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Policy insights for wind energy from a choice experiment stated preference efficient design in Apulia region (Italy)

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Abstract

The present work argues that wind energy is either a positive or negative determinant against the risks associated with its use, and aims at: evaluating the incidence of energy risks on the perception of wind energy; analysing the trade-offs between a wind farm installation, land conservation and energy risks; suggesting adequate policy indications for the efficiency of future energy markets. The study compares the results from logit models, which estimate the distribution of the utility coefficients with a Choice Experiment approach using a stated preference efficient design and honesty priming techniques to overcome the hypothetical bias. Main findings indicate a positive attitude for the proposed wind energy scenarios in terms of *Aesthetical impact*, CO_2 and *Bill savings*, and *Costs*, as well as more densely distributed wind farms producing more energy. Installation and maintenance costs and the rate of avian collisions are considered acceptable. From the main findings, useful policy insights assess the efficiency of wind farms projects to reduce costs and energy prices. Simplification of bureaucracy, direct economic benefits for local communities, citizens' participation, and dissemination of information are key practices for future developments of wind energy markets.

Keywords Wind energy · Energy policy · Energy risks · Choice experiment · Honesty priming

1 Introduction

In the last decades, renewable energy technologies have seen a rapid development worldwide. In Europe, this development finds support by the latest advance of the strategy beyond Kyoto—which aims to reduce the member states' dependence on fossil fuel sources and offers sustainable solutions in view to reduce climate change effects (European Commission, 2019). Nonetheless, the international debate fails to

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consider the issues of wind energy perception commensurate with the risks of energy production from fossil sources.

Wind energy perception is widely discussed in the literature. The negative perception of wind farms is frequently correlated to the visual impact and landscape change (Beer et al., 2023; Bush & Hoagland, 2016; Lothian, 2020; Magari et al., 2014; Westerlund, 2020) as well as noise pollution (Jensen et al., 2014; Karasmanaki, 2022; Klok et al., 2023). Considering the place attachment and the consequent power siting debate, some studies have found arguments for (Larson & Krannich, 2016; Weinand et al., 2021) and against (Fergen & Jacquet, 2016; Peri et al., 2020) environmental concerns.

Certainly, community engagement plays a pivotal role in shaping public perception of wind energy projects. The perceived benefits associated with these projects, including financial gains, local ownership, and involvement in decision-making processes, have been identified as influential factors. Existing studies, such as those by Firestone et al. (2020) and Solman et al. (2021), highlight how these aspects contribute positively to public perception and acceptance of wind energy initiatives. The above studies underscore the importance of fostering a sense of community involvement and ensuring that local residents have a stake in the decision-making processes surrounding such projects.

While advocates of wind energy often highlight its potential to mitigate climate change (Barthelmie & Pryor, 2021; Olabi & Abdelkareem, 2022; Petrova, 2013), this alone does not necessarily secure people's support or prevent indifference (Bidwell, 2015; Leiren et al. 2020; Petrova, 2016). In some cases, it may even fail to stave off an increase in opposition (McCarthy & Eagle, 2021; Olson-Hazboun et al., 2016). This underscores the importance of addressing various concerns and employing effective communication strategies beyond climate change considerations to foster public acceptance of wind energy projects.

The present work investigates the public perception of wind energy technology as sustainable alternative in the energy market, weighing up the risks affecting old and new technologies using a stated preference efficient design with discrete choice models. The novelty of the work is to assess the above risks through a choice experiment (CE) model for two scenarios: 1. fossil fuel plant *vs* wind energy alternative; 2. spatial distribution of wind energy (i.e., existing *vs* new developments of wind farms).

The use of a CE (one per the above scenarios) allows to define the weights of the attributes considered in the utility functions of wind energy alternatives and to estimate the relative willingness to pay (WTP). Furthermore, the use of honesty treatment offers a value-added to the methodology as it is applied to a complex choice process.

The work is structured as follows: Sect. 1 describes the aims and contributions of the paper; Sect. 2 illustrates a background on energy market risks and represents the foundations to define the alternative's attributes included in the CE; Sect. 3 shows the methodology. It focuses on the use of CEs for non-market valuation and offers the theoretical insights about the contribution of efficient designs and the honesty priming implementation. Section 4 explains the structure of the survey and the construction of the experimental design. Section 5 illustrates the obtained results. In addition, it depicts a description of the experimental survey and an illustration of two models

to explain the social acceptance of wind energy vs fossil fuels and of the spatial distribution of wind farms (i.e., existing vs new developments of wind farms). Section 6 presents a discussion of the main findings. Finally, Sect. 7 concludes and highlights relevant policy implications.

1.1 Aims and contributions

Based on the description illustrated above, the present work focuses on the following specific aims:

– Aim 1. To evaluate the incidence of energy risks on the perception of wind energy. We contribute to Aim 1 by developing a CE considering a wind energy farm as alternative to a fossil fuel plant (the *status quo*).
– Aim 2. To analyse the potential trade-off between wind farm installation, land conservation and energy risks. We contribute to Aim 2 with the inferential analysis applied to CE responses.
– A value added of the present study to current literature and to Aims 1 and 2 is the use of honesty priming methods to reduce response bias.
– Aim 3. To define adequate policy indications for the efficiency of national energy markets and overcoming climate changes issues. We contribute to Aim 3 with a comparative discussion of the obtained results with the international literature; and a description of ad-hoc policy insights to contribute to the social acceptance of wind energy at EU-level.

2 Background: evaluation of wind energy perception and energy risks

The first aim of the present work considers energy risks for the evaluation of wind energy perception. This reflection overcomes the limits of analysing a complex issue such as energy supply markets in a simplified and partial scenario. In particular, the description of this background section focuses on the meaning of wind energy perception and the importance of wind energy compared to other sources as well as main socio-environmental impacts. In the second part, it highlights the contribution of risks attributed to current energy markets and actual top-down policies and bottom-up strategies to raise community awareness. The third part of this section provides current national and regional energy power installation and electricity production in support of the case study analysed in the present work. Finally, the section highlights main methodological contribution in support of the CE analysis.

Wind energy perception is one of the most important aspects that affect the success or failure of a wind energy project. Often, the attention is focused on technical, economic, and environmental impacts of wind energy (Hamza et al., 2022; Kim et al., 2018; Langer et al., 2016; Laskowicz, 2021; Mendoza et al., 2015; Msigwa et al., 2022; Saidur et al., 2011), because measurement methods of social impacts are not easy to define and happen to be slow and complicated (Martínez-Mendoza

et al., 2020; Sevenant & Antrop, 2009). A comparative analysis of wind, solar and hydroelectric energy impacts on landscape carried out by Ioannidis and Koutsoyiannis (2020) reveals that wind energy is perceived as the most impactful on landscapes. This perception arises from academia, as well as policy frameworks and the public. Generally, wind turbines are identified as industrial elements which look bulky in terms of size, other than their blade movement, noise, and night lights.

Similarly, Dhar et al. (2020) provide current perspectives on socio- and environmental issues associated with wind energy developments. The authors suggest strategies to mitigate environmental impacts such as bird mortality, biodiversity, habitat loss, noise, and visual impact and propose some potential reclamation practices useful for wind energy planners and developers.

