Valuing public acceptance for on-shore wind energy: A choice experiment approach

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Valuing public acceptance for on-shore wind energy: A choice experiment approach

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The present Thesis highlights two views in relation to wind energy.

On the one hand, wind energy is considered as a positive element increasing the agent's utility against the risks occurring, should fossil fuels be exhausted in the next future. Main risks include energy supply due to resource exploitation and depletion; market risks due to energy price volatility; and environmental risk, due to market failures in the management and distribution of public goods.

On the other hand, wind energy is considered as a negative element decreasing the agent's utility due to its impact on the territory and public acceptance.

Over the last 15 years, there has been an increasing scientific debate on public acceptance of wind energy developments. The rise of asymmetries between stakeholders, policy makers and the general public about landscape issues and socio-economic benefits has brought the question of public acceptance of renewable energies to the attention of the international scientific community. The debate, so far, strongly focuses on empirical evidence worldwide and critical assessments to the conceptualization of acceptance, including, for example, economic (markets), regulatory and technological (innovation) aspects.

A particular stream of international scientific evidence is based on the valuation of public or social acceptance as one of the main factors affecting the success of wind energy projects. On the one hand, there is evidence of largely approved benefits such as competitiveness, sustainability, lower energy costs, energy independence. On the other hand, local communities often tend to contrast the development of renewable energies due to the relevant costs suffered by society. For example, the relative aesthetic impacts and impacts on the territory in relation to the spatial localization of wind farm installations can undermine the viability of some projects. Nonetheless, there are still gaps in terms of wind technology perception related to the energy risks of fossil fuels.

In this framework, the present Thesis aims at assessing actors' perception of wind farms and the existing trade-off between energy risks and territorial impact of wind energy production.

To reach the above aims, the present study uses a stated preferences approach expressed in hypothetical markets with particular focus on choice experiments (CEs) analysis. CEs combine the theory of value and the random utility model (RUM) proposed by McFadden. CEs have been recently used to value the impact of renewable energies on households.

In the practical implementation of CEs, the interviewee expresses his/her preference (which gives him/her the highest utility level) among the options obtained in the choice sets. This technique provides a large portfolio of information on attributes and socio-economic variables affecting consumer choice and a better understanding of consumer preferences and alternative scenarios of costs and benefits. Formally, the econometric analysis solves the problem that each individual i maximises his/her utility level associated to an alternative profile j subject to his/her income level.

The case study uses an ad-hoc survey for residents of Apulia region in the south of Italy. According to national statistics, this region can be considered as representative of the national wind energy context. The choice experiment adopted in the case study also considers an efficient design. The approach used in this study to compute the D-error assumes a-priori information from a pilot experiment.

The present Thesis's work provides interesting results in terms of choice behaviour between landscape conservation and two scenarios of landscape transformation.

Main results enables to: i) Evaluate the incidence of energy risks on the perception of wind farms using CEs; ii) Identify social, economic and environmental attitudes for the implementation of a wind project; iii) Analyse the potential trade-off between on-shore wind farms, land conservation and energy risks; iv) Investigate hypothetical bias in CEs; v) Understand the potential relationship occurring between wind energy perception clusters of innovators, assuming this technology as increasingly dominant and innovative in the energy market; vi) Suggest relevant insights from a bottom-up perspective and close the gap with top-down strategies.

Key words: wind energy, public perception, Choice Experiment, energy risks

EXTENDED ABSTRACT (ita)

Il presente lavoro di ricerca mette in evidenza due punti di vista in relazione all'energia eolica considerata come fonte rinnovabile per il fabbisogno energetico attuale e futuro della popolazione.

Da un lato, l'energia eolica aumenterebbe l'utilità dell'agente contro i rischi (energetici) che si verificano, nel caso in cui i combustibili fossili vengano sfruttati nel prossimo futuro. I principali rischi includono l'offerta di energia dovuta allo sfruttamento e all'esaurimento delle risorse; i rischi di mercato dovuti alla volatilità dei prezzi dell'energia; e il rischio ambientale, causata dai fallimenti di una gestione efficiente dei beni pubblici.

D'altra parte, l'energia eolica viene considerata una disutilità in termini di impatto sul territorio e accettazione pubblica.

