Journal of Economic Surveys

SURVEY ARTICLE OPEN ACCESS

Beyond the Wind: Mapping Externalities and Their Role in Shaping Willingness To Pay for Wind Energy

Gianluigi De Pascale | Luca Esposito | Melania Riefolo | Anna Romagno

Department of Economics, University of Foggia, Foggia, Italy

Correspondence: Luca Esposito (luca.esposito@unifg.it)

Received: 19 December 2025 | **Revised:** 13 May 2026 | **Accepted:** 18 June 2026

Keywords: Systematic Literature Review | Externalities | Willingness To Pay | Wind Energy

ABSTRACT

Wind power plays a central role in global low-carbon energy transitions, offering significant environmental benefits through reduced greenhouse gas emissions and decreased reliance on fossil fuels. Yet, local opposition to wind projects persists, often driven by perceived externalities affecting communities and landscapes. This study conducts a PRISMA-guided systematic review of literature published between 1984 and 2025 to identify key externalities associated with wind energy and assess their influence on individuals' Willingness To Pay (WTP). A total of 182 relevant studies were included. Findings reveal a broad spectrum of externalities: positive effects such as climate change mitigation, improved energy security, job creation, and local economic gains, and negative impacts including visual intrusion, noise, and wildlife disruptions. Evidence suggests that WTP increases when environmental benefits are salient, while visual and noise impacts substantially lower WTP, especially among locally affected groups. Additionally, social acceptance is strongly shaped by procedural factors, including community participation and perceived fairness in planning processes. Overall, the review underscores the need for context-sensitive, participatory approaches to wind energy planning to enhance social acceptance and support an equitable transition to sustainable energy systems.

JEL Classification: Q42, Q28, Q51, D83

1 | Introduction

In the context of the worldwide energy transition, onshore and offshore wind power is playing an increasingly central role in decarbonization policies (Long et al. 2023) and the reduction of greenhouse gas emissions (Magsar et al. 2024). Thanks to its limited environmental impact during operation, the absence of direct emissions, and its limited water resources requirements, wind power is one of the key technologies for achieving the targets of the Paris Agreement and the more recent ones set at the European level with the Green Deal (Fetting 2020). From 1990 to 2024, we have observed significant growth in global wind production, rising from 3.63 TWh to 2,497.25 TWh (see also Figure 1). This trend confirms the importance of wind energy in the global energy scenario and in energy transition processes. Furthermore, ongoing technological advancements and cost reductions have significantly improved the efficiency and competitiveness of wind energy compared to conventional fossil fuels (IRENA, 2022)[1]. Innovations in turbine design, materials, and digital monitoring systems have facilitated the construction of larger and more reliable wind farms, both onshore and offshore, which can generate greater amounts of energy. At the same time, supportive regulatory frameworks and increased private investment have accelerated the integration of wind energy into national energy systems.

However, despite its clear environmental and climatic benefits, wind energy is not without controversies, as highlighted by Ramalho et al. (2025a).

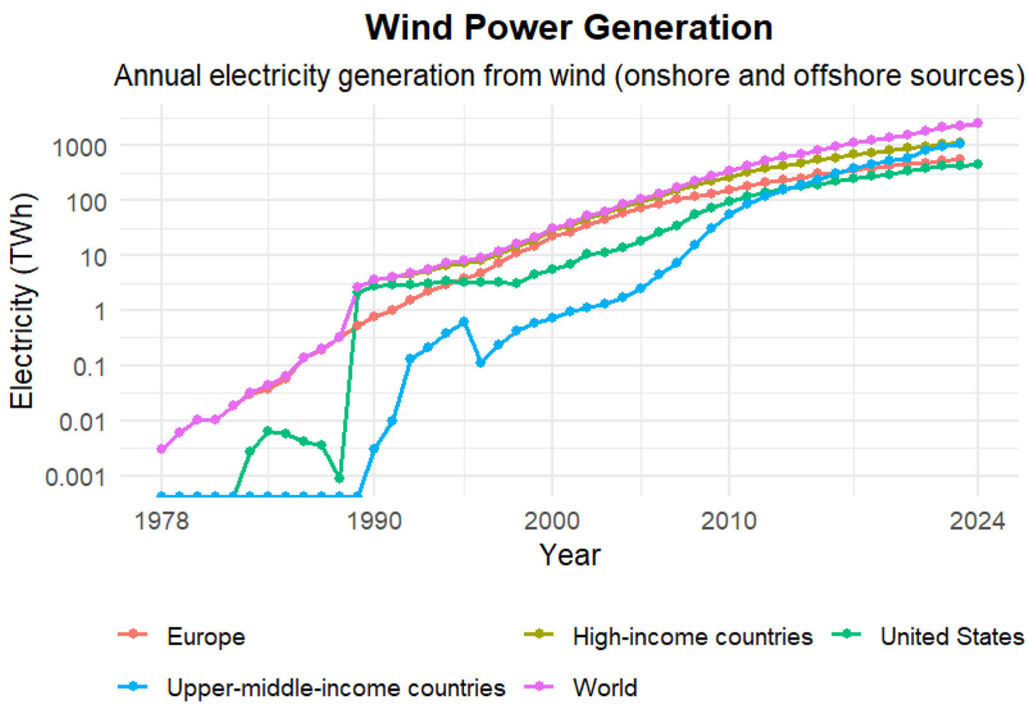

FIGURE 1 | Wind Power Generation (Source: OurWorld in Data) [Colour figure can be viewed at wileyonlinelibrary.com]

Several studies highlight that the development of wind power generates a range of externalities, these are indirect effects impacting on third parties not directly involved in the production or consumption of the energy generated (Krekel and Zerrahn 2017). Such externalities can be both positive, such as the reduction of air pollution (Yousefi et al. 2019) or stimulation of local employment during installation and maintenance phases (Aldieri et al. 2019), and negative, i.e., visual impact, noise pollution (Teff-Seker et al. 2022), risks for biodiversity (Bulling and Köppel 2016), and habitat fragmentation.

Such impacts can diminish the quality of life for local communities and are among the reasons for the so-called phenomenon of “Not In My Backyard” (NIMBY), or resistance to the siting of wind turbines near one’s residence, even among those who support the transition in general (Devine-Wright 2005). Additionally, it has been observed that those who oppose wind energy could normally continue to oppose it even in the face of compensation offers (Boyle et al. 2019).

The current literature highlights the growing importance of examining not only the character of such externalities but also the way they influence citizens’ attitudes and their willingness to pay (WTP) for the development of wind power. In particular, the WTP for wind power electricity is a useful tool for quantifying the perceived value, which can be positively and negatively associated with specific attributes of wind farms. Specifically, WTP represents the highest amount individuals or households are ready to spend for wind energy benefits; these advantages are mainly environmental and can include reduced emissions and improved energy security. From a financial perspective, instead, this willingness refers to higher energy bills or tax payments (Koto and Yiridoe 2019). In contrast, the literature also stresses the term Willingness to Accept (WTA), which refers to the minimum monetary compensation individuals would require to endure the negative externalities associated with wind infrastructure (Dimitropoulos and Kontoleon 2009; Brennan and Van Rensburg 2016). Wind energy has several disadvantages, including noise, visual intrusion, and impacts on biodiversity, particularly near residences. Hence, while WTP reflects the value that citizens attribute to wind energy’s benefits, WTA refers to the financial costs they associate with the challenges it can bring. It is essential to understand which externalities have the greatest influence on citizens’ evaluations to enable better and more socially acceptable public policy, as well as the development of mitigation measures and participatory governance arrangements that are tailored (Koto and Yiridoe 2019; Ladenburg and Dahlgaard 2012). In this regard, adopting a systematic framework that can map and classify the externalities of wind energy while considering territorial variation and processes affecting public perception is critical for renewable energy (Wolsink 2007). While growing academic and political attention has been directed at the externalities of wind farm development, the existing literature presents notable limitations that necessitate further research. Despite the growing interest in wind energy externalities, significant gaps remain to be addressed. Indeed, most studies have mainly developed single-country context research (Faulques et al. 2022a), with a focus on European countries (Ramalho et al. 2025), often applying outdated datasets (Calvert et al. 2013; Cetkovský and Nováková 2009), and applied stated-preference methods without adequate behavioral validation (Zerrahn 2017; Ramalho et al. 2025). More fundamentally, the vast majority of the contributions examine positive or negative externalities in isolation, without an integrated assessment of their current influence on citizens’ preferences. Indeed, as stressed by Ramalho et al. (2025), it is important to consider other factors related to citizens’ social spheres, such as their societal values, local customs, and perceptions, to provide different insights into the evaluation of externalities. While numerous studies have individually looked at the positive and negative externalities of wind power, much of this work predates the most technological advances and societal changes that have influenced public perceptions and the implementation methodology for implementing wind farms (Calvert et al. 2013; Cetkovský and Nováková 2009; Novan 2015; Raileanu et al. 2020). In particular, the majority of studies focus on isolated environmental or economic variables without an integrated and up-to-date assessment considering the complexity and interdependence between different types of externalities (Zerrahn 2017; Mattmann et al. 2016b; Ramalho et al. 2025), nor do they properly investigate how such externalities differentially affect WTP for wind energy generation. However, assessing wind energy externalities is multifaceted since they have several consequences of different nature, such as environmental degradation, economic transformations, and societal implications. WTP is not determined by isolated perceptions of individual impacts, but by the cognitive trade-off citizens make between perceived costs and benefits (Dimitropoulos and Kontoleon 2009). In particular, the majority of studies focus on isolated environmental or economic variables without an integrated and up-to-date assessment considering the complexity and interdependence between different types of externalities (Zerrahn 2017; Mattmann et al. 2016b), nor do they properly investigate how such externalities differentially affect WPT for wind energy generation. Isolated perceptions of individual impacts do not determine WTP, but rather the cognitive trade-off citizens make between perceived costs and benefits. When reviewing public acceptance of policies, it is crucial to consider both positive and negative externalities together, as separate evaluations can lead to a misunderstanding of how decisions are actually made and result in policy recommendations that do not align with reality (Wolsink 2007; Devine-Wright 2005). Given the blatant energy transition process and the consequent evolving socio-environmental context, this integrated assessment is necessary to better understand how citizens develop their preferences (Ramalho et al. 2025). Using such a combined approach allows simultaneous adjustment of compensation mechanisms and participatory governance tools, while avoiding the risk of overstating opposition to wind energy. There are several reasons behind coupling positive and negative externalities in a unique assessment. First, from a behavioral perspective, citizens evaluate wind projects by simultaneously weighing perceived costs against perceived benefits (Wolsink 2007; Peri et al. 2020; Langer et al. 2018). Second, from a more political perspective, compensation mechanisms and participatory governance instruments can be calibrated by simultaneously evaluating both the negative and positive impacts of this technology (Garcia et al. 2016; Knauf 2022; Brennan and van Rensburg 2025). Third, from a methodological standpoint, research has mainly focused on negative externalities, thereby risking a flawed evaluation of the acceptability of this technology (Liebe et al. 2017; Mattmann et al. 2016b). The main gap this study addresses is precisely the lack of up-to-date, rigorous studies that concurrently evaluate the size and relative importance of positive and negative externalities in shaping citizens' preferences, especially in a situation where the energy transition is picking up speed and social and environmental dynamics remains in flux. In addition, few studies have addressed the relative importance of various externalities in setting the WTP level for wind power development, a fact that is key to more successful, participatory, and socially acceptable policy-making.