In addition, the inclusion of risks attributed to current energy markets need to be considered during the social acceptance analysis, and, consequently, in the decision process. Sposato and Hampl (2018) introduce the cultural theory of risk, which, from an empirical point of view, looks at how some specific worldviews affect the perception of specific risks in comparison to other predictors of risk perception. This theory starts from a twofold assumption. On the one hand, the observance to certain organizational forms of social relations is related to some cultural biases or worldviews. On the other hand, four distinct cultural worldviews are identified in a two-dimensional space. The latter is composed by a group and a grid dimension, namely Hierarchism, Egalitarianism, Individualism and Fatalism. 'Patterns of risk' explain the worldviews outperforming knowledge, personality, traits, and demographic variables (Douglas & Wildavsky, 1983). In a few words, risk perceptions are the result of an interplay of cultural biases and the type of assessed hazard (Douglas & Wildavsky, 1983). Therefore, some particular risks are more salient to individuals from one group than they are to individuals from another group (Douglas & Wildavsky, 1983). To understand this process and analyse wind energy perception in the light of the risk factors affecting fossil fuels energy markets, these are directly included in the CEs for wind energy perception evaluation.

A first relevant issue of current energy markets is the 'supply risk' which is the possible exhaustion of energy stocks. The 2019 BP Statistical Review of World Energy (BP, 2019) estimates that oil reserves are sufficient to meet the global production requirements for 52.9 years; whereas natural gas and coal reserves for 55.7 and 109 years, respectively. Moreover, the dominance of reserves in certain areas of the planet should not be underestimated. This involves significant asymmetries in the bargaining power of energy supply companies. Because of these market imperfections, advantages arise for limited countries selling resources for the rest of the world, which is heavily dependent on these countries and subject to the risk of external supply disruptions. Therefore, the energy market should be balanced off by means of substitutability between energy sources with adequate energy policies.

A second risk affecting the market is 'energy costs volatility', blamed of being a heavy burden for the population (International Energy Agency, 2023; Ronchi et al., 2013). According to Heinemann et al. (2022) and the Istituto Nazionale di Statistica (ISTAT, 2023), Italy has seen its energy bills almost tripled in the last 25 years. A similar scenario appears across several European Union (EU) countries (Ari et al., 2022; Statista, 2022). This phenomenon is a result of a combination of the increased demand in the 'post-pandemic' economic recovery, the rise in natural gas and coal

prices (due to shortfalls in supply in Europe and Russia) (ARERA, 2023), the wars in Russia–Ukraine and Gaza–Israel–Palestine, the drop in renewable power generation due to low wind speeds, increased inflation rates, and the uncertainties of the energy transition (International Energy Agency, 2023).

A third and a fourth risk which are of particular concern can be referred to as 'environmental risks' and 'health risks'. These two forms of risks appear closely related (Iqbal & Khan, 2018; Siler-Evans et al., 2013; Teneler & Hassoy, 2023; van Kamp & van den Berg, 2021). The combustion of fossil fuels causes pollution and the occurrence of further contamination from poisonous substances is also devastating for human health. This contamination contributes to global warming and the increase of biologically harmful ultraviolet radiations on the Earth's surface with an impact on population's health (Kampa & Castanas, 2008; Vohra et al., 2021).

In terms of policies, the EU favours several action plans focusing on strengthening cooperation and more reliable information on climate changes risks (Bezirtzoglou et al., 2011). Along the lines of the EU, the Intergovernmental Panel on Climate Change (2017) summarises major climate change mitigation actions, which, in the long-term, should enable changes in individual attitudes and lifestyle. Renewable energy is among the priority areas of these changes. The 2023 IEA World Energy Outlook reports that renewables capture two-thirds of global investment in power plants to 2040, and that the annual coal capacity decreased from 100 GW (the 2012 peak) to 50 GW in 2022 (International Energy Agency, 2023). Significant investments in coal dwindled, and solar photovoltaic (PV) and wind power began to dominate the expansion of electricity systems. Consequently, the average capacity factor of coal power plants was nearly ten percentage points lower over the past decade compared to the preceding decade. In 2022, global wind capacity additions decreased to 75 gigawatts (GW). Although this level is almost a third lower than the peak in 2020, it still exceeds deployment levels that were seen before 2020. Looking ahead, the STEPS (Stated Policies Scenario) anticipates that by the end of this decade, global wind capacity additions will increase to 175 GW per year. This growth is attributed to ongoing technological improvements and cost reductions. However, meeting this demand will require additional manufacturing capacity. From a longer-term view, the annual deployment levels are expected to reach 195 GW by the year 2050. This projection takes into consideration the replacement of aging wind turbines, indicating sustained expansion and progress in the wind energy industry. In the Announced Pledges Scenario (APS), 240 GW of wind capacity will be added by 2030, with the figure of deployment level increasing to 310 GW by 2050. Meanwhile, in the Net-Zero Emissions (NZE) Scenario, these estimates are even higher, reaching 320 and 350 GW in 2030 and 2050 respectively.

In the EU, renewables account for 80% of the new capacity and wind power should become the leading source of electricity beyond 2030. In 2018, on a path to the 2020 target of 20%, renewable energy represented 18.9% of energy consumed in the EU (Eurostat, 2020). In particular, high shares of energy produced from renewable sources in the EU member states are located in Sweden, Finland, Latvia, Denmark and Austria. Italy is one of the ten member states (Sweden, Finland, Denmark, Estonia, Croatia, Lithuania, Bulgaria, Italy, Czechia and Cyprus) that overcome the 2020 target of shares of renewable energy.

At national level, there exists a well-developed market of renewable energy and several potential perspectives for future developments. Italy, as well as other EU

countries, is taking into account the recommendations of the new EU renewable energy policy by identifying specific targets to reach the new renewable energy mix by 2030. The specified targets emphasize the substantial significance of wind power. In the last 15 years, the electricity production from wind sources has seen significant growth, surging from 2,971 gigawatt-hours (GWh) in 2006 to 18,762 GWh in 2020. During 2020, the production of electricity from wind sources amounted to 18,762 GWh, corresponding to 16% of the total production from renewable sources (GSE, 2022). At the end of 2020, 5660 wind farms were installed in Italy (GSE, 2022). The total wind power installed in the country, equal to 10,907 MW, represents 19% of the entire national plant fleet powered by renewable sources (GSE, 2022).

Puglia (or Apulia), with 4802 GWh of electricity produced, holds the record for wind production, followed by Sicily (2765 GWh) and Campania (3209 GWh) (GSE, 2022). This remarkable increase in wind energy production highlights the growing role of wind power in the energy landscape, particularly in Puglia. Considering the above scenario, an investigation on the public acceptance of wind energy developments in this region is essential to meet the requirements of the current EU energy policy goals.

Considering the above policy scenario and to close the gap between current top-down policies and community needs, recent literature (Gebreslassie, 2020; Leiren et al., 2020; Vasudevan et al., 2023) suggests community inclusive policies for future planned wind farm developments. In particular, public consultations would improve confidence and ownership by the public and reduce potential resistance to wind farm developments. In addition, land compensation and payments to the community other than developing public benefit packages are advised accordingly. Finally, mechanisms to increase peoples' awareness, international best practices and independent power producers should also be addressed.

