease of establishing and operating such projects in a given country, has a significant impact on their profitability.

The research questions posed in the publication were as follows:

- Did countries in similar geographic locations have comparable wind farm profitability?
- To what extent did temporal effects (better or worse weather in a given year) influence the median profitability of wind farms?
- To what extent did legal and social issues impact the financial results of wind farms?

To achieve the research objective and verify the hypothesis, as well as answer the research questions, we selected companies that are almost exclusively involved in wind energy production. This selection process included reviewing their business codes and names that suggested a focus on wind energy. We eliminated companies whose business activities included energy production from other sources or unrelated sectors to avoid distorting the picture of wind industry profitability. This approach often led to the exclusion of large, financially strong enterprises with diversified business profiles from the study, but allowed us to focus solely on companies dedicated to wind energy.

For most of the countries studied, we collected data from a relatively high percentage of enterprises in relation to the total number of wind farms in each country. While it is difficult to call this research sample fully representative, since it excludes the largest conglomerates and companies that do not publish financial reports, it nonetheless provides insight into the financial condition of a specific group of wind energy producers.

It should also be noted that we were unable to determine which of the investigated companies operate onshore or offshore wind farms. While cost analyses show that offshore farms tend to be more profitable, we were unable to verify which companies operate offshore farms or to what extent. Nevertheless, theoretically speaking, regardless of the wind energy subsidy system or the location of

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the wind farm (onshore or offshore), with state support, the payback period for investment outlays should not exceed 15–20 years. This suggests that profits should eventually allow for the repayment of the initial investment or, at a minimum, cover ongoing operational costs. The study period covers the years 2015–2022, as financial reports for 2023 were not yet available.

An overview of the literature

Numerous studies have analysed wind farm profitability and its determinants. The most obvious and primary determinant of a wind farm's profitability is its location and favourable wind conditions. Olivares-Cabaello et al. (2024) suggest that in addition to analysing the current wind conditions of a given location, it is essential to consider how these conditions may change due to climate change. According to research, wind resources are increasing in Northern Europe and decreasing in Southern Europe, with improvements also seen in South America (Frate et al., 2020). Another challenge to the profitability of wind farms is the unpredictability of weather conditions over specific periods or even years (Frate et al., 2020).

Energy prices during construction and operation also affect wind farm profitability. This is closely tied to the renewable energy support system. In theory, wind farms are shielded from energy price declines through various payment and subsidy systems. However, the effectiveness of these systems varies, and nearly every system has its limitations, making wind farm profitability at least partially dependent on market energy prices in many cases (Mallaret et al., 2024). Ragwitz and Steinhilber (2014), Del Rio (2014), Abolhosseini and Heshmati (2014), Soroush et al. (2022), and Poullikkas et al. (2012), have written extensively on the pros and cons of different subsidy systems.

Auction systems are now popular in Europe, where developers bid on prices for selling wind-generated electricity under long-term contracts. While the system is considered relatively effective (Mallaret et al., 2024), it has its shortcomings. In recent years, auction prices have significantly decreased, sometimes resulting in zero state subsidies and full dependence on market prices (Jansen et al., 2020). The issue is that this steep drop in auction prices was not solely due to improved turbine efficiency, but also because auctions occurred in imperfect markets, raising concerns related to game theory in situations of incomplete information (Wilson, 1992). In other words, developers participating in these auctions were forced to predict the costs of projects planned for implementation several years after the auction, often using untested technology, forecasting future weather conditions, and anticipating energy market prices (Rubio-Domingo & Linares, 2021). Ultimately, the auction was won by the most optimistic developer, who may have been overly optimistic about these assumptions (Matthäus, 2020).

Unexpected events, such as the COVID-19 pandemic or the Russian invasion of Ukraine, also had a significant impact on the profitability of wind farms by disrupting energy distribution and market stability (Simchi-Levi & Haren, 2022).

Another factor highlighted by researchers is the importance of a favourable investment climate and active government actions to encourage private investment in wind farms. A lack of clear policies aimed at reducing risk, establishing incentive systems, and co-financing projects leads to a shortage of such investments (Kurbatova & Khlyap, 2014).