While primary empirical research would be required to generate new estimates of positive externalities, a systematic literature review serves a complementary purpose (Moher et al. 2009): it maps, synthesises, and renders visible evidence that currently remains scattered across disciplinary silos. In doing so, it provides researchers and policymakers with a structured baseline from which to identify what is known, what remains under-studied, and what specific empirical work is most urgently needed.

Moreover, this study aims to contribute to the wind energy literature and to bridge gap between wind energy externalities and WTP. On the one hand, numerous papers investigate negative wind externalities, such as Schütt (2024) that underline the potential devaluation of local property next to wind turbines, or Krekel and Zerrahn (2017) that the negative impact of wind turbines on the visual landscape and people's well-being. There are also some recent literature reviews and meta-analysis analyzing the wind power externalities; for instance, Ramalho et al. (2025) investigate the principal economic externalities related to the installation of wind farms; Mattmann et al. (2016b) conduct a first quantitative meta-analysis of the nonmarket valuation literature on the external effects associated with wind power production; Mattmann et al. (2016a) attempt the economic valuation of the effects of hydropower, quantifying and explaining the economic values for positive and negative hydropower externalities. However, no one of these seems to analyze noise, visual, environmental, biodiversity, fauna, well-being, and profitable externalities jointly; also, the positive externality and the benefits of wind energy production seem largely absent from the literature. On the other hand, WTP plays a central role in directing appropriate policy regarding ambitious renewable energy targets (Muhammad et al. 2021). For instance, Cerdá et al. (2024), Ma et al. (2015), Wang et al. (2024) and Soon and Ahmad (2015) present two meta-analysis of choice experiments to examine the evidence on WTP of households for renewable energies in general, without a specific focus on wind energy. Moreover, there is also a sample of social science studies investigate the impact of wind power characteristics on its public acceptance (or WTA) such as Bouras et al. (2023); Sovacool and Ratan (2012); Garcia et al. (2016). Thus, the authors aim to address the following Research Questions (RQs) by conducting this systematic literature review:

- RQ1: What are the positive and negative externalities of wind energy reported in the existing literature, and how do these externalities differ e across contexts?

- RQ2: How do these externalities (individually and jointly) shape citizens' WTP for wind energy development?

Addressing both questions adds novelty to our paper. Firstly, focusing on RQ1 allows us to conduct the first systematic literature review that combines both positive and negative externalities in different deployment contexts (Zerrahn 2017; Ramalho et al. 2025). This approach helps fill a gap in the existing literature and enables a comprehensive evaluation of wind energy applications and their acceptance among citizens. Second, exploring RQ2 enables us to identify which externalities are most influential in consumers' decision-making, thereby attuning the design of targeted, socially acceptable energy policies (Antheaume and Bebbington 2021; Allcott et al. 2012). As a matter of fact, leveraging the most influential factor can make wind energy applications more appealing to citizens and a point of departure for a more sustainable energy system. In this way, this paper attempts to significantly contribute to the literature by providing the first integrated analysis of positive and negative wind power externalities and WTP, by exploring the current research literature, giving helpful political insights for wind energy spread, and it also pinpoints areas where future empirical research is most needed.

2 | Literature Review

2.1 | WTP and Wind Energy

Over the past decade, we have witnessed a gradual transition from fossil fuels to renewable energy sources (Mutezo and Mulopo 2021; Droege 2011; Esposito et al. 2025), which, in addition to mitigating climate change, have also played an important role in economic growth (Esposito 2023; Bhattacharya et al. 2016). Wind energy is among the most promising renewable technologies for the global energy transition (Wojtaszek et al. 2025). Its technological maturity has enabled rapid deployment, ensuring steady growth in energy production, and significantly contributing to the reduction of greenhouse gas emissions and the diversification of the energy mix in many countries (de Falani et al. 2020; Rabbi et al. 2022; Aslam et al. 2024).

However, the expansion of this energy source is not without controversies and challenges, mainly due to the external effects or "externalities" associated with its installation and operation (Ramalho et al. 2025; Krekel and Zerrahn 2017). Therefore, scientific literature has focused a significant portion of research on the analysis of these impacts and their influence on the WTP of affected communities. A study conducted by Cerdá et al. (2024) observed that the WTP for renewable energy ranges from € 113 to € 124 household per year, and that there is a preference for onshore wind farms over offshore ones. Before addressing the WTP, we will review the main externalities. When discussing externalities (Helbling 2010), we refer to collateral effects, which can be positive or negative, that a given activity has on third parties who are not directly involved in the decision-making or production process. In the case of wind energy, externalities can take various forms: visual, acoustic, environmental, and sociocultural. Based on the study conducted by Ramalho et al. (2025), we will distinguish externalities, considering three macro impacts: the impact on well-being, the avoided externalities, and wind turbines. Starting with the impact on a community's well-being, we have several observable benefits. The installation of wind farms can foster the economic growth of local communities and, at the same time, act as a deterrent to the depopulation of rural areas through the creation of green jobs, with possible knock-on impacts on the added value of properties and the quality of life (Trapp and Rodrigues 2016; Skenteris et al. 2019) (see also Table 3 in Ramalho et al. (2025)). The provision of wind turbines brings a series of benefits, including avoided (or positive) externalities, which can be classified into three macro categories: reductions in greenhouse gas emissions, improvements of air quality, and a valid tool for combating climate change. Within this context, the concept of WTP represents a central tool in economic analysis (Cerdá et al. 2024). As confirmed by the literature, in the energy sector, WTP is used to assess the monetary value that citizens attribute to the benefits and costs associated with specific production technologies.