2.1 Methodological background

The use of CE to investigate public perception of wind energy allows to consider the multivariate factors affecting its development, as well as the above-mentioned risks characterizing the current energy market.

A growing number of studies apply non-market valuation methods (including CE) to evaluate hypothetical wind farms through survey questions (Cashmore et al., 2019; Kim et al. 2019; Vuichard 2022; Wen et al., 2018). Furthermore, several studies do not offer a visualisation of wind plants and focus only on a partial feature of the issue related to wind energy perception. It follows that the potential of the methodology used, like CEs, is not fully exploited and the case study is not analysed in its complexity and multi-variability.

With the use of Stated Choice Methods (SCM) for non-market evaluation, individuals or decision makers are involved in recognizing the necessity to solve problems, make choices, or obtain benefits. For this reason, individuals search and learn what solutions are available to meet their needs. Generally, these solutions are based on ranking a given number of alternatives. To define the alternatives, several attributes

are considered based on social perception of environmental and economic attributes. It is on these attributes that individuals make their evaluations and comparisons.

The role of public policy in the management of resource and environmental systems requires knowledge on the values of the service flows.

The concept of value is based on neoclassical Welfare Economics and has the purpose of increasing individual's well-being. It is based on the axiom that each individual is the best judge of how well off he or she is in a given situation (Freeman et al., 2014). Freeman's (1979) standard economic theory aims to measure changes in individuals' well-being. Changes consider both prices and quantities of goods purchased in the market. The above measurement is also extended to public goods and other non-market goods/services, such as environmental quality. Freeman's theoretical background is based on the assumptions that: 1. People have well-defined preferences among alternative bundles of goods (considering quantities of both market and non-market goods); 2. People know their preferences. Preferences allow for substitutability between market and non-market goods to form the bundle. Substitutability implies that the increase in the quantity of an element in an individual's bundle substitutes for the decrease in another element. This concept establishes margin values (trade-off comparisons between pairs of goods). 3. WTP and willingness to accept compensation (WTA) are value measures based on people's preferences and approximate the price of non-market goods. SCM is a flexible approach for the collection of preference data from subjects in hypothetical situations (Louviere et al., 2010) as is a hypothetical wind energy plant development.

3 Methodology

3.1 Theoretical insights

The foundations of SCM include the consumer theory of Lancaster (Lancaster, 1966) which proposes a new assumption of the utility function. A variant of SCM is the discrete CE, where respondents are asked to indicate their preference among two or more multi-attribute alternatives. Generally, the decision scenario and product descriptions are generated using experimental design techniques. These techniques aim to minimize the number of alternatives and statistically identify the underlying preference functions. Usually, respondents are faced with multiple scenarios for an efficient use of resources (Hoyos, 2010).

Random Utility Theory and utility maximization represent the conceptual framework to analyse choice and the ranking of alternatives deriving from SCM applications. Thurstone (1927) explains dominance judgments among pairs of offering/ alternatives. The author assumes that consumers generally choose the offerings/ alternatives they like the best, subject to constraints—such as time or income—as is defined in standard economic theory. However, consumer choice may not be the same as the preferred alternative. To explain the above, let us consider the following utility function which includes a random element (Thurstone, 1927):

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{1}$$

where U_{ij} is the unobservable utility of offering/alternative j for individual i; V_{ij} is the deterministic/systematic (i.e., known) component of utility; and ε_{ij} is the random component (i.e., the error term). The presence of the random component is justified by the difficulty of considering all possible variables and by others biases, such as measurement errors. The presence of a stochastic utility determines the probabilistic structure of the behavioural model. In particular, the probability that consumer i chooses offering/alternative j is as follows:

$$P_{ij} = Pr\big[\big(V_{ij} + \varepsilon_{ij}\big) > \big(V_{il} + \varepsilon_{il}\big)\big] = Pr\big[\big(V_{ij} - V_{il}\big) + \big(\varepsilon_{ij} - \varepsilon_{il}\big) > 0\big]\,\text{for each}\,j \neq l \tag{2}$$

where l is the attribute level. In relation to the distribution of the error term ε, and in particular to the differences between groups of variables ε_{ij} and ε_{il}, this could be normally (probit models) or logistically (logit models) distributed.

The systematic component of the utility function is the portion of the alternative attractiveness related to the alternative attributes. The analysis of attributes may be based on preliminary qualitative research including focus groups and interviews of experts tailored to a particular project (Vass et al., 2017; Vennedey et al., 2016); and a secondary research based on the literature.

In terms of the functional form of the utility, a linear-in-the-parameters function of the explanatory variables expresses the systematic component as follows:

$$V_{ij} = \beta x_{ij} \tag{3}$$

where β is a k-vector of utility coefficients associated with an x-vector of explanatory variables. Thus, Eq. (2) can be rewritten as:

$$P_{ij} = Pr\big[\big(\beta x_{ij} + \varepsilon_{ij}\big) > \big(\beta x_{il} + \varepsilon_{il}\big)\big] = Pr\big[\big(\beta x_{ij} - \beta x_{il}\big) + \big(\varepsilon_{ij} - \varepsilon_{il}\big) > 0\big]\,\text{for each}\,j \neq l. \tag{4}$$

In accordance with the distribution of the error term, a specific probabilistic choice model can be used. Multinomial Logit (MNL) models are generally used in choice model applications (McFadden & Train, 2000). An MNL model assumes that the error term is independent and identically distributed (IID) across alternatives and individuals (McFadden & Train, 2000).

3.2 D-efficient design application

Experimental design theory is based on two common objectives: the ability to independently detect the effects of multiple variables on some observable outcomes and the improvement of the statistical efficiency of the experiment (Viney et al., 2005). The use of logit models to analyse discrete choice data requires a prior information about parameter estimates (Hensher et al., 2015). This information is required in the form of priors to compute the expected utilities for each alternative in order to obtain the asymptotic variance–covariance (AVC) matrix which minimizes the error. The most common measure of design efficiency is the D-error that takes into account the

determinant of the AVC matrix assuming a single respondent. The design with the lowest *D-error* is named *D-optimal* (Bliemer & Rose, 2005; Ferrini & Scarpa, 2007). Nonetheless, a design with sufficiently low *D-error* (i.e., D-efficient design), can also be defined (Bliemer & Rose, 2005; Kanninen, 2002).

3.3 The use of honesty treatment to overcome the hypothetical bias

Louviere et al. (2010) show several reasons in support of CEs (or in general stated preference methods). These include the introduction and/or removal of products and services or new attributes and shifts in technological and innovative frontiers. In contrast, the main limitation of CEs is the well-known hypothetical bias. De-Magistris et al. (2013, p. 1) define the hypothetical bias as: "*the difference between values obtained through hypothetical methods and the values (or what an individual might actually pay for the prevision of the good) obtained through non-hypothetical methods*".