The profitability of wind farms is further influenced by the frequency of repairs and damage to wind turbines, as well as energy transmission costs. These factors are closely linked to the external conditions prevailing at the farm (e.g., strong gusts of wind, temperature fluctuations, dust), the age of the turbines, and the technical solutions employed. Both the age of the turbines and adverse external conditions significantly increase the likelihood of failures and reduce turbine efficiency (Martinez et al., 2009). For this reason, many wind farms are decommissioned at the end of their lifespan unless they opt for full-service decommissioning or transition to a hybrid model combining wind and solar energy generation (Kadhirvel et al., 2020).

Peimani (2018) demonstrated the low profitability of renewable energy compared to fossil fuels, noting that, at least in the short term, non-renewable energy sources are far more profitable than renewable ones in Asia. Peimani also showed that most renewable installations in Asia are currently unprofitable. The lack of commitment from national governments has led to long delays in developing the renewable energy sector in the region.

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Another important aspect of wind farm profitability is the utilisation of the wind turbines after they have been withdrawn from operation. A brilliant idea about their utilisation can be found in Broniewicz et al. (2023).

Research methods

The study utilised a panel data model where the dependent variable was the profitability of a given wind farm in a particular year, and the independent varia-bles were elements of the Doing Business index, a dummy variable representing the year, and a dummy variable representing each company (the overall impact of time and specific entities proved to be insignificant). We deliberately excluded a lagged dependent variable from the model to avoid masking the influence of the factors we aimed to highlight – namely, administrative difficulties in starting and operating a business, especially those related to renewable energy. A fixed-effects model was selected for our research, based on both the nature of the studied phenomenon and the results of the Hausman test. The model form is presented below:

$$y_{it} = \propto_i + \beta X_{it} + \delta_t + u_i + e_{it}, \tag{1}$$

where:
y_{it} – return on equity after tax,
α_i – constant representing the individual characteristics of a given wind farm,
β – beta coefficient representing the response of the dependent variable (increase or decrease),
x_{it} – independent variables (selected elements of the World Bank's doing business index),
δ_t – time effects, in particular, an unknown coefficient for the time regressors,
u_i – within-entity error term,
e_{it} – overall error term.

In particular, the estimated models took the following form:

$$\begin{gathered}\mathrm{ROE}_{it} = \\ \propto_i + \beta_1 \mathrm{StartBusinessDaysOfProcess}_{it} + \\ \beta_2 \mathrm{DealingWithConstructionPermitsBuildingQualityControlIndex}_{it} + \\ \beta_3 \mathrm{TotalScoreEaseOfGettingCredit}_{it} + \delta_t + u_i + e_{it},\end{gathered} \tag{2}$$

$$\begin{gathered}ROE_{it} = \propto_i + \beta_1 DlngWthCnstrPrmBldngQltCntrlndx_{it} + \beta_{pl} X_{pl,t} + \beta_{it} X_{it,t} \\ + \beta_{sr} X_{sr,t} + \beta_{gr} X_{gr,t} + \beta_{sl} X_{sl,t} + \beta_{ge} X_{ge,t} + \beta_{pt} X_{pt,t} + e_{it}.\end{gathered} \tag{3}$$

where:
i – represents a country,
t – represents time,
StartBusinessDaysOfProcess – the number of days it takes on average to set up a company in a particular country (a part of the World Bank Ease of Doing Business Ranking),
DealingWithConstructionPermitsBuildingQualityControlIndex – the index representing the level of difficulty for buildings and constructions to meet quality standards (a part of the World Bank Ease of Doing Business Ranking),
TotalScoreEaseOfGettingCredit – the index representing the ease of obtaining bank credit in a particular country (a part of the World Bank Ease of Doing Business Ranking),
pl – Poland,
it – Italy,
sr – Serbia,
gr – Greece,
sl – Slovakia,
ge – Germany,
pt – Portugal.

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For the panel data analysis, we followed the procedure suggested by Verbeek (2017). First, we tested the variables used in the models for the presence of unit roots, employing tests such as Levin-Lin-Chu, Fisher-type (Augmented Dickey-Fuller, Phillips-Perron), and Hadri tests. Although the results were not always conclusive, we decided that the variables included in the models are I(0), with the caveat that we detrended two variables: DealingWithConstructionPermitBuildingQuality-ControlIndex and TotalScoreEaseOfGettingCredit. These variables should be stationary without visible trends; however, due to the short time period, they exhibited trends. For the same reason, we included time effects in the model.