Regarding the methodological aspect, some of the approaches that have employed stated preferences techniques like the Contingent Valuation Method (CVM) and Choice Experiments (CE) in estimating the WTP of wind farm aspects include, among others: distance from home, number and height of turbines, turbine placement onshore and/or offshore, impact on the scenery, monetary compensation, and involvement of the community (Koundouri et al. 2009; Einarsdóttir et al. 2019; Abdullah and Jeanty 2011; Lienhoop 2018). On one hand, CVM is based on a simple and straightforward approach that involves asking participants what they are ready to pay to avoid an adverse impact on the environment or receive an improvement in the environmental situation. A study conducted in Greece by Koundouri et al. (2009), documents that respondents would be (on average) willing to pay around 8.68 euros (bimonthly bills), with the ultimate goal of contributing to the financing of the wind farm. Another study for South Korea, again using the contingent valuation method, documents how the WTP (for renewables) had a significant increase following the Fukushima disaster (Lee and Heo 2016). One of the key advantages of the CVM approach is that it is relatively easy to understand and allows researchers to obtain a direct monetary valuation of the changes in the environmental situation (Koundouri et al. 2009; Lee and Heo 2016; Abdullah and Jeanty 2011). Indeed, there are several drawbacks associated with the CVM method that should be mentioned. In particular, the CVM method is inherently hypothetical; hence, it can be subject to hypothetical bias, strategic answering, and framing effects. On the other hand, the CE apply an indirect approach based on random utility theory (Kim et al. 2019; Lienhoop 2018; Strazzera et al. 2012). In contrast to CVM, where there is no need to explicitly ask people to put monetary values to alternatives, CE provide individuals with a series of hypothetical choices (for instance, wind farms of various types) with a number of attributes including the height of the turbine, number of turbines, distance from residential areas, landscape impacts, payment schemes, and community involvement (Kim et al. 2019). In these sets of options, the individual selects his or her choice. Through repeated selections, one is able to establish the relative weight of attributes and estimate marginal WTP values for specific attributes. CE thus enable deeper understanding of behavior, but the assumptions made about rationality of decision making are stricter (Iwata et al. 2023; Lienhoop 2018; Ek and Persson 2014). Additionally, Koto and Yiridoe (2019) estimated the WTP, showing that respondents in Canada are willing to pay 14% more per month for wind energy. While, Ladenburg and Dahlgaard (2012) tested the effect of turbines on attitudes using a sample of 1084 respondents, finding a significant insight: factors such as age, household income, and education level can influence attitudes. However, another relevant element is the role of externalities that are not directly visible, like avoided CO2 emissions or the impact on energy security. Although these benefits are often appreciated at an abstract level, they do not always translate into a concrete increase in WTP unless they are clearly communicated and contextualized at the local level (Ek 2006).

2.2 | Positive Externalities

Wind energy generates several positive externalities that go far beyond the simple production of clean energy (Ouerghi et al. 2024). One of the most important benefits is the reduction of air pollution, which improves air quality and has positive public health effects, including reduced respiratory disease and lower healthcare costs (Novan 2015; Raileanu et al. 2020). A recent study by Millstein et al. (2024) estimated that wind power generation contributed to a reduction of 1200–1600 premature deaths in 2022. Furthermore, wind energy plays a crucial role in combating climate change (Barthelmie and Pryor 2014), as it replaces high-emission fossil fuels and reduces the emission of greenhouse gases such as CO2, helping to mitigate extreme weather events. Additionally, wind turbines occupy a relatively "small" area, allowing for the combined use of land for agriculture or livestock farming (Denholm et al. 2009). This coexistence also provides access to nearby farms at a very competitive energy price. As a result, landowners, especially those in rural areas, have the opportunity to earn additional income by leasing land to wind energy producers. The economic benefits also extend to employment: the wind sector creates jobs in the production (Aldieri et al. 2019), installation, maintenance, and management of electricity grids, contributing to local development and the economic revitalization of many disadvantaged areas. In this direction, there are several studies discussing their contribution to job creation and local economic growth (Dugstad et al. 2020; Skenteris et al. 2019; Ramalho et al. 2025). Furthermore, energy security is another factor associated with the use of wind energy (Duranay et al. 2024). Wind energy provides diversification in the energy portfolio and increases energy independence. It also has significant geopolitical weight and minimizes the chances of energy shortages and energy inflation (Zafirakis and Chalvatzis 2014; Balcerzak et al. 2026). All these positive externalities are reported in Figure 2.

2.3 | Negative Externalities

Despite the positive consequences, wind energy production determines several negative externalities. One of the most studied aspects concerns the direct and indirect environmental impacts of wind turbines. The main problems reported concern the loss of habitat and biodiversity for animal species, especially birds and bats, which can suffer fatal collisions with the blades (Marques et al. 2014); however, as highlighted by Calvert et al. (2013) and Erickson et al. (2005), collisions with wind turbines appear to kill fewer birds than collisions with other man-made infrastructure (e.g., power lines, buildings, etc.). This criticality has led to research on mitigation strategies, such as careful site selection and temporal management of turbine activity. Some studies have focused on the cognitive abilities of respondents to consider the possible placement of wind turbines at different sites (Hevia-Koch and Ladenburg 2019).

In addition to the fauna, there is an impact on the landscape, with consequent aesthetic alterations that can negatively influence the social perception of rural and coastal territories (Cetkovskỳ and Nováková 2009). Wind turbines, visible from great distances, can transform landscape identity and the sense of place, contributing to forms of local opposition, better known as "NIMBY" phenomena (Devine-Wright 2005). Studies such as those by Wolsink (2007) highlight that visual impact is one of the main factors reducing the WTP for wind projects. In addition to visual impact, noise can also play a significant role in the negative perception of wind farms. The noise generated by turbines can be annoying for communities living near wind farms, but so is subjective perception, often amplified by factors such as lack of trust in project promoters, the feeling of being imposed on others, or fear of health effects (Pedersen and Waye 2007; Van Den Berg et al. 2008). A significant challenge related to the negative externalities of wind energy concerns the end-of-life phase of wind turbines (Deeney et al. 2025; Majewski et al. 2022; Martinez Luengo and Kolios 2015). When the systems reach the end of their operating life, the disposal of the blades poses a significant problem, as they are made of composite materials such as fiberglass and resins that are difficult to separate and recycle (Liu et al. 2019; Deeney et al. 2021 (Deeney)). This makes complete material recovery complex and often requires the use of landfills or treatment processes that are still costly and not always widespread. Furthermore, the growing number of turbines installed in recent decades makes this issue increasingly relevant from an environmental and management perspective. A detailed description of negative externalities, has been reported in Figure 3.

2.4 | Externalities of Wind Energy: A Comparative Analysis of Onshore and Offshore Plants

In the context of wind energy, analyzing externalities requires a systemic approach that distinguishes not only between positive and negative externalities, but also takes into account the structural differences and the different technological and locational configurations of the plants, specifically between onshore and offshore wind (Enevoldsen and Sovacool 2016; Perveen et al. 2014; Jensen et al. 2018; Meyerhoff et al. 2010). These characteristics generate divergent impacts in various respects: environmental, economic, and socio-territorial.

The externalities associated with wind energy are structured differently depending on whether we are talking about onshore or offshore wind (Marafia and Ashour 2003; Diógenes et al. 2020). Specifically, onshore wind is characterized by lower investment costs and greater technological maturity (Junginger et al. 2020; Hoogwijk et al. 2004).

These two aspects allow for widespread territorial diffusion and generate localized positive externalities, such as tax revenues for municipalities and supplementary income for landowners. While offshore wind requires higher capital and complex infrastructure (Esteban et al. 2011), it offers higher returns thanks to stronger and more intense wind regimes, contributing steadily to energy production and reducing supply variability (Musial et al. 2006). On the negative externalities side, environmental and social costs emerge that are not internalized in market prices, including the impact on biodiversity, with risks of collisions with birdlife, and, in the case of offshore wind farms, alterations to marine habitats and natural ecosystems (Drewitt and Langston 2008; Laranjeiro