Recent literature purposes various ex-ante calibration methods to apply in hypothetical experiments to mitigate the hypothetical bias. One of these is the honesty priming (Jacquemet et al., 2011), which is an approach derived from Psychology (Bargh, 1990; Chen & Bargh, 1997; Bargh & Ferguson, 2000) and is based on the automatic activation of mental representation (i.e. honesty) that involve reflexive responses to certain triggering conditions. Automatic thought processes are detected from a stimulus event or object (also named triggering event) for the individual sensory system. Triggering event does not require individual's awareness, instead priming can unconsciously influence peoples' perception, evaluations, behaviour, and choice (Chartrand et al., 2008; Kay & Ross, 2003). Therefore, the use of priming techniques activates the concept of cooperation in a social dilemma game by increasing contribution levels (Drouvelis et al., 2010). In particular, the following two hypotheses are tested in the present study.

Hypothesis #1: The first hypothesis is defined as follows:

H01: (MNLHHP–MNLHB)=0, and

H11: (MNLHHP–MNLHB)<0

Where MNL is the MNL model estimates, HHP denotes the hypothetical CE with honesty priming and HB denotes the hypothetical baseline CE.

If H01 is rejected, the honesty priming in the hypothetical CE would reduce hypothetical bias because MNL estimates with honesty priming would be more consistent than in the standard baseline hypothetical CE.

Also, If H01 is rejected, the honesty priming task could have some effects on hypothetical WTP values. To test this assumption,

Hypothesis #2, is defined as follows:

H02: (WTPHHP–WTPHB)=0, and

H12: (WTPHHP–WTPHB)<0.

Other hypothetical bias measures are not considered due to their limited consensus in the renewable energy field (Brummett et al., 2007; Lusk et al., 2003).

4 The survey

The survey was carried out before the occurrence of the pandemic event. It is structured in three sections: The first one comprises socio-demographic information of respondents; the second one includes the Honesty Treatment to check for hypothetical bias; the last section describes the CE in which the interviewee indicates his/her preferred choice among three alternatives (including the status-quo). After a brief introduction, the survey starts with a section where the Honesty Treatment version used in De-Magistris et al. (2013) is proposed. Before completing their choices, respondents are asked to develop a series of 10 grammatically corrected sentences. The choices are then used as ex-ante calibration in the same spirit as the honesty pledge, for eliciting honest answers and mitigate hypothetical bias during choice experiments.

Figure 1 shows the honesty treatment section included in the survey.

Before proceeding with the expression of their preferences, respondents are provided with a brief explanation of the choice procedure including a description of the alternatives and their attribute levels.

Five choice sets for each block are presented. Each choice set comprises three alternatives including the coal power plant (the status-quo) and two alternatives of wind energy plants. Therefore, each respondent is asked to make a total of five choices. In addition, for each choice set they are asked to order their choices, from the first to the third order of preference. Figure 2 shows an example of the choice set.

The survey is distributed to randomly chosen consumers through face-to-face (i.e. CAPI—Computer Assisted Personal Interviewing) interviews. It reaches a total sample of 266 interviews collected among citizens in Apulia region, with a response rate of 89.87% (=239 interviews). Block 1 comprises a total of 114 responses, while block 2 contains 125 responses (see next section for an explanation of the blocking technique). Table 8 summarizes useful socio-demographic information of the sample.

4.1 The construction of the CE

The construction of the choice sets consists of the identification of relevant attributes affecting people's choice. In line with current literature previously mentioned, and preliminary studies using focus groups at regional level (Caporale et al., 2020), attributes and attributes' levels are considered in the experiment. Synthetic descriptions of selected attributes as provided in the study of Caporale et al. (2020) are as follows:

– *Aesthetical impact*. This attribute is based on a visualization method (i.e. 3D pictures) widely applied to surveys and CEs (Al-Kodmany, 1999; Davies et al., 2002; Guilfoos et al. 2023; Newell & Canessa, 2018; Shr et al., 2019). The latter reduces asymmetric information (Bateman et al., 2009, Matthews et al., 2017) and hypothetical bias (Fang et al., 2021). The 'Aesthetical impact' attribute presents four levels. The first one is represented by a picture of the coal power plant sited in Brindisi, in the south of Italy (the status-quo). The Brindisi

Fig. 1 Honesty treatment section of the survey

power plant is ranked second in Italy in terms of extension and electricity production, and first at national level in terms of the damage costs caused by CO_2 emissions (European Environment Agency, 2020). The second, third and fourth picture consider a wind farm varying in terms of its spatial distribution across the territory.

– *Energy production*. This attribute has four levels. The first one is the status quo, while the remaining levels refer to wind energy. As for the coal plant, energy production is computed in relation to the plant energy capacity and annual energy consumption per person. As for wind energy, the computation of energy production per person is based on single turbines between 1 and 3 MW. The proxy for each level considers the energy produced per number of persons.

STUDY ON WHAT YOU THINK ABOUT WIND FARMS IN THE APULIA REGION

SCENARIO 1

Consider being able to express your opinion on the installation of a wind farm or a coal plant in your municipality.

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Energy production	5,000 persons	3,400,000 persons	1,700 persons
CO2	750 g/kWh saved	800 g/kWh emitted	750 g/kWh saved
Avifaunal death	0,65 per turbine (=0.0003 per MWh)	20,700 per plant (=5,180 per MWh)	44 per turbine (=0.012 per MWh)
Costs	0.02 €/kWh	0.02 €/kWh	0.06 €/kWh
Bill savings	180€ year/pp	none	3,560€ year/pp
Dismantling	yes	no	no
Information	none	partial	complete

Order the alternatives you see in the image from 1st (best) to 3rd (worst) place, according to your preference

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
1st place	○	○	○
2nd place	○	○	○
3rd place	○	○	○

Fig. 2 Choice set in the CE section of the survey

- CO_2. This attribute considers four levels. The status quo refers to the amount of CO_2 emissions. In the alternative case of wind energy, it is represented by the amount of CO_2 savings per gr/kW/h.
- *Avifaunal impact*. This attribute considers four levels and is represented by the amount of birds killed per turbine (for each wind energy scenario) and per plant (for the status-quo).
- *Costs*. This attribute has four levels, each considered as proxy levels for plant operation and maintenance and the unit value is given by Euros/kWh.

Table 1 Attributes and attribute levels

Attributes	Coal power plant (status-quo) level	Wind farms levels
Aesthetical impact		
Energy production	For 3,400,000 persons	For 1,700; 3,400; 5,000 persons
CO_2 savings	800 g/kWh	500; 750; 1000 g/kWh
Avifaunal impact	20,700 per MWh	0.0003; 0.005; 0.012 per MWh
Costs	0.02 € per kWh	0.02; 0.04; 0.06 € per kWh
Bill savings	0 €	180; 1900; 3560 € per year
Dismantling	Yes	No
Information	Partial	None; partial; full

Source: Our elaborations based on current literature

- *Bill savings*. This attribute presents four levels, each of which considers savings in the energy bill and the unit value is given by Euros spent per year.
- *Dismantling*. This attribute has two levels. 0=no dismantling; 1=dismantling.
- *Information*. This attribute has one level for the status-quo (i.e. partial) and three levels (i.e. none, partial and full) for the wind energy alternatives.

Table 1 summarises the attributes and their relevant levels.