After confirming stationarity, we checked whether the use of panel data was necessary and whether it provided significant advantages over the pooled OLS model. This was done using the F-test for fixed effects, the Breusch-Pagan LM test for random effects, and the Hausman test for comparing random effects with fixed effects. For both estimated models, panel effects were significant, and fixed-effects models were preferable.

Once we selected the model specification, we conducted cross-sectional dependence tests (Breusch-Pagan LM and Pesaran CD tests), which indicated the presence of serial correlation across entities. Consequently, the models were estimated using the Driscoll-Kraay method (Driscoll-Kraay standard errors). This approach eliminated the need for additional heteroskedasticity and autocorrelation tests for residuals.

Finally, we assessed the normality of the residuals' distribution using the Jarque-Bera test and a histogram. The normality tests for both models indicated a bell-shaped distribution, albeit not perfectly symmetrical or fully matching a normal distribution. However, visual analysis of the graphs showed that the distribution was close to normal. Applying logarithmic transformations to the variables did not improve the residuals' distribution. Moreover, the Driscoll-Kraay method is robust to heteroskedasticity and cross-sectional dependence, meaning that non-normality of residuals rarely affects the results.

In addition to the panel model, we also analysed the median return on equity ratios for wind farms in different countries to explore whether there is a relationship between the profitability of farms in a given country and the political climate towards these farms. The Doing Business Index may have been too general to fully capture the positive or negative attitudes towards wind farms in specific countries.

In particular, the research procedure was as follows. First, all companies involved in energy generation were searched for in the Orbis database, and then entities where the dominant portion of income came from wind energy generation were filtered. Subsequently, the medians for individual countries were calculated and presented in a table. In the next step, a model for panel data (formulas 2 and 3) was constructed, aimed at verifying the significant impact of country-specific individual factors on the ROE indicator of wind farms in those countries.

Results of the research

To better understand the impact of various factors on the profitability of wind energy companies across different countries, it is essential to delve deeper into the data. Table 1 presents the median Return on Equity (ROE) for wind energy in selected European countries between 2015 and 2022. This data forms the foundation for our subsequent discussion regarding the specific conditions prevailing in individual countries and allows for the verification of the research hypothesis.

When analysing Table 1, we observe significant differences in the profitability of wind farms between countries. Nations such as Greece, Italy, Poland, Serbia, and Slovakia exhibit low returns on equity. In contrast, Austria, Germany, Spain, Ireland, and Portugal demonstrate much higher profitability, with median values that are either positive or considerably greater than in less profitable regions.

In our further analysis, we focused on countries with the lowest profitability in order to better identify the barriers and challenges faced by the wind energy sector in these regions. This approach enables a more precise identification of specific factors that negatively affect the financial performance of wind farms. By diagnosing these obstacles, we can formulate recommendations to improve the situation in these countries and derive conclusions relevant to other regions with similar charac-

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teristics. Furthermore, examining less profitable markets may reveal common patterns and structural factors that inhibit wind energy development. Such information is crucial for developing more effective support strategies and optimising public policies aimed at increasing the profitability and financial stability of wind farms worldwide.

Table 1. Median ROE for wind energy in selected European countries [%]