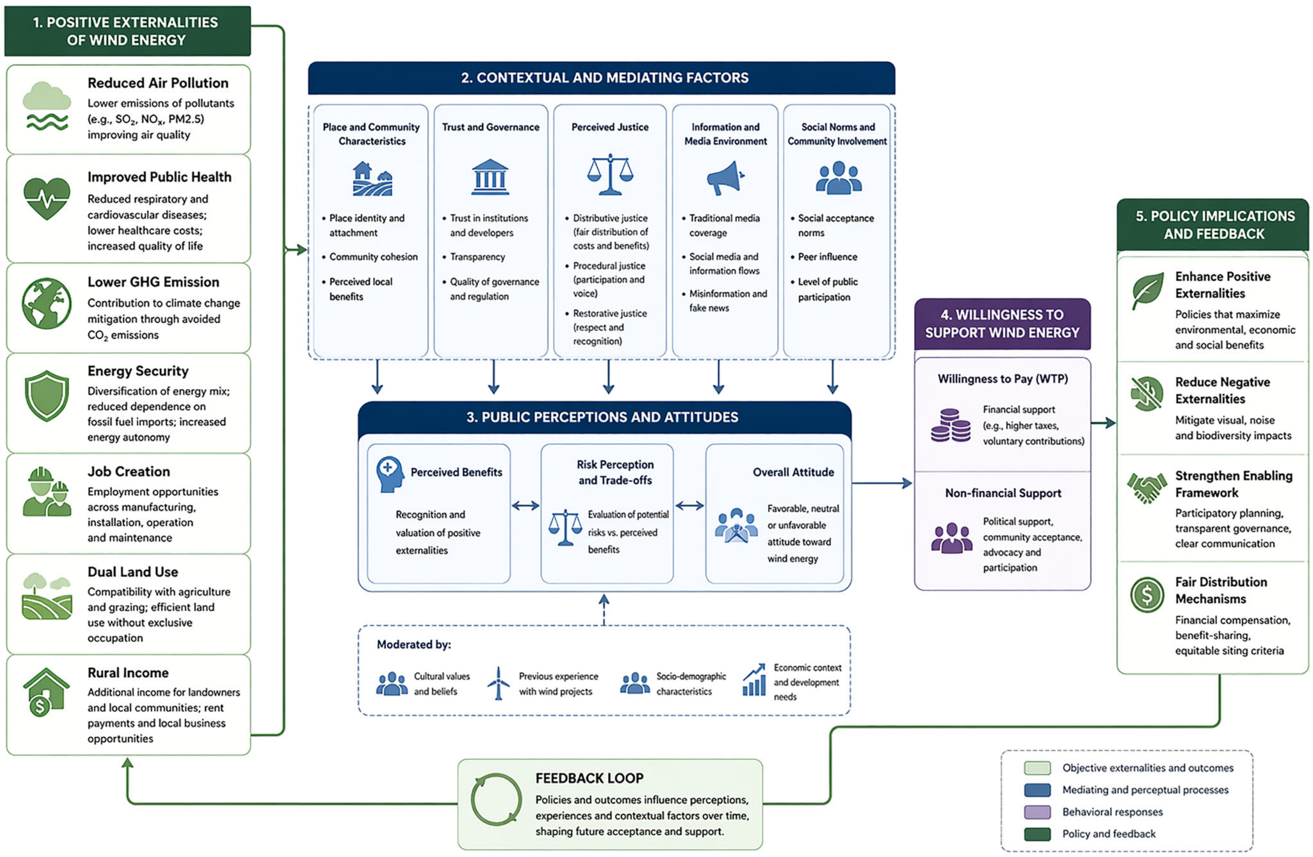

FIGURE 2 | Positive externalities caused by wind energy [Colour figure can be viewed at wileyonlinelibrary.com]

et al. 2018; Bergström et al. 2014). Furthermore, onshore wind farms can also generate landscape problems, with NIMBY phenomena and with acoustic and visual impacts that affect real estate values and the quality of life of local communities (Olsen 2010; Boyle et al. 2019). Offshore wind farms, while mitigating these effects due to their distance from the coast, introduce specific externalities such as interference with shipping lanes, restrictions on fishing activities, high grid connection costs, and complex management and maintenance, as well as potential ecological risks during the installation of foundations and submarine cables (Galparsoro et al. 2022; Thomassen et al. 2025). Figure 4 provides a comparison among the main categories of externalities associated with onshore and offshore wind power, using a grayscale intensity scale to visually illustrate the differences in their relative significance (very low, low, medium, and high).

2.5 | An Integrated Conceptual Framework: Externalities and Public Assessment of Wind Energy

The level of public acceptance of wind energy depends on a sophisticated set of interrelated factors. The conceptual framework model, which structures the analysis conducted in this systematic literature review, serves as an interpretive tool that combines the main determinants of wind energy acceptance identified in the existing literature. Specifically, this conceptual framework, illustrated in Figure 5, helps to classify, compare and discuss the papers selected for analysis in order to reveal consistent patterns, connections, and mediators that appear to have been overlooked before.

Thus, the framework does more than just summarize previous knowledge; it actually guides the whole analytical process, thereby enabling the systematic connection of empirical results to theoretical constructs. Furthermore, this type of framework allows researchers to make sense of inconsistent data and interpret the relationship between positive and negative externalities, as well as other contextual and socio-political factors. On the one hand, we have positive externalities (e.g., reductions in CO2 emissions and greater energy security) and on the other, negative externalities (such as visual impact, noise disturbance, and risks to biodiversity) (Sovacool et al. 2016; Ramalho et al. 2025; Krekel and Zerrahn 2017). These two elements represent the starting points of our framework. However, these objective impacts are not perceived neutrally; they are filtered through contextual variables, such as place identity, trust in institutions, and perceptions of justice. All elements belong to a complex mechanism that can shape the interpretation of their benefits. Furthermore, social norms (e.g., the level of participation of local communities) and the role of the media in informing (e.g., media coverage, distribution of fake news, etc.) also play an important role in contributing to strengthening or attenuating the perception of impacts (Ard 2024). The interaction of these three elements generates "public attitudes and perceptions" which constitute the true crux of the model and translate into greater or lesser WTP, that is the population's willingness to financially and politically support wind energy. Indeed, according to Hojnik et al.

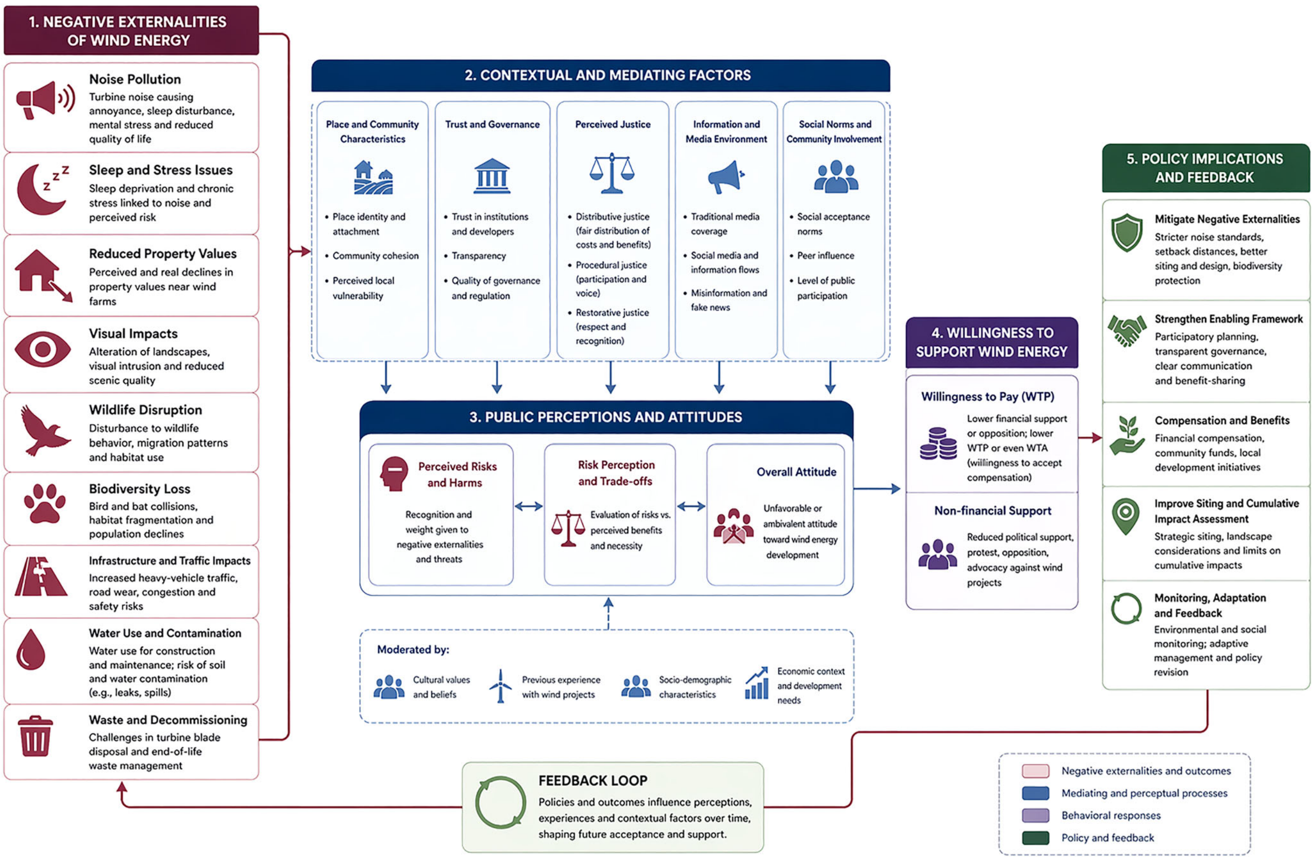

FIGURE 3 | Negative externalities caused by wind energy [Colour figure can be viewed at wileyonlinelibrary.com]

(2021), the acceptance of social norms and knowledge about green energy (such as water, sun, and wind) have a significant positive impact on WTP and, therefore, serve as drivers of WTP for green energy. Finally, policy implications constitute the framework's final outcome and also serve as feedback mechanism. Indeed, various tools can be adopted, such as participatory planning, financial compensation, or the definition of more equitable site criteria. In this regard, public policies can reduce negative externalities, enhance positive ones, and modify the social and communication framework within which perceptions develop, thus influencing the future acceptance of wind energy from a circular perspective.

3 | Methodology

To investigate the link between WTP, wind energy and their associated positive and negative externalities, we conducted a Systematic Literature Review (SLR) using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Protocol methodology (Page et al. 2021). Adopted to ensure a rigorous and transparent review process, PRISMA protocol was developed in 2009 when the guideline QUality Of Reporting Of Meta-analyses (QUOROM) was updated to address several conceptual and practical advances in the science of systematic reviews, and was renamed in PRISMA. The original PRISMA statement was published in various scientific journals (Moher et al. 2009) and reviewed multiple times over time (Liberati et al. 2009). In particular, in 2017, an international group revised the original version, incorporating methodological advances and terminological changes that arose in systematic reviews over the past decade. The updated version, renamed PRISMA 2020, was published in March 2021 by Page et al. (2021), which contains a detailed description of the methodologies used to update the PRISMA statement. This protocol guides the identification, screening and inclusion of relevant studies, providing a comprehensive and structured approach to literature synthesis (Güzel et al. 2025; Kim et al. 2018; Paschou et al. 2020). Despite the rigorous advantages for this methodology, selective outcome reporting and aggregating diverse studies are the major threat to a systematic review (O'Dea et al. 2021). For this reason, it is necessary to develop a well-defined query and a search strategy capable of identifying the relevant papers. Indeed, a SLR starts with formulating a research question, which serves as a guideline for thematic searches, the initial selection, and the definition of inclusion and exclusion criteria for selecting articles (Rastegar et al. 2024).