Negli ultimi 15 anni c'è stato un crescente dibattito scientifico sull'accettazione pubblica degli sviluppi dell'energia eolica. L'aumento delle asimmetrie informative tra stakeholder, politici e pubblico sulle questioni paesaggistiche e sui benefici socio-economici ha portato la questione dell'accettazione pubblica delle energie rinnovabili all'attenzione della comunità scientifica internazionale. Il dibattito, finora, si concentra fortemente su evidenze empiriche in tutto il mondo e valutazioni critiche per la concettualizzazione dell'approvazione, inclusi, ad esempio, aspetti economici (mercati), normativi e tecnologici (innovazione).

Un particolare flusso di prove scientifiche internazionali si basa sulla valutazione dell'accettazione pubblica o sociale come uno dei principali fattori che influenzano il successo dei progetti di energia eolica. Da un lato, vi sono prove evidenti di benefici ampiamente approvati dalla collettività come la competitività, la sostenibilità, i costi energetici più bassi, l'indipendenza energetica. D'altra parte, le comunità locali tendono spesso a contrastare lo sviluppo di energie rinnovabili a causa dei costi rilevanti subiti dalla società. Ad esempio, i relativi impatti estetici e gli impatti sul territorio in relazione alla localizzazione spaziale degli impianti

eolici possono minare la redditività di alcuni progetti. Nonostante ciò, sono ancora persistenti le lacune in termini di percezione della tecnologia eolica in relazione ai rischi energetici dei combustibili fossili.

In questo contesto, il presente progetto di ricerca mira a valutare la percezione da parte degli attori dei parchi eolici e il *trade-off* esistente tra i rischi energetici e l'impatto territoriale della produzione di energia eolica.

Per raggiungere gli obiettivi di cui sopra, il presente studio utilizza un approccio di preferenze dichiarate espresso in mercati ipotetici con particolare attenzione all'analisi dei *Choice Experiments* (CEs). I CEs combinano la teoria del valore e il modello di utilità casuale (RUM) proposto da McFadden. Recentemente i CEs sono stati utilizzati per valutare l'impatto delle energie rinnovabili sulle famiglie.

Nell'implementazione pratica dei CEs, l'intervistato esprime la sua preferenza (che gli fornisce il più alto livello di utilità) tra le opzioni ottenute nelle serie scelte. Questa tecnica fornisce un ampio portafoglio di informazioni su attributi e variabili socio-economiche che influenzano la scelta del consumatore e una migliore comprensione delle preferenze dei consumatori e scenari alternativi di costi e benefici. Formalmente, l'analisi econometrica risolve il problema che ogni individuo i massimizza il suo livello di utilità associato a un profilo di alternativa j soggetto al suo livello di reddito.

Il caso di studio utilizza un sondaggio ad hoc per i cittadini della regione Puglia e considera un modello statisticamente efficiente. L'approccio utilizzato in questo studio per calcolare il *D-error* presuppone un'informazione a priori. Questo è disponibile da un esperimento pilota e da più iterazioni per ottenere il disegno *D-optimal* con il più basso *D-error*.

Il presente lavoro fornisce risultati interessanti in termini di comportamento di scelta tra conservazione del paesaggio e due scenari di trasformazione del paesaggio. In particolare, gli intervistati ordinano le loro preferenze per ciascun gruppo di scelta fornito nel sondaggio.

I risultati principali consentono di: i) valutare l'incidenza del rischio energetico sulla percezione dei parchi eolici utilizzando i *CE*; ii) identificare le attitudini sociali, economiche e ambientali per la realizzazione di un progetto eolico;

iii) analizzare il potenziale *trade-off* tra parchi eolici *on-shore,* conservazione del territorio e rischi energetici; iv) investigare l'efficienza dei metodi per mitigare l'ipotetico pregiudizio nei CE; v) comprendere la percezione dell'energia eolica relativa ai cluster di innovatori, assumendo che questa tecnologia sia sempre più dominante e innovativa nel mercato dell'energia; vi) indicare le intuizioni di *policy* da una percezione bottom-up per colmare il divario con le strategie top-down.

Parole chiave: energia eolica, percezione pubblica, Choice Experiment, rischi energetici

INTRODUCTION

Over 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 member states' dependence on fossil fuel sources and offers sustainable solutions in view to reduce climate change effects.

In literature, the issue of global warming is largely recognised. A high concentration of CO_2, CH_4, CFCs, halons, N_2O, ozone and peroxy-acetylnitrate in the atmosphere traps heat radiated from the Earth's surface and raises the surface temperature (Panwar et al. 2011). Air pollution and warmer climates weakens crop production and alters animal reproductive performance and production, metabolic and health status, and immune response (Nardone et al. 2010). Moreover, the process of desertification reduces the carrying capacity of environment and the adaptability of animal genotype. Similarly, other effects such as sea level rise, decreased precipitation, diseases and severe weather events.