Country	no of wind farms (thewindpower.net)	item	2022	2021	2020	2019	2018	2017	2016	2015
Austria	287	median	38.79	8.49	13.18	21.57	9.82	15.35	6.96	8.48
Austria	287	no of obs	17	6	7	6	6	4	3	6
Bulgaria	51	median	58.57	10.57	9.48	4.32	4.65	0.59	5.10	3.43
Bulgaria	51	no of obs	10	12	13	14	14	14	16	17
Croatia	25	median	3.19	13.92	7.42	18.78	7.39	6.72	4.62	14.51
Croatia	25	no of obs	19	20	18	16	15	15	13	11
Czech Rep	76	median	19.12	-18.64	1.79	-0.78	27.95	18.47	16.67	11.03
Czech Rep	76	no of obs	2	4	5	5	5	5	4	3
Denmark	1,807	median	9.29	5.05	4.35	5.58	2.45	2.24	-2.33	-0.13
Denmark	1,807	no of obs	226	218	221	233	232	194	25	20
Finland	314	median	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-1.20
Finland	314	no of obs	118	109	92	79	61	56	49	44
France	1,569	median	12.46	11.28	20.26	11.65	7.11	0.00	-2.59	7.26
France	1,569	no of obs	404	395	380	376	313	275	258	235
Germany	6,443	median	33.20	8.18	9.29	9.24	5.68	7.46	2.80	6.72
Germany	6,443	no of obs	172	241	270	315	252	190	183	128
Greece	283	median	-20.19	-3.25	-1.67	-2.72	-3.34	-12.45	-16.83	-20.23
Greece	283	no of obs	83	85	67	62	57	59	55	44
Ireland	330	median	39.93	12.06	9.81	9.49	6.07	4.06	-0.27	6.50
Ireland	330	no of obs	71	58	55	50	40	41	38	36
Italy	5,731	median	-1.81	0.00	-4.95	-0.13	4.50	-1.05	-0.57	-0.92
Italy	552	no of obs	160	144	133	130	125	122	128	121
Norway	85	median	8.19	4.22	-1.11	0.00	0.38	-0.15	-0.21	-8.69
Norway	85	no of obs	25	23	22	20	22	19	17	10
Poland	357	median	1.71	-0.22	-0.23	-0.06	-0.30	-0.57	-0.72	-1.23
Poland	357	no of obs	129	120	103	97	88	103	61	76
Portugal	273	median	25.80	24.06	25.18	29.78	32.05	28.86	32.22	30.40
Portugal	273	no of obs	77	75	79	81	83	84	74	74
Serbia	21	median	-4.66	-11.74	-6.45	-1.56	-2.48	-3.46	-7.99	-0.32
Serbia	21	no of obs	17	15	10	10	9	8	9	3
Slovakia	12	median	-3.03	4.18	-2.43	14.77	8.02	46.23	19.45	0.22
Slovakia	12	no of obs	5	5	4	5	6	6	5	8
Spain	1,304	median	51.89	18.53	-0.02	3.45	2.47	6.42	-1.53	2.61
Spain	1,304	no of obs	146	160	157	155	155	140	132	134

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Country	no of wind farms (thewindpower.net)	item	2022	2021	2020	2019	2018	2017	2016	2015
Sweden	1,178	median	1.34	0.98	-2.25	0.82	-0.73	-2.08	-2.07	-2.22
Sweden	1,178	no of obs	185	191	185	152	184	196	187	179
UK	1,252	median	44.1	20.44	15.34	14.12	17.02	15.43	7.92	12.51
UK	1,252	no of obs	334	304	288	280	276	249	231	226

Source: authors' work based on the Orbis database (2024).

Let us now turn to the analysis of specific cases.

In the case of Greece, the low profitability of wind farms is confirmed by research conducted by Sakka et al. (2020), which indicates that energy prices in Greece are generally too low to ensure the profitability of wind farms, except in certain areas such as the Aegean islands, the southern-central continental coast, the eastern Peloponnese, and southern Attica (Sakka et al., 2020). These regions have more favourable wind conditions, allowing for more profitable investments. Additionally, Greece has experienced an unstable political climate over many years, resulting in uncertainty surrounding the subsidies available to investors. For instance, a reduction in subsidies in 2014 negatively impacted the internal rate of return (IRR) of new wind farms, lowering it to a range of 10–15% (Leidecker et al., 2023). This variability in subsidy policies creates uncertainty, deterring potential investors and complicating long-term planning (Winikoff & Parker, 2023). Bureaucratic obstacles also contribute significantly to delays in the implementation of wind farm projects in Greece. Administrative processes are complex and time-consuming, leading to higher costs and project delays (Rakocevic et al., 2022). Furthermore, although public support for wind energy exists, concerns about landscape aesthetics, the impact on wildlife, and noise pollution, particularly with larger wind farms, hinder new developments (Sakka et al., 2020). Additionally, integrating wind farms with the national grid requires substantial financial investment to modernise and expand the energy infrastructure, further reducing profitability (Mallaret et al., 2024). Nevertheless, recent policy changes introduced by the Greek government in 2024 aim to improve investment conditions by simplifying administrative procedures, increasing financial support, and modernising network infrastructure, potentially boosting profitability in the near future (Aposporis, 2023).