In this study, the research was conducted in July 2025 and was based on title-abstract-keywords criteria. The search keywords selected are as follow:

("wind energy" OR "wind power" OR "wind turbine" OR "onshore wind" OR "offshore wind") AND (" wind externality" OR "wind externalities" OR "emission*" OR "pollution" OR "noise pollution" OR "employment" OR "green job*" OR "job creation" OR "economic growth" OR "energy security" OR "energy efficiency" OR "knowledge" OR "technology" OR "education" OR "tourism" OR "landscape" OR "land use" OR "investment*" OR "NIMBY" OR*

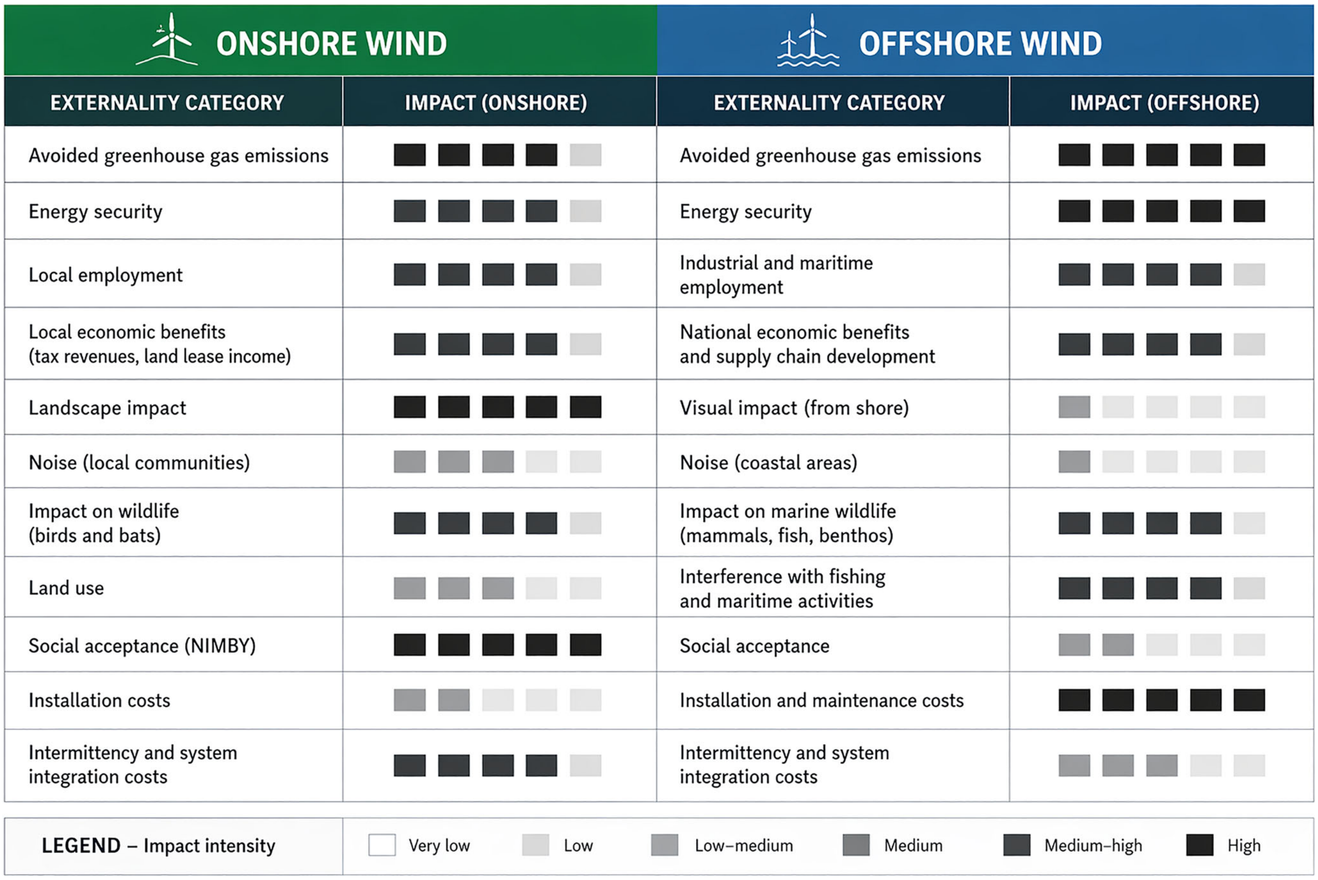

FIGURE 4 | A comparative analysis of externalities in onshore and offshore wind energy systems (based on the literature review) [Colour figure can be viewed at wileyonlinelibrary.com]

"Not In My Back Yard" OR "biodiversity" OR "life cycle assessment" OR "LCA" OR "community acceptance" OR "health impact" OR "property value" OR "environmental justice") AND ("valuation" OR "WTP" OR "willingness to pay" OR "WTA" OR "willingness to accept" OR "stated preferenc" OR "revealed preference*" OR "contingent valuation" OR "choice experiment*" OR "hedonic pricing" OR "economic impact assessment").*

These keywords were selected based on the existing literature. Specifically, following Mattmann et al. (2016a; 2016b), Ramalho et al. (2025), and Wang et al. (2024), three main cluster of keywords were formulated: the first refers to wind energy, in all its variants (in-shore or off-shore); the second refers to the main positive and negative externalities identified in the literature; the third refers to WTP or WTA, and to all the proxies or synonyms used to measure them.

The PRISMA procedure is shown in Figure 6. The first phase, namely "study identification", was carried out through a systematic search of two academic databases, that are Scopus and Web of Science, aiming to identify relevant studies on the adoption of wind energy, as well as their economic evaluations and socio-environmental impacts. The search time of the paper was 1984–2025. Based on this criteria, 666 papers were detected, of which 227 papers removed as duplicates between the two databases. During this screening phase, 439 articles were read and screened, of which 145 papers excluded as off topic (since not relevant to the out discussion) and the other 294 articles were sought for retrieval. Moreover, 61 papers were not retrieved and 223 were considered eligible. Subsequently, 151 were excluded according to predefined criteria: 141 articles were discarded after analyzing the abstracts and keywords, as they did not directly answer the our search question; 6 papers were excluded due to language limitations, as they were not available in English; and 4 papers were excluded due to lack of access to full texts. Finally, within the inclusion phase, the remaining 182 papers were subjected to a comprehensive assessment to confirm their relevance and methodological quality, ensuring that the final set of selected studies provided a solid basis for analysis.

This approach ensured transparency, reproducibility, and rigor in the study selection, allowing for a reliable synthesis of evidence on the economic and socio-environmental impacts of wind projects, including both benefits and potential negative impacts perceived by communities and stakeholders.

4 | Results and Discussion

The growing concern over climate change, geopolitics, the large dependency on oil, has considerably contributed to the boost of the wind power sector (Dimitropoulos and Kontoleon 2009). As one of the main renewable energy sources, the wind power has great benefits for the environment, pursuing the green transition; however, there are numerous controversial externalities associated with it. This systematic review of the

FIGURE 5 | An integrated conceptual framework: externalities and public assessment of wind energy [Colour figure can be viewed at wileyonlinelibrary.com]

literature shows that wind energy generates both positive and negative externalities, with significant impacts on environmental, economic, and social scales (Ouerghi et al. 2024; Millstein et al. 2024; Aldieri et al. 2019; Marques et al. 2014; Wolsink 2007; Erickson et al. 2005). These effects, listed below, may alter local communities' acceptance, with significant impacts on WTP and WTA (Cerdá et al. 2024). Before analyzing them, it is important to bear in mind the conceptual distinction introduced earlier between WTP and WTA. Specifically, the first measures the maximum amount citizens are willing to pay to obtain the benefits associated with wind energy (Le Gall-Ely 2009). In contrast, the latter measures the minimum compensation citizens would require to tolerate the negative externalities of wind infrastructure near their residences (Garcia et al. 2016). However, most of the articles selected according to the PRISMA protocol refer to WTP, reason in which this paper is based on the study of the relationship between WTP and wind energy externalities. The following subsections (section 4.1 and section 4.2) highlight both