To implement a D-error experimental design, the following steps are considered: (1) Carry out an early pilot study with an Orthogonal Design; (2) Retrieve the priors of the utility function from the obtained results of the pilot study; (3) Implement a D-error experimental design; (4) Setting up and distribute the final survey; (5) Model estimation.

Given that no information is available on the priors, these should be estimated. This initial step is performed with the use of NGENE v.1.2 software (Choice Metrics, 2018). Considering the number of parameters, the software needs to estimate (i.e., 9 parameters) a minimum number of 18 rows (i.e. choice sets) to obtain an Optimal Orthogonal Design. However, 18 choice sets appear a large number of sets to submit to respondents and missing responses may arise. To avoid this, a *blocking* technique is employed. The obtained two blocks of nine choice sets each seems an adequate number that can be handled by respondents.

From the estimated results of the MNL logit, the attributes are statistically significant at 99% and 95% within the confidence interval (CI) and present the correct sign. Therefore, their estimated coefficients can be used as priors for the computations of the D-error experimental design.

The efficient design (i.e. D-error experimental design) is computed considering the following utility functions with priors taken by the above pilot study:

$$U(\text{coal}) = \beta_{\text{coal}}(-0.91); \tag{5}$$

$$
\begin{aligned}
U(\text{wind1}) = \beta_{\text{wind}} &+ \beta_1(-0.09) * \text{aesthetical\_impact } [0, 1, 2] + \beta_2(0.46) \\
&* \text{energy\_production } [1700, 3400, 5000] + \beta_3(0.24) * CO_2 \, [500, \ 750, \ 1000] \\
&+ \beta_4(-0.26) * \text{avifaunal\_death}[0.003, 0.005, 0.012] + \beta_5(-0.13) \\
&* \text{costs } [0.02, \ 0.04, \ 0.06] + \beta_6(0.44) * \text{bill\_savings}[180, \ 1900, \ 3560] \\
&+ \beta_7(0.25) * \text{dismantling } [0, 1] + \beta_8(0.21) * \text{information } [0, 1, 2];
\end{aligned}
\tag{6}
$$

$$
\begin{aligned}
U(\text{wind2}) = \beta_1 &* \text{aesthetical\_impact } + \ \beta_2 * \text{energy\_production } + \ \beta_3 \\
&* CO_2 + \ \beta_4 * \text{avifaunal\_death } + \ \beta_5 * \text{costs } + \ \beta_6 * \text{bill\_savings} \\
&+ \beta_7 * \text{dismantling } + \ \beta_8 * \text{information}.
\end{aligned}
\tag{7}
$$

Table 2 provides the results of the Efficient Design with the lowest D-error (0.21) and a minimum of 10 choice sets, split in two blocks.

Table 2 Efficient design estimation (D-error)

MNL efficiency measures									

D error									0.21
A error									0.27
B estimate									16.12

Prior	Aesthetical Impact	Energy production	CO_2	Avifaunal impact	Costs	Bill savings	Dismantling	Information	
Fixed prior value	−0.09	0.46	0.24	−0.26	−0.13	0.44	0.25	0.21	
Sp estimates	83.96	5.22	15.88	12.52	41.27	5.94	32.09	18.09	
Sp t-ratios	0.21	0.86	0.49	0.55	0.30	0.80	0.35	0.46	

Design

Choice sets	Alt	Aesthetical Impact	Energy production	CO_2	Avifaunal impact	Costs	Bill savings	Dismantling	Information	Block
1	1	Img.3	5000	500	0.012	0.02	1900	No	Complete	2
	2	Img.1	1700	1000	0.0003	0.06	1900	Yes	None	2
2	1	Img.1	5000	1000	0.005	0.06	180	No	None	2
	2	Img.3	1700	500	0.0003	0.02	3560	Yes	Partial	2
3	1	Img.2	5000	750	0.0003	0.02	180	Yes	None	1
	2	Img.2	1700	750	0.012	0.06	3560	No	Complete	1
4	1	Img.1	3400	500	0.005	0.06	1900	Yes	Complete	1
	2	Img.3	1700	1000	0.005	0.02	1900	No	None	1
5	1	Img.1	1700	1000	0.012	0.02	1900	Yes	Partial	1
	2	Img.3	5000	500	0.0003	0.06	180	No	Partial	1
6	1	Img.2	3400	1000	0.0003	0.04	3560	No	Partial	1
	2	Img.1	3400	500	0.005	0.02	180	Yes	None	1
7	1	Img.3	1700	750	0.0003	0.04	180	Yes	Complete	2
	2	Img.1	5000	500	0.012	0.04	3560	No	None	2
8	1	Img.3	3400	750	0.012	0.06	3560	Yes	None	2
	2	Img.1	3400	750	0.0003	0.02	180	No	Complete	2
9	1	Img.2	1700	500	0.005	0.04	180	No	Partial	1
	2	Img.2	5000	750	0.005	0.04	1900	Yes	Partial	1
10	1	Img.1	1700	500	0.0003	0.02	3560	No	None	2
	2	Img.2	3400	1000	0.012	0.04	180	Yes	Complete	2

Source: Our elaborations

Sample estimates (i.e. S-estimate in Table 2) suggests the optimal number of observations ($n=84$) needed for each block. The above obtained experimental design was included in the final survey.

5 Results

Each choice set includes three alternatives: the *status-quo* and two alternatives of wind energy as described in Table 2. Respondents are asked to order their choices from the first to the third order of preference the proposed alternatives within each choice set. Two behavioural information can be obtained by this choice process: i. The preference between coal power plant and wind energy; ii. The preference between two different wind energy scenarios based on their spatial distribution (more *vs* less densely distributed turbines).

In relation to the above, two databases are computed, one for each behavioural information.

5.1 Fossil vs wind energy: logit regression

The total sample considering this behavioural mechanism is retrieved from the responses obtained in the choice sets of blocks 1 and 2 of the survey and comprises 4780 observations. More than 70% responses are in favour of a wind energy scenario, compared to just about 30% responses for fossil fuels (i.e. the status-quo). To model fossil vs wind energy behaviour, we use a Logit model as shown in Table 3.

The estimated coefficients are statistically significant at 99% CI and 95% CI except for *Energy production*, *Avifaunal impact*, and *Dismantling* attributes. Looking at the sign of the coefficients, it emerges that a positive sign increases the probability to prefer

Table 3 Binary logit model estimates of 'coal' *vs* 'wind' choices

Variable	Coefficient	*p*-Value	St. error
Aesthetical impact	0.13***	0.01	0.06
Energy production	−0.010	0.83	0.05
CO_2	0.13***	0.01	0.05
Avifaunal impact	0.04	0.38	0.05
Costs	0.15***	0.00	0.05
Bill savings	0.12**	0.01	0.05
Dismantling	−0.05	0.61	0.09
Information	−0.11**	0.03	0.05
Log-Likelihood	−3092.18	0.00	
Obs	4780		

Source: Our elaborations

***Statistically significant at 99% CI level

**Statistically significant at 95% CI level

*Statistically significant at 90% CI level

wind energy *vs* fossil fuels. As for the positive sign of *Aesthetical impact*, it implies a positive preference towards a landscape with wind farms. A similar consideration can be drawn for CO_2, *Bill savings* and *Costs* attributes. The above estimated positive aspects of wind energy would induce to consider coal power as a minor energy source to satisfy consumer needs.