In Italy, similar challenges arise. Complex and lengthy administrative procedures significantly delay the implementation of wind farm projects, with research by Sensi et al. (2022) showing that the average time required to legalise a wind farm is 5.5 years. These bureaucratic delays raise costs and diminish the attractiveness of wind energy investments. Public resistance, particularly regarding concerns over landscape aesthetics, noise, and impacts on wildlife, also complicates the development of new wind farms (Seredocha, 2014). Additionally, many Italian wind farms are nearing the end of their operational life (De Laurentis & Windemer, 2024). Although repowering programs exist, they require significant financial resources and logistical coordination. Moreover, restrictive legislation regarding the location of wind farms further limits suitable areas for investment, increasing the costs of land acquisition and spatial planning (Ministry of the Environment and Safety Energy, 2021). Italy's deep coastal waters also pose a technical and financial challenge for offshore wind farm installation, further reducing profitability (Serri et al., 2020).

In Poland, the low profitability of wind farms stems from multiple structural and regulatory issues. A key factor was the failure of the green certificate system, which initially served as the main financial support mechanism for wind farms but was later abandoned (Rapacka, 2023). This left wind farms scrambling to find alternative financing options. Additionally, regulatory uncertainty, particularly the 2016 "Distance Act" (also known as the "Wind Act"), imposed strict restrictions on the location of new wind farms, creating significant barriers for new investments (Kryszk et al., 2023). Problems with grid integration also hinder profitability, as Poland's energy infrastructure struggles to keep pace with the rapid expansion of wind farms (Polish Electricity Association, 2022). Low electricity prices in Poland, relative to other EU countries, further depress profitability by slowing the return on investment. Offshore wind farms face additional challenges, such as inadequate port infrastructure (Sierak, 2021) and growing cybersecurity threats, which will require further investment and could negatively impact future profitability (NIK, 2022). Moreover, despite rising environmental awareness in Poland, wind farms continue to face local opposition, particularly over issues related to noise, landscape aesthetics, and potential health impacts (Bednarek-Szczepańska, 2016; Rauba & Zimińska, 2018).

In Serbia, the low profitability of wind farms is linked to several key factors. As Serbia is not an EU member, it lacks access to EU funds that could support renewable energy projects (Stojilovska & Kolovrat, 2024). Serbia's financial situation, coupled with high capital costs and insufficient government support mechanisms, makes it difficult to implement large-scale wind farm projects (Kovandžić, 2011). Infrastructure limitations also pose challenges, as Serbia's energy system requires modernisation to accommodate new renewable energy sources (Stavrakas et al., 2021). Political instability and complex bureaucratic processes further discourage potential investors (Turkovic, 2019). Additionally, low electricity prices exacerbate the issue by extending the payback period for wind farm investments (Simchi-Levi & Haren, 2022).

In Slovakia, the development of wind farms has been significantly hampered by regulatory restrictions and investment uncertainty. Since 2009, the construction of new wind farms has virtually ceased, and only two small parks have been built since then (Rynik, 2023). Complicated permitting processes and high grid connection fees further deter new investments (Fabregue, 2023). Moreover, Slovakia has not fully utilised EU funds earmarked for renewable energy development, limiting the availability of financial support (Wind Europe, 2024). Public resistance to wind farms, driven by concerns over environmental impact and lengthy environmental review processes, also contributes to the sector's low profitability (Suder, 2023).

It is also worth noting that the energy prices in the four discussed countries (with the highest social resistance to wind farms) were the highest in the European Union. The question arises whether people from these countries realise that they could lower their energy bills if there were more wind farms in their neighbourhoods.