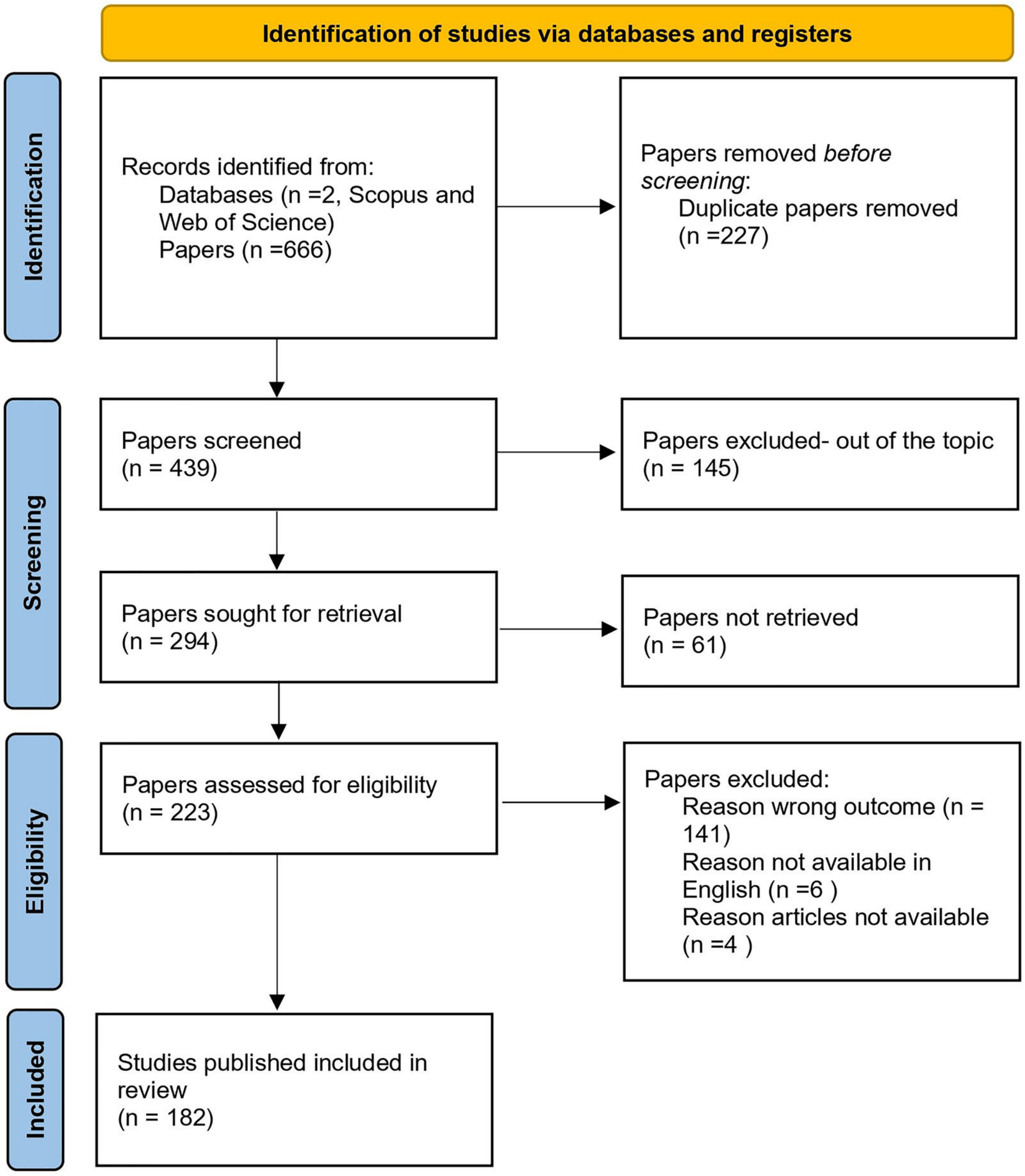

FIGURE 6 | PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only. Source: Page MJ, et al. BMJ 2021; 372: n71. doi: 10.1136/bmj.n71. This work is licensed under CC BY 4.0. To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/ [Colour figure can be viewed at wileyonlinelibrary.com]

the positive and negative aspects and contextualize the results by distinguishing between the main systemic characteristics (section 4.3).

4.1 | Discussion on Negative Externalities

Firstly, people may hold generally positive attitudes toward renewable energy, but experience or perceive significant negative external effects and the changes they imply for landscape amenity (Oehlmann et al. 2021) or for landscape aesthetics (Krekel and Zerrahn 2017; Meyerhoff et al. 2010). Moreover, onshore wind power is criticized for its negative visual impact on the landscape and its visual (Ladenburg and Lutzeyer 2012; Zerrahn 2017; Thomson and Kempton 2018); also offshore wind farms are primarily reproached for their negative landscape externalities (Westerberg et al. 2013). According to Dimitropoulos and Kontoleon (2009), some authors suggest that the primary motive stems from concerns over landscape intrusion, although this is strongly related to the type of landscape where the turbines are to be installed and its capability to incorporate wind turbine installations, as perceived by the local population (Johansson and Laike 2007).

The "crowding" of wind turbines in the urban fringe, especially in more densely populated rural areas, usually meets resistance (Ladenburg et al. 2013). This factor is correlated also with people's use of the costal zone for recreational purposes: planning of offshore wind farms should take into account the distribution of potential users of the coastal areas, especially tourists, where offshore wind farms are planned to be located (Ladenburg and Dubgaard 2009; Westerberg et al. 2013); its development would also have negatively impacted on the tourist experience (Einarsdóttir et al. 2019). Offshore wind farms close to the shore generate significant welfare losses, and these can be reduced by locating them at more distant sites (Ladenburg and Lutzeyer 2012). Furthermore, Drechsler et al. (2011);2012) and Zerrahn (2017) believe that wind energy production can negatively affect not only the landscapes quality, but also humans and biodiversity (especially birds and bats) or threaten wildlife. Indeed, according to Drechsler et al. (2011), turbines must maintain a minimum distance from towns and villages to avoid adverse effects such as noise or shading. The impact of noise on the local ecosystem results in resistance to wind power installations (Dimitropoulos and Kontoleon 2009). This noise is generated from the rotation of blades and shadow and light effects from the turbines (Warren et al. 2005; Westerberg et al. 2013; Thomson and Kempton 2018). In addition, wind power generation determines economic and social negative externalities; specifically, in regard to micro wind turbines, Claudy et al. (2011) state that homeowners are clearly concerned about the reactions of neighbors and local residents (i.e. social risk). The construction of wind turbines near to households has significant negative external effects on residential well-being (Krekel and Zerrahn 2017), reducing the people's welfare (Ladenburg and Lutzeyer 2012). The local negative externalities of wind energy fall under a broader category of Locally Undesirable Land Use (LULU). In turn, these local uses of land may lead to any construction or structural changes in land use by those who residing in the immediate vicinity of the area concerned (so-called NIMBY syndrome). O'hare (1977) argued that this syndrome may lead to inefficient resource allocation because the costs of the negative externality are born locally while the benefits are distributed more broadly (Cicia et al. 2012; du Preez et al. 2012).

4.2 | Discussion on Positive Externalities

The first aspect that encourages people to accept and promote renewable energy is the environmental one: the adoption of wind turbines for energy production has the great advantage of preventing environmental impact, mitigating emissions, and improving air quality in surrounding areas (Ek 2005; Zerrahn 2017). Indeed, the primary source of greenhouse gas emissions stems from the combustion of fossil fuels, which is carried out mainly for energy production (Höök and Tang 2013); therefore, the energy transition, such as the installation of wind turbines, and the reduction of dependence on fossil fuels, are considered positive externalities (Moran and Sherrington 2007). Furthermore, the presence of a wind farm can strengthen the "green image" of tourist communities, with positive consequences for the economy (Westerberg et al. 2013). Also, from an economic point of view, wind energy creates new jobs and additional employment opportunities, especially in rural areas (Dimitropoulos and Kontoleon 2009). As mentioned by Hanley et al. (2004), employment seems to be the only real benefit captured by rural areas where people live in closest to the environmental costs of renewable projects. Moreover, wind farms deliver a net welfare gain to society (Moran and Sherrington 2007). Finally, governance represents a positive externality to scholars. In particular, the governance characteristics of the planning procedure are the most important determinants of local community welfare in relation to wind farms (Dimitropoulos and Kontoleon 2009). The perception of political processes, such as trust, transparency, awareness, and distributive justice, influences acceptance towards wind energy (Langer et al. 2016; Brennan and van Rensburg 2025).

To summarize, among the most reported positive externalities in the studies analyzed is the reduction of greenhouse gas emissions, thanks to the possibility of generating energy without fossil fuels. This important result contributes directly to climate change mitigation and improved air quality, with visible effects on public health (Haines et al. 2007). The literature also highlights the important role of wind energy in diversifying the energy mix and ensuring security, which is particularly playing a relevant role within geopolitical and economic contexts. Furthermore, benefits emerge at different scales. At the local level, the development of wind farms can generate direct economic benefits, such as job creation (Aldieri et al. 2019), infrastructure investments, and financial compensation for host communities (Macdonald et al. 2017). Conversely, looking at rebound externalities, we note primarily the potential visual and landscape impact of turbines, especially in natural areas; this is considered one of the main causes of local resistance. From a more ecological perspective, the literature highlights potential risks to wildlife, with moderately severe consequences for biodiversity loss, primarily driven by the collision risk. However, indirect socioeconomic impacts also emerge, including the perceived value of real estate and social conflicts. Finally, although greater consideration of both positive and negative externalities is needed in future integrated marine planning for offshore wind farms, authors point out that externalities beyond visual impact, such as benefits to marine wildlife, are often overlooked (Börger et al. 2015). Consequently, an assessment and analysis of the context and the onshore and offshore wind farm systems is required.