Without further mitigation actions of greenhouse gas (GHG) reduction the heavy impacts on human and natural systems will be potentially irreparable (Lorenzoni et al. 2007).

GHGs increased over the course of the 20^{th} century due to human activities. Recent studies argue that global warming caused by human activities and linked to carbon dioxide is nearly irreversible for more than 1,000 years (Solomon et al. 2009).

Solomon et al. (2010) show that the warming due to non-CO_2 greenhouse gases, although not irreversible, persist notably longer than anthropogenic changes in GHG concentrations. The authors argue that the timing effects of various GHGs are strongly dependent both on the lifetime of the gases and on climate system timescales.

Global warming produces effects that alter the whole ecosystem. Besides the negative effects on health caused by GHG emissions and related pollution, a note should be considered for the impact of extreme weather conditions on infection transmission, alteration of human immune-system and infection response, and outbreak scenarios (Bezirtzoglou et al. 2011).

The European Union (EU) predicted several action plans that focus 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 as follow:

- Sustainable development and equity as basis for assessing climate policies and addressing the risks of climate change;
- Effective mitigation as a collective action problem at the global scale (not individual interests);
- Economic evaluation used to inform climate policy design;
- Climate policy intersection with other social goals;
- Consideration of a diverse array of risks and uncertainty to inform climate policy makers;
- Consideration of public perception of risks and uncertainties to design climate policy.

On this line the weight of scientific evidence points to a significant human contribution towards changing the world's climate.

In order to develop sustainable solutions for climate change, it is essential to enable long-term changes in individual attitudes and lifestyle.

On the one hand, there exists a discrepancy between public awareness and concern about climate change, and, on the other a limited behavioural response is still present (Lorenzoni et al. 2007). The literature highlights that individuals perceive a wide variety of barriers to engage with climate change issues. In particular, Stoll-Kleemann et al. (2001) discuss the psychological barriers of dissonance and denial to behavioural change in light of alternative energy as well as social and institutional barriers.

Lorenzoni et al. (2007) suggest that people recognize their personal, social and/or moral responsibilities to address climate change, but often identify reasons for not taking action. They classify these constraints in individuals and the society in relation to the level of barriers perception. Individual barriers include lack of knowledge, uncertainty and scepticism, distrust in information sources, denial of responsibility and blame, reliance on technology, perception of climate change as a distant threat, importance of other priorities, reluctance to change lifestyles, fatalism, and helplessness.

Social barriers comprise lack of action by governments, business and industry, 'free rider behaviours', pressure of social norms and expectations, and lack of enabling initiatives.

All these aspects drive the perception of climate change and risk arising in current energy markets. Consequently, they produce important effects on action/decision-making behaviour mainly due to lack of knowledge/information and uncertainty.

The literature fails to consider the issues of wind energy perception commensurate with the risks of energy production using fossil sources. Recent studies (Bonar et al. 2015) seems to follow this direction and the present Thesis wishes to contribute to actual research developments.

The present Thesis proposes to investigate public perception of wind energy technology as sustainable alternative in the energy market, weighing up all risks affecting old and new technologies.

A relevant issue of current energy markets is the 'supply risk' which is the possible exhaustion of energy stocks. The 2018 BP Statistical Review of World Energy has estimated that oil reserves are sufficient to meet the global production requirements for 52.9 years; natural gas will satisfy the global production for 55.7 years; and coal reserves are adequate for the needs of 109 years of global production.

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 that unevenness, advantages arise for limited countries that sell resources against the rest of the world, which is heavily dependent on these countries and subject to the risk of external supply disruptions.

Such events would imply serious consequences for the global economy and substantial costs for the entire socio-economic system. Therefore, the energy market should be balanced off by means of substitutability between energy sources with adequate energy policies.

A further risk that influences the market is 'energy costs volatility', blamed of being a heavy burden for the population (Ronchi et al. 2013). Ronchi et al. (2013) argues that Italy has seen its energy bills tripled over the recent 20 years (causing an increase in total costs energy by € 45 billion per year).

Of particular concern are 'environmental risks' and 'health risks'. The combustion of fossil fuels causes pollution and the occurrence of further contamination from poisonous substances. 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. Human health effects can range from nausea and difficulty in breathing or skin irritation, to cancer (Kampa & Castanas 2008). Effects of GHG emissions can affect different organs and systems, as the respiratory, the cardiovascular, the nervous, the urinary and the digestive system.