In summary, the analysis of wind farm profitability across these countries reveals a range of common challenges. Greece faces low energy prices, political uncertainty, and bureaucratic obstacles, while Italy struggles with public resistance, regulatory complexity, and infrastructural issues. Poland is hampered by regulatory hurdles, inadequate infrastructure, and low energy prices, whereas Serbia faces financial difficulties, political instability, and limited access to external funding. Finally, Slovakia grapples with regulatory constraints, a lack of investment support, and public opposition. Addressing these challenges through regulatory reforms, streamlined administrative procedures, infrastructure improvements, and increased financial support is crucial to enhancing the profitability and attractiveness of wind energy investments (Mallaret et al., 2024).

Table 2. Parameters of panel model 1 with fixed effects (Drisc/Kraay)

ROE	Coef .	Robust			[95% conf Interval]	
		StdErr	tP>t	p		
StartBusinessDaysofProcess	-1.72	0.55	-3.11	0.02	-3.02	-0.41
DealingWithConstructionPermitsBuilidngQuality-ControlIndex	-4.64	1.02	-4.57	0.00	-7.04	-2.24
TotalScoreEaseOfGettingCredit	0.15	0.03	4.51	0.00	0.07	0.24
year	-17.05	1.51	-11.33	0.00	-20.61	-13.49
2016	-11.42	2.27	-5.02	0.00	-16.80	-6.04
2017	-5.61	3.16	-1.77	0.12	-13.09	1.87
2018	-3.13	3.18	-0.98	0.36	-10.65	4.40
2019	-8.95	3.54	-2.53	0.04	-17.33	-0.57
2020	-2.14	2.96	-0.72	0.49	-9.14	4.86
2021	5.74	2.38	2.41	0.05	0.10	11.37
2022	74.98	15.66	4.79	0.00	37.94	112.01
_cons	-1.72	0.55	-3.11	0.02	-3.02	-0.41

Source: authors' work based on the Orbis database (2024).

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Table 2 presents the results of a simple panel model with fixed effects, aimed at testing the hypothesis that the political climate and administrative barriers significantly influence the profitability of the wind energy sector. The results show that delays in project implementation, construction permits, and financing availability are significant factors reducing profitability. The overall fit of the model was as follows: R-sq within = 0.0083. It should be noted that the model was estimated for 15,526 observations and 3,408 entities.

To better assess the impact of national policies on the profitability of wind farms, we developed a simple panel model in which dummy variables were introduced to represent the countries where government policy had a statistically significant effect. In addition to these countries, Poland and Italy were included, as the direction of the policy's impact was consistent with expectations, despite not being statistically significant due to fluctuations in government policy from unfavourable to favourable, and vice versa.

The results of the model estimation are presented in Table 3 (R-sq overall = 0.024, number of observations = 15,526, number of groups = 3,408). As shown in the model, a statistically significant positive impact of government policy was recorded for Germany and Portugal, while a negative effect was observed for Poland, Italy, Serbia and Greece.

Table 3. Parameters of panel model 2 (Drisc/Kraay)

ROE	Coef .	StdErr	from P>z	p	[95% Conf Interval]	
DlngWthCnstrPrmBldngQltCntrlndx	-1.28	0.38	-3.40	0.01	-2.17	-0.39
year						
2016	-10.88	0.19	-55.99	0.00	-11.34	-10.42
2017	-2.33	0.33	-6.96	0.00	-3.12	-1.54
2018	3.11	0.37	8.51	0.00	2.25	3.97
2019	9.62	0.40	23.79	0.00	8.66	10.57
2020	7.58	0.38	19.95	0.00	6.68	8.48
2021	13.95	0.33	42.39	0.00	13.17	14.73
2022	23.19	0.33	70.47	0.00	22.41	23.97
Poland	-11.83	5.67	-2.09	0.08	-25.23	1.58
Italy	-17.38	5.85	-2.97	0.02	-31.20	-3.55
Serbia	-49.70	20.67	-2.41	0.05	-98.57	-0.83
Greece	-34.46	6.11	-5.64	0.00	-48.91	-20.00
Slovakia	-36.98	15.98	-2.39	0.01	-68.31	-5.66
Germany	10.87	3.36	3.24	0.01	2.93	18.81
Portugal	29.28	3.62	8.08	0.00	20.71	37.85
_cons	15.60	4.54	3.43	0.01	4.86	26.34

Source: authors' work based on the Orbis database (2024).