4.3 | Contextualization of Main Findings

All the evidence gathered from the review of the papers through the SLR led to the identification of two clusters of externalities (one negative and the other positive, conceptually) and the observation of their impact and the dynamics associated with WTP. The most relevant studies for WTP are reported in Table 1, which shows also their key contributions to the wind energy literature. The analysis shows that WTP is closely related to the perception of its externalities, whether positive or negative, which transcends the neoclassical notion that the production of a certain good damages the production of another specific good (Zerrahn 2017). Understanding this relationship is crucial to interpreting how people evaluate social and environmental impacts, as well as all policy measures that increase public support. Consequently, the analysis of the results needs to take into account different contexts, such as the typology of wind farms (onshore and offshore), the availability of wind resources, and the impact on the local area (Faulques et al. 2022b). Furthermore, the perception of the positive or negative nature of the externality is closely linked to citizens' level of perception and awareness.

Starting from an overview of the main results, an interesting study conducted by Cerdá et al. (2024), using a meta-analysis to examine households' WTP for renewable energy, highlighted an average WTP ranging from € 113 and € 124 per household per year; in addition, onshore wind energy emerges to be the most popular in terms of WTP. Furthermore, the analysis also reveals geographical differences, with higher WTP in Southern Europe and lower in Asia. Dan Ombak (2022) analyzed Malaysian consumers' WTP to promote renewable energy development

TABLE 1 | Most relevant papers according to our literature review study

S.No.	Source	Title of the study	Contribution of the study
1	Ladenburg et al. (2025)	"Distance to offshore wind farms, onshore wind power spillover relationships, and the WTP for farshore, large-scale wind power development"	It contributes analyzing the WTP to locate offshore wind farms, as well as the spillover effects of onshore wind power farms.
2	Vergine et al. (2024)	"WTA a wind power plant: A survey study in the South of Italy"	The study introduces an innovative questionnaire that captures the evolution of climate change perceptions. It shows that project acceptance depends on place attachment and environmental attitudes, not on NIMBY logic.
3	Cerdá et al. (2024)	"WTP for renewables: Insights from a meta-analysis of choice experiments"	The study offers a global meta-analysis of WTP for renewable energy based on 63 articles and nearly 53,000 participants. It shows that promoting renewables is socially desirable, with an average annual WTP of more than € 110 per household.
4	Schütt (2024)	"Wind turbines and property values: A meta-regression analysis"	The study provides the first comprehensive meta-analysis of the impact of wind turbines on property values, combining 720 estimates from 25 hedonic studies. It shows an average reduction in property prices within 3.2 km of turbines, which disappears beyond 4.5 km.
5	Hyun et al. (2024)	"Evaluating a floating offshore wind farm: Households' WTP in South Korea"	It contributes analyzing households' WTP for wind farm installation, and funding how respondents' education level, income level, residence, and perceptions have a significant impact on the WTP.
6	Sirr et al. (2023)	"An analysis of the factors affecting Irish citizens' willingness to invest in wind energy projects"	The study analyzes for the first time market acceptance of citizen investments in wind farms, based on a national survey of 2,023 participants. It shows that investment interest varies significantly with the project's location and identifies the socio-demographic, geographic, and attitudinal factors that influence both the decision and the amount invested.
7	Mäntymaa et al. (2023)	"Residents' interest in landscape value trade related to wind energy: application of the attitude–behavior framework to WTP"	It investigates how Psychological ownership (PO) contribute to explaining the disparity between WTP and WTA for nonmarket goods, including wind energy externalities, through endowment effect mechanisms.
8	Koto and Yiridoe (2019)	"Expected WTP for wind energy in Atlantic Canada"	The study surveys households in three Atlantic Canadian provinces on WTP for wind power. Education, income, homeownership, and local perceptions affect participation, with households willing to pay 14% more per month.
9	Wang et al. (2019)	"Consumer support and WTP for electricity from solar, wind, and cow manure in the United States: evidence from a survey in Vermont"	The study assesses consumer support and WTP for solar, wind, and on-farm anaerobic digestion (ADS) energy in Vermont. Solar energy is the most preferred, ADS the least, with differences linked to education, political affiliation, property ownership, and local farming engagement.
10	Zerrahn (2017)	"Wind power and externalities"	It investigate how wind turbines can impact on the quality of human life through noise and visual impacts, and threaten wildlife. It analyzes both positive and negative effects.

(Continues)

TABLE 1 | (Continued)

S.No.	Source	Title of the study	Contribution of the study
11	Meyerhoff et al. (2010)	"Landscape externalities from onshore wind power"	It identifies the negative landscape externalities that would result from expanding wind power generation, and the nexus with a lower WTP for moving turbines further away from residential areas.
12	Moran and Sherrington (2007)	"An economic assessment of windfarm power generation in Scotland including externalities"	By using cost-benefit analysis, it assesses the economic feasibility of large scale windfarm projects, taking into account positive and negative externalities of wind generation.

through a survey of 672 consumers on the east coast of Peninsular Malaysia. They found that the average WTP was approximately USD 1.18 per month, as a contribution to a renewable energy fund on their bills. However, investment opportunities also depend on several factors. Sirr et al. (2023) analyze market acceptance of citizen investment opportunities in wind farms, based on a survey of 2023 Irish citizens. The results show that 56% would invest in a local project, 41% in a portfolio of projects, and 29% in a nonlocal one. Socio-demographic, geographic, and attitudinal variables influence the propensity and amount of investment, providing useful insights for policies aimed at encouraging citizen participation and the expansion of wind energy. A further study conducted by Vergine et al. (2024) analyzed the various factors influence public acceptance of a new offshore wind farm in southern Italy; the study used a survey conducted in 2022 on approximately 1000 residents. The analysis offers interesting results, as it refutes the NIMBY hypothesis, highlighting instead the positive role of place attachment and environmental attitudes; in fact, it emerges that greater environmental "sensitivity" and concern for climate change increases the propensity to accept the project. Gao and Ashina (2022) conducted a simulation of the WTP for renewable energy in Japan in different socioeconomic contexts and observed how this could favor diffusion within the energy sector between 2015 and 2050. By integrating the estimated WTP into a multiregional optimal generation planning model applied to emissions reduction targets in Japan, the results confirm a significant increase in WTP and the share of solar and wind energy, which could reach between 4.3% and 9.9% by 2050. Woo et al. (2019) analyze the acceptance of community-based renewable energy projects in South Korea and assess the public and local residents' willingness to participate according to the expected returns on investment. A further important contribution was made by Koto and Yiridoe (2019), who analyzed wind energy demand in three Atlantic Canadian provinces, identifying households' WTP a premium for wind-sourced electricity. The results show that 73% of participants are willing to pay an average of 13% more per month; however, there are several factors that influence this propensity, including income, education, and perception of local externalities. Other studies, such as Wang et al. (2019) paper, have analyzed support and WTP for various renewable energy sources in Vermont (USA). No interesting results emerge for wind power, while we observe a marked preference for solar energy and relatively low support for biogas, influenced by various socio-demographic factors and the level of technological maturity. Education level also appears to be an important factor in the study conducted by Ntanos et al. (2018), analyzing the factors that influence public opinion and WTP for the expansion of renewable energy in Nikaia (Greece). The results, in addition to showing a positive attitude toward renewable sources, with an average WTP of € 26.50 per quarter, influenced by education, energy subsidies, and state support. Citizen involvement in the energy transition process is crucial, in addition to a careful assessment of the possible factors that can influence WTP. Germeshausen et al. (2023) observed through an instrumental variable approach that the presence of turbines reduces local support, but this effect decreases with distance.

Additionally, the literature highlights that differences between onshore and offshore wind farms affect WTP and acceptance costs significantly. Although offshore wind involves higher capital costs and more complex infrastructure (Esteban et al. 2011), it benefits from stronger and more stable wind conditions, with higher energy yields and less variability in supply (Musial et al. 2006). In contrast, onshore wind power has lower investment costs and greater technological maturity (Hoogwijk et al. 2004; Junginger et al. 2020). However, when considering widespread expansion scenarios and including high estimates of acceptance costs at the national level, onshore does not show a clear cost advantage over offshore; this advantage emerges only in the presence of moderate expansion and is limited to local acceptance costs (Hevia-Koch and Jacobsen 2019). In terms of preferences, the WTP related to move turbines from onshore to offshore represents a monetary measure of the acceptance costs of onshore installations, that is the amount individuals are willing to pay to remove them from land and place them at sea (Hevia-Koch and Jacobsen 2019). Furthermore, no significant economic arguments emerge in favor of locating offshore wind farms completely out of sight, given the size of the turbines under consideration (Ladenburg et al. 2025). WTP related to locate offshore wind farms farther from the coast increases with age, income, and frequency of beach visits, while it decreases among individuals with a direct view of an offshore wind farm (Ladenburg and Skotte 2022).