The computation of the marginal rate of substitution (MRS) between *Aesthetical impact* and *Costs* provides an indication of the WTP for wind energy. In this context, Scarpa and Rose (2008) show that the unit WTP for an attribute can be derived as a function of the coefficient attributes:

$$WTP_K = \frac{\beta_k}{-\beta_{\text{cost}}} \tag{8}$$

By applying Eq. (8) to the estimated coefficients of *Aesthetical Impact* and *Cost*, the trade-off between these two attributes is obtained as follows:

$$WTP_{aesthetical\_impact} = \frac{\beta_{aesthetical\_impact}}{-\beta_{costs}} = \frac{0.13}{-0.15} = -0.87 \tag{9}$$

Equation (9) shows that a change of landscape from a coal power plant to a landscape with a wind energy farm would imply a reduction of about a unit cost. It means that consumers are willing to pay about 0.90 units more to have a wind energy installation, rather than a coal power plant.

5.2 Wind energy alternatives: multinomial logit regression

Given the results obtained from the previous section, the present subsection deals with the behavioural analysis of wind energy alternatives. The total sample considering this behavioural mechanism is retrieved from the responses obtained in the choice

Table 4 Multinomial logit model estimates of wind energy alternatives

Variable	Coefficient	*p*-Value	St. error
Aesthetical impact	0.18***	0.00	0.04
Energy production	0.13***	0.00	0.04
CO_2 (savings)	0.34***	0.00	0.04
Avifaunal impact	0.15***	0.00	0.04
Costs	0.36***	0.00	0.04
Bill savings	0.27***	0.00	0.05
Dismantling	0.11	0.10	0.07
Information	−0.01	0.78	0.04
Log-likelihood	−742.48	0.00	
Obs	1195		

Source: Our elaborations

***Statistically significant at 99% CI level

**Statistically significant at 95% CI level

*Statistically significant at 90% CI level

sets of blocks 1 and 2 of the survey and comprises of 1195 observations. Table 4 shows the estimates of the MNL model.

The estimated coefficients are statistically significant at 99% CI, except for *Dismantling* and *Information* attributes. The sign of coefficients suggests that respondents prefer wind farm alternatives more densely distributed, producing more energy, and with CO_2 savings. Considering the *Avifaunal impact*, the number of birds killed seems to be acceptable by respondents. A similar argument can be drawn for the sign of the estimated *Costs* coefficient. Finally, *Bill savings* are also considered adequate to the wind farm scenario under consideration.

5.3 HT use vs non-HT use: empirical analysis and results

The present subsection deals with the analysis of results obtained to mitigate hypothetical bias in CEs. The survey has been constructed with an Honesty Treatment section randomly submitted to respondents.

Table 9 reports the socio-demographic characteristics of the participants in the two treatments.

A chi-squared Person's test was performed to determine differences in socio-demographic profiles across treatments. The result of this test suggests that the null hypothesis of equality between socio-demographic characteristics across hypothetical honesty treatment samples is accepted at 95% significance level for gender, age, employment, and income. Therefore, it suggests that randomization is successful across the two hypothetical honesty treatments.

Table 5 Estimates of binary logit regression and MNL logit regression

Variable	Coal vs Wind power plan		Wind energy alternatives	
	Binary Logit regression		MNL logit regression	
	HB	HHP	HB	HHP
Aesthetical impact	0.09 (0.24)	0.15* (0.07)	0.15*** (0.00)	0.20*** (0.00)
Energy production	0.00 (0.96)	−0.01 (0.92)	0.11* (0.06)	0.18** (0.01)
CO_2	0.23*** (0.00)	0.03 (0.63)	0.34 (0.00)	0.37*** (0.00)
Avifaunal impact	0.08 (0.27)	0.02** (0.73)	0.10* (0.07)	0.21*** (0.00)
Costs	0.13* (0.06)	0.14* (0.08)	0.31*** (0.00)	0.40*** (0.00)
Bill savings	0.10 (0.13)	0.14** (0.03)	0.21*** (0.00)	0.36*** (0.00)
Dismantling	−0.13 (0.29)	0.05 (0.72)	0.07 (0.45)	0.15 (0.14)
Information	−0.16** (0.03)	−0.04*** (0.56)	−0.05 (0.40)	0.03 (0.64)
Log-likelihood	−1588.20 (0.00)	−1500.99 (0.00)	−384.12 (0.00)	−355.64 (0.00)
Obs	2460	2320	615	580

Source: Our elaborations

***Statistically significant at 99% C.I level

**Statistically significant at 95% C.I. level

*Statistically significant at 90% C.I. level. p-value in parenthesis

Table 6 Hypothesis tests of equality across Hypothetical and non-hypothetical treatments

Hypothesis tests of equality	Obs	Binary logit regression		MNL logit regression	
		Log-likelihood	*p*-Value	Log-likelihood	*p*-Value
Coal vs wind choice					
All treatments	4780	−3092.18			
Hypothetical baseline CE (HB)	2460	−1588.20			
Hypothetical CE with honesty priming (HHP)	2320	−1500.99			
$H0_{1coal}$ = Test of equality across hypothetical treatments		0.01	0.92		
Wind energy alternatives					
All treatments	1195			−742.47	
Hypothetical baseline CE (HB)	615			−384.12	
Hypothetical CE with honesty priming (HHP)	580			−355.64	
$H0_{1wind}$ = Test of equality across hypothetical treatments				0.05	0.83

Source: Our elaborations

***Statistically significant at 99% C.I level

**Statistically significant at 95% C.I. level

*Statistically significant at 90% C.I. level. p-value in parenthesis

Table 7 Marginal WTP values and hypothesis tests across hypothetical and non-hypothetical treatments

Hypothesis tests	Binary logit regression	MNL logit regression
	βAesthetical_impact/βCosts	βAesthetical_impact/βCosts
Coal vs wind choice		
WTP^{HHP}	−1.09	–
WTP^{HB}	−0.69	–
HO_{2coal} ($WTP^{HHP} - WTP^{HB}$) = 0	−1.78	–
Wind energy alternatives		
WTP^{HHP}	–	−0.50
WTP^{HB}	–	−0.48
HO_{2wind} ($WTP^{HHP} - WTP^{HB}$) = 0	–	−0.98

Source: Our elaborations

An MNL regression is estimated for each of the two hypothetical honesty treatments considering the two types of choice: i. coal power plant *vs* wind energy; and ii. wind energy alternatives. Table 5 summarizes the MNL model estimates.

Differences arise between the two hypothetical honesty treatment regression estimates (Table 5).

The likelihood ratio (LR) test for the joint equality between the two hypothetical honesty treatment estimates is implemented. Table 6 reports the results of the estimated Log-likelihood as well as the LR tests for the coal *vs* wind energy choice.

The obtained results indicate that the joint null hypothesis of equality between hypothetical and non-hypothetical treatments (LR = 0.01 p-value = 0.92 and LR = 0.05 p-value = 0.83) is accepted.