Discussion/Limitation and future research

Summarising the conducted research, our analysis of the profitability of wind energy production companies demonstrated that the social and political stance of a given country towards wind farms has a statistically significant impact on their profitability. It does not appear to be a coincidence that the median profitability of wind farms in some countries is considerably lower than in others. Our data shows that profitability was notably low in countries such as Greece, Italy, Poland, Serbia, and Slovakia, while in Austria, Germany, and the UK, it tended to be more positive. This disparity is closely tied to the renewable energy targets set by individual countries – those with lower profitability also had less ambitious renewable energy goals.

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The obtained results allowed for answering the previously mentioned research questions. The geographic similarity of the analysed countries did not result in statistically significant similarities in the financial performance of wind farms, as legal regulations, in addition to wind conditions, played an important role. Geographic and temporal effects had some impact on the performance of the farms, but the decisive factor was the specific conditions of each country, particularly the investment environment and legal regulations.

Our research in no way undermines the importance of obvious factors affecting wind farm profitability, such as location and wind conditions, electricity prices, the quality and cost of wind turbine construction, or the effectiveness of renewable energy support systems in each country. However, in our opinion, social resistance to wind energy, often reflected in government policies, can have an unexpectedly large influence on profitability. This raises the question: who is right in this debate – supporters or opponents of wind farms? How serious are the commonly cited concerns about wind energy, such as the potential threat to local wildlife, nuisance to nearby residents, unpredictability of energy generation, or difficulties in connecting to the grid? It is worth considering whether wind energy can realistically replace traditional energy sources at scale in the near future.

Despite these challenges and uncertainties, statistical data indicate that renewable energy, including wind energy, is becoming an increasingly important component of the global energy mix, particularly in Europe. The findings of our research suggest that wind farms can indeed be profitable, but this requires a favourable combination of economic, political, and social conditions. Wind energy has the potential to be a viable and profitable source of energy, but achieving this requires robust political and economic support, along with societal acceptance.

A key challenge facing the development of wind energy is its impact on wildlife. If wind turbines are designed to operate quietly, they can become a “silent trap” for birds and bats, which may not notice the spinning blades until it is too late. On the other hand, louder turbines may be more easily avoided by wildlife but could disturb humans and other animals. How can we protect wildlife from wind turbines without compromising their efficiency? Technological innovations in this area are crucial to finding a balance between wildlife protection and the functionality of wind farms.

Another issue relates to the visual impact of wind turbines, particularly in areas of historical or cultural significance (Wartecka-Ważyńska, 2023). Wind turbines, often visible from great distances, can disrupt the aesthetic of historic sites, causing tension between preserving the past and embracing modern renewable energy solutions. A question arises: is there a minimum distance at which turbines could be placed to mitigate this conflict, or are some locations simply unsuitable for such developments? Understanding this balance is vital for gaining public acceptance in areas where heritage preservation is a priority.

Moreover, wind turbines are highly dependent on specific weather conditions to operate effectively. In the absence of wind, entire regions, or even countries, may have to rely on stored energy, which is often insufficient, or fall back on traditional energy sources. This raises a critical question: will we ever fully overcome this issue of energy intermittency, and if not, what technologies should we use to supplement renewable energy sources? The challenge of balancing renewable energy with reliable backup systems remains one of the key hurdles to a sustainable energy future.

Another growing concern is the difficulty of integrating additional wind farms into national energy grids. As more wind farms are developed, grid capacity becomes strained, leading to questions about whether there is a saturation point for wind energy in any given country. If such a threshold exists, have some countries already reached it, or is it still a future concern? Interestingly, negative reactions to wind turbines often occur in countries where wind energy penetration is low, while countries with a high density of wind farms tend to show greater acceptance and profitability. This raises the possibility that social resistance may not be as strongly linked to the number of turbines as previously thought. However, the question remains: is there a saturation point at which the benefits of additional wind farms no longer outweigh the costs?

The future of the renewable energy sector, particularly wind energy, will largely depend on the ability to adapt to evolving political, social, and environmental conditions. Technological advancements will also play a critical role in overcoming existing barriers. Innovations in wind turbine efficiency, grid integration, and energy storage could help address some of the major challenges facing the industry today, such as energy intermittency and public resistance.