From a methodological perspective, WTP for wind energy externalities also varies depending on the methodology used to assess these externalities (Ramalho et al. 2025). In stated preference methods, such as the choice experiment and the discrete choice experiment, the monetization of the externality is achieved by assessing individual preferences regarding scenarios and sets of alternatives characterized by different attributes (Meyerhoff et al. 2010; Dugstad et al. 2020); in this case, WTP arises from choices made among hypothetical options. In contrast, contingent valuation estimates the value attributed to the externality by directly asking individuals how much they would be willing to pay (du Preez et al. 2012). In revealed preference methods, such as hedonic pricing, WTP is inferred from the analysis of observed behaviors in the real estate market, assuming that property prices also reflect environmental attributes (Skenteris et al. 2019), while the travel cost method derives it from the expenses incurred by individuals to reach a specific destination (Kipperberg et al. 2019). Lastly, alternative techniques such as the life satisfaction approach and the system dynamics approach estimate the externality through a micro-econometric function that links reported life satisfaction to environmental variables and through mathematical simulation models, respectively (Trapp and Rodrigues 2016; Krekel and Zerrahn 2017).

Finally, the high or low availability of energy resources across different regions also influences the relationship between WTP and wind energy externalities. In fact, countries such as Denmark and the United Kingdom-Scotland, which are more predisposed to wind and therefore have a higher capacity to produce wind energy, boast a greater density of wind farms and consequently a higher WTP for and social acceptance of renewable wind energy (Hvelplund et al. 2017; Shao et al. 2022; Johansen and Emborg 2018). Furthermore, it appears that Europe, North America, and all those countries with greater institutional and political stability show higher WTP values than some Asian countries or less developed regions (Soon and Ahmad 2015; Cerdá et al. 2024).

5 | Conclusions

In conclusion, the literature review demonstrates that wind energy creates various externalities, affecting positively and negatively environmental, economic, and social dimensions: from the reduction of greenhouse gas emissions to the improvement of air quality and contribution to climate protection, diversification of the energy mix, energy security, job creation, local economic benefits, governance, and transparent planning processes. These positive aspects increase community welfare and public acceptance (Gross 2007). Additionally, the negative externalities are mainly related to landscape and visual impacts, noise, disturbances to wildlife, and localized social and economic effects, including possible decreases in the values of property and social conflicts. These negative perceptions greatly depend on proximity to turbines, landscape characteristics, and the degree of local awareness and engagement (Soini et al. 2011; Delicado et al. 2016). The assessment of wind energy externalities is carried out by assigning a monetary value. This value depends on the type of externality being assessed, which in turn can take various forms. Importantly, the literature also suggests that public acceptance and WTP are closely related to perceptions of these externalities; indeed, support for wind projects would increase as environmental awareness and place attachment increases. Geographical, socio-demographic, and attitudinal factors are also of relevance in driving WTP and investment behavior (Mäntymaa et al. 2023).

To conclude, perceived positive and negative externalities will be instrumental in defining effective policy design, public support, and investment facilitation for wind energy, while contributing to broader objectives of energy transition and sustainable development (Enzensberger et al. 2002). Furthermore, projecting the future perspectives of these externalities can support policymakers and researchers in making informed decisions on wind energy.

5.1 | Policy Implications

The systematic review highlights important considerations for policymakers promoting energy transition (specifically through wind energy), to ensure both social acceptance and the maximization of collective well-being. First, the findings highlight that perceptions of both positive and negative externalities significantly influence the WTP for wind energy (Ramalho et al. 2025). An important aspect is related to policies that highlight environmental and economic benefits, such as reduced greenhouse gas emissions, climate change mitigation, and job creation (including in rural areas), which can increase public support, acceptance, and WTP. Effective communication campaigns aim at highlighting these benefits are crucial in this regard. Conversely, negative externalities, especially visual impact, noise, and potential impacts on biodiversity, remain significant barriers to local acceptance (Nazir et al. 2020). In this regard, policymakers should prioritize land-use planning strategies that can reduce these impacts, including strategic site selection (with less landscape "invasion and intrusion"), maintaining adequate distances from residential areas, and a tendency to favor the installation of offshore wind farms, which are characterized by higher yields but associated with higher operation and maintenance costs. The analysis also highlights that policymakers should favor a bottom-up approach, as top-down approaches appear to less effective than participatory models, that involve local communities. Additional interesting policy measures could include financial compensation, such as revenue-sharing schemes or local investment opportunities in wind projects, which can further improve WTP and foster community acceptance. A final interesting aspect concerns differentiated policies by geographical area. WTP and acceptance vary greatly based on cultural, socioeconomic, and landscape differences, all of which must be incorporated into project design and regulatory frameworks to optimize outcomes (Rocchi et al. 2022; López-Martínez 2023).

5.2 | Limitations and Future Directions

This literature review offers a comprehensive and exhaustive overview of the externalities associated with wind energy and their role in WTP. However, several ideas for future research emerge, particularly methodologically, as reported in the appendix (Table A1). A first observation concerns the need to harmonize the different existing methods of surveying students. Indeed, the research analyzed uses heterogeneous approaches (different economic evaluation methods, nonuniform measurement units, and incomplete socio-demographic variables), significantly limiting the comparability of results. In this regard, the availability of more complete and standardized datasets would enable a meta-analysis to more accurately estimate the average effect of externalities on WTP and identify the possible role of moderating effects with greater precision (Schütt 2023). Furthermore, a further limitation concerns geographic concentration; therefore, future studies should broaden their territorial coverage, also to investigate how cultural, social, economic, and institutional differences may shape the perception of externalities and WTP (Mattmann et al. 2016b; 2016a). At the same time, studies evaluating the temporal evolution of social acceptance are lacking, a crucial aspect in light of technological improvements and changes in the population's environmental awareness.

Further investigations could focus on the role of procedural and distributive justice, attempting to analyze how different forms of public participation, including benefit sharing, can influence attitudes and WTP (Jørgensen et al. 2020).

Author Contributions

Gianluigi De Pascale: conceptualization, methodology, formal analysis, investigation, data curation, visualization, writing – original draft, writing – review and editing, supervision. **Luca Esposito:** conceptualization, methodology, formal analysis, investigation, data curation, visualization, writing – original draft, writing – review and editing, supervision. **Melania Riefolo:** visualization. **Anna Romagno:** conceptualization, methodology, formal analysis, investigation, data curation, visualization, writing – original draft, writing – review and editing, supervision.

Acknowledgments

The content of Figure 2, Figure 3, Figure 4, and Figure 5 is original and developed entirely by the author. The graphical representation was created with the support of artificial intelligence tools. The AI software used is ChatGPT, developed by OpenAI. All underlying concepts, data, and interpretations are fully elaborated by the author.

Open access publishing facilitated by Universita degli Studi di Foggia, as part of the Wiley - CRUI-CARE agreement. A preliminary version of this paper was presented at the Third Wind Value Conference (2025), University College Cork. This paper has benefited from the feedback received at the conference.

Funding

Gianluigi De Pascale and Luca Esposito have contributed to this work within the CLIMETransition project. The CLIMETransition project was funded by the European Union "Next Generation EU" through the Italian Ministry of University and Research within NRRP Mission 4 "Education and Research" - Component C2 - Investment 1.1 "Fondo per il programma Nazionale di Ricerca e progetti di Rilevante Interesse Nazionale (PRIN)" approved by the Decree n. 1376, September 1st 2023, and running under the CUP Master F53D23009450001 [CUP De Pascale and Esposito - D53D23017840001]. The information and views set out in this publication are those of the author(s) only and do not necessarily reflect those of the European Union or the Italian Ministry of University and Research. Neither the European Union nor the granting authority can be held responsible for them. Cup: F53D23009450001

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The authors have nothing to report.

Endnote

[1] https://www.irena.org/Publications/2023/Aug/Renewable-Power-Generation-Costs-in-2022/

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Appendix A

TABLE A1 | Future studies and key challenges in wind energy

Challenges	Description	Future directions
Local opposition	Communities often resist wind projects due to perceived negative externalities such as noise, visual intrusion, and wildlife disruption.	Conduct context-specific studies to understand local perceptions and develop strategies to mitigate negative externalities.
WTP variation	WTP for wind energy is influenced by perceived environmental benefits and negative impacts, with strong differences among local populations.	Investigate socio-demographic, cultural, and environmental factors influencing WTP to inform policy and incentive design.
Social acceptance	Acceptance is heavily shaped by procedural fairness, community participation, and transparency in planning processes.	Explore participatory planning models and policy interventions that enhance perceived fairness and community involvement.
Balancing externalities	Positive effects (climate mitigation, energy security, and economic benefits) must be weighed against negative impacts (noise, visual, and wildlife).	Develop integrated assessment frameworks that quantify both positive and negative externalities to guide decision-making.