In terms of estimated Log-Likelihood values, hypothetical CEs with honesty priming (−1500.99 and −355.64) converge at a better fit than hypothetical CEs without honesty priming (−1588.20 and −384.12), respectively.

Table 7 illustrates the obtained results from testing hypothesis #2 across WTPs computed according to Eq. (14).

The results of WTP hypothesis tests indicate that the null hypothesis H02 is rejected, suggesting that the WTP is generally affected by the honesty priming task in hypothetical CEs.

6 Discussion

The investigated case study supports a series of interesting results in terms of wind energy perception and people's attitudes for wind energy technology, but also in terms of CEs application.

First, the use of the D-error in the experimental design significantly reduces the error other than the sample size during the survey analysis. This result also appears in other studies on the same topic (Gracia et al., 2012; Karlõševa et al., 2016; Mariel et al., 2021; Scarpa & Willis, 2010).

Second, hypothetical choice experiments with honesty priming tasks can mitigate the hypothetical bias arising in CEs and this result is aligned to the best practice recommended by the literature (De-Magistris et al., 2013; Jacquemet et al., 2011; Johnston et al., 2017).

Third, the case study highlights that the drivers of public preferences for wind energy are cleanliness of the energy and acceptability of costs (i.e. maintenance and operational). Different studies (İlkiliç, 2012; McKenna et al., 2020; Rehman, 2004; Tague, 2022) also suggest similar findings.

Slattery et al. (2012) investigates public perceptions of wind energy in two of the most important US states for wind development (Texas and Iowa) and finds that 82% of respondents indicated that wind energy is a clean source of energy production, as well as safe for 86% of respondents. Similarly, Swofford and Slattery (2010) consider the general wind energy attitudes and find evidence of the cleanliness and safety perception of wind energy source.

Our results imply a positive preference towards a landscape with wind farms. This means that the inclusion in the choice set of a real alternative (as is the case of the Brindisi power plant) to wind energy would guide towards a positive attitude for the adoption of the new technology.

All aspects considered in the CE seem to affect a general perception of wind energy, with the exception of information and dismantling issues, which are

factors emerged during the focus groups analysis (Caporale et al., 2020). A mismatch between hypothetical and real-world applications of wind energy emerges. For this reason, a certain degree of underestimated information arises. This aspect agrees with the deficit-information model by Bidwell (2016) which is a conventional perspective on public attitudes and behaviour explaining the change of public views as a result of the provision of information. In contrast, the study by Fast and Mabee (2015) criticizes the deficit model demonstrating that the correlation between knowledge and attitudes is less than perfect.

Similarly, the obtained results also reveal that the dismantling issue and avifaunal impact are considered as minor aspects. This may be explained by the relatively low bird mortality in the area under study, compared to coal power plants. Some studies considering avifaunal impact and estimating collision mortality (Choi et al., 2020; Deb et al., 2020; Loss et al., 2013), highlight the existence of different avifaunal collision rates according to the turbine hub height and the location of the wind facility siting. On the other hand, wind energy kills 13 times fewer birds per kilowatt-hour of electricity generated in comparison to fossil fuel plants (Sovacool, 2013) and the number of birds collisions is much lower than the collisions with some other anthropogenic sources (i.e., windows, towers, vehicles, etc.) (Zimmerling et al., 2013). We argue that an in-depth territorial analysis should be carried out to assess the collision risk of the wind plant prior to its installation.

7 Conclusion and policy implications

Wind energy is generally considered a cleaner alternative to conventional energy sources. However, local residents generally present an obstructive behavior for wind farm developments close by where they live. In order to turn negative feelings into positive perceptions, all issues argued in the present work should be considered during the design and development phases of a wind farm. A positive perception of local residents may be encouraged by promoting community participation and information initiatives. Linked to this aspect is also the education to renewables development, as argued also by Marra and Colantonio (2021), that represents a support with positive cross-cutting effects on different drivers.

The use of CEs was the core of the present study. However, preference analysis and price estimation of attributes may present more complexity. CEs application presents a series of advantages, such as the possibility of product disaggregation into different value attributes; avoiding part-whole bias issues; inclusion of monetary measure as implicit element; modelling non-collinear attributes; modelling a large number of parameters estimation using D-efficient Design; stimulus control subject to respondents; evaluation of marginal variations in hypothetical multi-dimensional scenarios and an implementation of a multi-dimensional, multi-attribute and multi-value scenarios survey.

The investigation of wind energy preferences is restricted to the analysis of hypothetical market. As a consequence, the complexity of a well-defined market limits the alternatives offered in the choice sets as well as the investigation to set a well-defined market could be expensive and time-consuming, particularly for the survey design,

management, and data collection. Due to these difficulties, an ex-ante calibration method, as the one performed in the present work, is a good solution to mitigate the hypothetical bias.

The main findings suggest that the potential risks linked to the perception of wind energy affect social acceptance, but seem less relevant than the risks attributed to fossil fuels. Also, compared to environmental and aesthetical impacts, socio-economic benefits significantly affect wind choice behaviours. People would seem risk-takers for wind energy innovations, and this could favour the social acceptance of wind energy.

7.1 Policy implications

Wind energy is the most advanced technology providing green electricity in several EU member states, including Italy (International Energy Agency, 2023). To achieve renewable targets, governments need to get full information on social preferences in order to implement adequate and efficient policy instruments.

The obtained results of the present work reveal a controversy about public acceptance of wind energy. In general, wind energy is preferred to fossil fuels because of a relevant perception of current energy market risks. At the same time, there exists a common perception about issues and benefits of wind energy.

Aesthetical impact of wind farms appears as a minor factor compared to other issues proposed in the present study. Therefore, it contrasts most of the literature (Strazzera et al., 2012; Sunak & Madlener, 2016). In addition, local communities would care most about economic aspects and technological efficiency of wind farms rather than other aspects; and strive to achieve more information about social benefits. This result is also supported by recent evidence (Adeyeye et al., 2020; Lisiak et al., 2020; Purkus et al., 2018). The adoption of turbines of modern technology could address or re-address current functional efficiency and reduce wind energy risks. It is shown that the higher is people's perception of turbines' aspect (i.e. colour and dimension), maintenance and implementation impacts, profit and disinformation, the higher appears the importance of location. This result may suggest a major awareness from people living nearby a wind farm to attributes that are strictly linked to the territory and the interest of citizens.

The assessment of functional efficiency and wind farm location is a primary issue in order to preserve the identity of a territory and promote innovation and sustainable initiatives to local communities. Of course, the main focus of wind energy policy should be targeted to investments in new capacity, despite it suggests a 'productivist' view of energy policy purpose (Rodgers et al., 2019). This aspect drives the promotion of technological progress, reductions of costs and energy prices, and thus social acceptance. Haas et al. (2004) and Lauber (2004) argue that an energy policy mix should evolve parallel to technological developments and reduction of production costs. This aspect would suggest a first policy indication.

Policy Implication 1: In order to support the adoption of more efficient turbines employing the latest technology, a simplification of the bureaucracy is advised in terms of current approval procedures and time for the implementation of a wind project.