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Moreover, governments must take proactive steps to create policies that not only encourage the development of wind farms but also address social concerns in a balanced way. Effective communication strategies to promote the benefits of wind energy and to mitigate public opposition will be key to fostering greater acceptance of this technology. Only through a coordinated effort by policymakers, industry stakeholders, and local communities can wind energy reach its full potential and contribute significantly to the global transition towards sustainable energy.

Conclusions

This study has explored the profitability of wind energy production companies in selected European Union countries, highlighting how socio-political factors significantly influence financial outcomes.

The analysis revealed that countries like Austria and Germany, with higher political and social support for renewable energy, exhibit greater profitability, while nations such as Greece, Poland, and Serbia face persistent challenges due to regulatory and social barriers. Despite these insights, the research is not without limitations.

The dataset was constrained to companies exclusively engaged in wind energy, potentially excluding broader industry trends. Moreover, the analysis did not distinguish between onshore and offshore wind farms, which may differ in profitability. Future research could expand on this study by including a larger dataset, incorporating more diverse energy sources, and exploring the impact of recent policy changes on wind energy investments. It is clear that improving the regulatory environment, streamlining administrative processes, and enhancing public acceptance are crucial steps toward fostering the growth and profitability of wind energy.

Policymakers should consider adopting more targeted support mechanisms and communication strategies to address public concerns and highlight the benefits of renewable energy. Technological advancements in turbine efficiency, grid integration, and energy storage will also play a pivotal role in overcoming existing limitations. As renewable energy continues to grow in importance, future studies should investigate its long-term sustainability, focusing on how socio-political and economic factors can be aligned to achieve a successful transition to cleaner energy sources.

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The contribution of the authors

Conceptualisation, J.W., P.D., A.Z. and Ł.P.; literature review, J.W., A.Z., Ł.P. and P.D.; methodology, J.W., A.Z. and P.D.; formal analysis, J.W., A.Z. and Ł.P.; writing, A.Z., P.D., Ł.P. and J.W.; conclusions and discussion, J.W., A.Z., P.D. and Ł.P.

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WPŁYW CZYNNIKÓW SPOŁECZNO-POLITYCZNYCH NA RENTOWNOŚĆ FARM WIATROWYCH W WYBRANYCH KRAJACH UNII EUROPEJSKIEJ

STRESZCZENIE: Cel: Niniejsze badanie analizuje rentowność firm zajmujących się produkcją energii wiatrowej oraz sposób, w jaki postawy społeczne i polityczne wobec farm wiatrowych wpływają na ich wyniki finansowe. Metodyka/zastosowane podejście: W badaniu zastosowano analizę danych panelowych dotyczących rentowności farm wiatrowych w różnych krajach, uwzględniając polityki rządowe i cele w zakresie energii odnawialnej. Wyniki: Rentowność znacznie różni się w zależności od kraju; na wyniki wpływają akceptacja społeczna oraz wsparcie polityczne. Austria i Niemcy wykazują wyższą rentowność, podczas gdy Grecja i Polska napotykają trudności. Kraje z największym oporem wobec energii wiatrowej miały również najwyższe ceny energii elektrycznej. Ograniczenia/implikacje badawcze: Skupienie się na rentowności może pomijać inne czynniki wpływające na rozwój energii wiatrowej, a analiza ogranicza się do firm zajmujących się wyłącznie energią wiatrową. Implikacje praktyczne: Wyniki wskazują, że zwiększenie wsparcia politycznego i społecznego jest kluczowe dla ekonomicznej rentowności energii wiatrowej. Implikacje społeczne: Zrozumienie społecznego oporu wobec farm wiatrowych jest kluczowe dla przyszłego rozwoju tego źródła energii. Oryginalność/wartość dodana: Niniejsze badanie podkreśla wpływ czynników społecznych i politycznych na rentowność inicjatyw związanych z energią odnawialną.

SŁOWA KLUCZOWE: energia wiatrowa, rentowność, akceptacja społeczna, wsparcie polityczne, energia odnawialna