An interesting aspect emerging from the case study is the assessment of social acceptance of wind energy in terms of willingness to accept social costs. In particular, the costs attributed to maintenance, implementation and dismantling seem significantly less important compared to profits. This means that users are willing to accept such costs if they could rely on an adequate economic incentive. In addition, CE results highlight that public preferences for wind energy is due because this renewable source is perceived clean, and with acceptable costs. This aspect suggests the following second policy indication.

Policy Implication 2: An energy cost reduction scheme should be provided for those municipalities hosting a wind farm. This reduction scheme could be proportional to the amount of wind energy consumption used to replace fossil fuel energy use. This would create a direct economic benefit for citizens providing further positive effects to the local community (Balash et al., 2013; Gonyo et al., 2021). Also, an adoption of 'advanced renewable tariffs' offering stepped and digressive rates for a specific location, and compensating measures for wind regimes and technological improvements of turbines should be taken into account. Some examples of 'advanced renewable tariffs' are adopted in Germany, France and Spain (Chabot, 2013). These measures set tariffs at levels that are fair and efficient overcoming excessive prices and undue profits.

A high level of misinformation emerged from all studies undermining public opinion with negative perceptions of wind energy projects. Similarly, the lack of information contributes to a critical attitude of consumers judging the effectiveness of wind power, which, in several cases, leads to an obstructive behaviour of the public. Mistrust for policy makers and stakeholders is an issue widely argued in the literature (Caporale & De Lucia, 2015; Caporale et al., 2020; Cohen, 2014; Enevoldsen, 2016). This aspect seems to arise doubts of fairness, honesty and self-interest and contributes to a negative public perception of wind energy, as also discussed by Stigka et al. (2014), Enevoldsen and Sovacool (2016) and Liebe and Dobers (2020).

Policy analysis of 'innovation systems' could be useful to identify an optimal policy approach in relation to different requirements due to market innovation stages (Foxon et al., 2005). Aspeteg and Bergek (2020) explain the success of the German and UK wind energy policy by purposing a combination of their four-strand approach. This approach emphasises tailored policies according to the stages of the wind technology adoption. It is worth noting, though, that only mature stages encourage social legitimacy of wind energy. Based on this aspect, a third policy indication could be suggested.

Policy Indication 3: Citizens' participation and dissemination of information among the public could re-address bottom-up knowledge towards wind farms. To overcome the NIMBY (Not In My Backyard) phenomenon, the local community should be adequately informed about the social costs and benefits related to the wind energy projects that the decision maker and investors plan to implement on the territory.

The case study revealed that CO_2 savings can be considered an important attribute compared to other aspects. Instead, avifaunal impact would not seem to negatively influence wind perception as expected. This aspect contrasts the current literature arguing on perceived risks in the ecosystem (Dai et al., 2015; Masden & Cook,

2016). It emerges that a lack of information and regulation on 'who has the right' to invoke the dismantling of turbines heavily affect public acceptance of wind energy. However, dismantling issues becomes a secondary aspect in CE. Protest groups against wind energy usually contrast the view that wind energy entails economic, social and environmental costs. While the attention of policy makers seems shifted to internalise economic costs, other costs, such as environmental and social costs, have received less attention. Based on the above considerations, a fourth policy indication can be addressed:

Policy Indication 4: Awareness of people to environmental issues should be carefully addressed. First, communities should be aware on major benefits of wind energy (as well as other renewable sources) in terms of pollution reduction and improved environmental quality; second, communities should be aware about current procedures for restoring local ecosystems during the building stage of wind farms, as well as procedures for recycling and/or upgrading turbines; and third, the enhancement of community acceptance and proactive community participation on the portfolio of renewable energy sources at local as well as national level are key element for future developments of wind energy market in the EU.

7.2 Limitations and future perspectives

The present work underscores the importance of addressing various issues when planning and developing wind farms to foster positive perceptions among local residents, who often exhibit resistance to projects in proximity to their homes. Encouraging community participation and providing comprehensive information initiatives can be instrumental in converting negative sentiments into positive perceptions, as suggested by Dai et al. (2015).

Furthermore, the adoption of advanced technology and modern wind turbines can enhance functional efficiency and environmental sustainability, especially with the support of effective governmental strategies and local planning.

The assumptions in the existing literature are substantiated by an investigation of Stated Preference in the region of Puglia, which is a representative area for national wind energy production. It is recommended that future research delve into wind energy perception in areas with limited wind power plant presence. Conducting a cross-country comparative analysis between regions with low and high diffusion of wind power plants can help address the NIMBY phenomenon and its impact on public acceptance.

Lastly, expanding the scope of this work to include the public acceptance to other renewable sources, such as solar panels, as also suggested by other studies (Rand & Hoen, 2017) and delving into latent issues that arise in perception studies would assist policymakers in formulating effective energy policy mix for a more sustainable and environmentally friendly future.

Appendix

See Tables 8 and 9.

Table 8 Socio-demographic information of the sample

Variable	Obs	Freq	Percentage	Mean	SD
Sex	239				1.54
Male		109	46		
Female		130	54		
Age	239			2.32	1.11
18–25		56	23		
26–35		103	43		
36–50		42	18		
51–65		24	10		
> 65		14	6		
Province of residence	239				1.63
Bari		149	62		
Barletta-Andria-Trani		14	6		
Brindisi		2	1		
Foggia		53	22		
Lecce		9	4		
Taranto		12	5		
Education	239				3.73
Elementary school degree		5	2		
Junior high school degree		2	1		
High school degree		78	33		
Bachelor's degree		128	54		
Post-graduate degree		24	10		
Other		2	1		
Employment	239				4.41
Director		3	1		
Entrepreneur		4	2		
Self-employed		41	17		
Employee		81	34		
Student		81	34		
Retired		13	5		
Unemployed		16	7		
Other					
Income	239			2.59	1.42
Up to 16,000€		71	30		
16,001-28,000€		59	25		
28,001–40,000€		42	18		
40,001–52,000€		30	12		
> 52,000€		37	15		

Source: Our elaborations

Table 9 Socio-demographic characteristics, HB and HHP percentages

Variable	Obs	Hypothetical baseline	Hypothetical honesty priming
Sex	239	123[a]	116[a]
Male		44	47
Female		56	53
Age	239	123[a]	116[a]
18–25		27	20
26–35		45	41
36–50		15	21
51–65		6	15
> 65		7	4
Province of residence	239	123[a]	116[a]
Bari		67	58
Barletta-Andria-Trani		4	8
Brindisi		2	0
Foggia		14	31
Lecce		7	0
Taranto		6	3
Education	239	123[a]	116[a]
Elementary school degree		4	0
Junior high school degree		2	0
High school degree		14	41
Bachelor's degree		59	47
Post-graduate degree		10	1
Other		1	0
Employment	239	123[a]	116[a]
Director		2	1
Entrepreneur		2	2
Self-employed		15	19
Employee		30	38
Student		36	31
Retired		7	3
Unemployed		7	
Income	239	123[a]	116[a]
Up to 16,000€		32	27
16,001-28,000€		23	27
28,001–40,000€		19	16
40,001–52,000€		10	16
> 52,000€		16	15

Source: Our elaborations

[a]Number of observations

Data availability Data may be available upon request.

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