In order to address the above issues, the European Union has set a target which aims at reducing greenhouse gas emissions by all member countries. In Italy, about 40 per cent of national energy production uses renewable sources (GSE 2016). There exists a well-developed national market of renewable energy and several potential perspectives for future developments.

This is one of the most important challenges worldwide. 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.

In particular, the above targets specify considerable importance to wind power which have seen an increase of the average annual growth by 19% compared to 2015 (GSE 2016).

The implicit consideration of sustainability in energy technologies follows three dimensions such as Ecological sustainability, Economic sustainability, and Social sustainability; plus a fourth dimension focusing on political systems, namely Political sustainability (G. Assefa & Frostell 2007).

In particular, the ecological sustainability targets the preservation of natural capital. The economic sustainability deals with the efficiency of economic systems to ensure a continuous and socially equitable, quantitative, and qualitative progress within society. Social sustainability includes fairness in distribution and opportunity, and adequate provision of social services including health and education, gender equity, and political accountability and participation. Finally, the political sustainability aims to satisfy an overall framework of national and international governance.

Considering the above aspects, what are the potential implications for sustainable development?

Renewable energy and in particular wind energy is capturing increasing attention within the global energy market in view of a further expansion of the sector. Similarly, the social view on wind energy is gaining attention.

Over the last 15 years, there has been an increasing scientific debate on public acceptance of wind energy developments. Nonetheless, there are still gaps in terms of wind energy technology perception in comparison to energy risks caused by the use of fossil fuels.

The research topic of the present Thesis highlights two views in relation to wind energy. On the one hand, wind energy would increase agent's utility against the risks associated with the use of fossil fuels such as energy security and supply; energy price volatility; health risks; and environmental risks.

On the other hand, wind energy would decrease agent's utility due to its impact on landscape (i.e. environmental risks), public acceptance (i.e. social risks), investment burden (i.e. economic risks), reliability of the project (i.e. functional risks), noise (i.e. health risks) .

A third aspect that the present Thesis investigates is the degree of innovation diffusion of wind energy development.

Brundtland offered the pioneering definition of the sustainable development approach as:

> *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"*
> (World Conference on Environment and Development, 1987, p. 43).

The report reiterated a view that environmental protection, economic growth and social development were not contradictory but complementary goals. This view also argued for a deepening and broadening of environmental policy integration into not just economic policies, but also into policy-making procedures. It opened the door to greater recourse to deliberative and inclusionary processes, involving a broader cross-section of the population. On this wave, the diffusion of innovation is considered as a universal process of social change where wind technology plays its part in the new de-carbonisation process of the energy market.

Generally, innovation generates uncertainty with respect to the occurrence of the new event and the relative probabilities of its alternatives. Innovation – defined as an idea, practice or object – is perceived as new by an individual and this motivates the information seeking.

The probability that the new idea is superior to previous practice is not initially known with certainty by individual problem solvers. Therefore, a convergence process of interpersonal networks favours the information exchange about a new idea.

In this framework, the diffusion of innovation is a social process in which perceived information about new ideas is transferred from person to person, thus affecting social acceptance.

Given the above views, and considering wind technology as innovation within the current energy market, the primary goal of this thesis is the understanding of preferences of public acceptance for on-shore wind energy attributes and their incidence on public well-being.

Specifically, the present work has three objectives:

- Use Choice Experiments to understand public perception of wind energy attributes;
- Investigate the efficiency of Honesty Priming Tasks to mitigate hypothetical bias in Choice Experiments;
- Understand consumers' attitude to innovate.

The analysis of community acceptance of wind energy development is important to explore which attributes mainly influence local acceptance as well as how and which of these attributes affect social perception with the objective of supporting decision-makers during the process of wind energy development and requalification.

The methodology used to reach the above aims is CEs, which help to analyse general public behaviour about the choice/decision process.

CEs help answering the main research questions: (i) to evaluate the incidence of energy risks on the perception of wind energy; (ii) to identify social, economic and environmental attitudes for the implementation/requalification of a wind energy project; (iii) to analyse the potential trade-off between turbine installation, land conservation and energy risks; (iv) clustering people's perception according to Roger's class of innovators membership; (v) to verify the efficiency of Honesty Treatment for Stated Preference application; and (vi) to define policy indications for the efficiency of national energy markets and overcoming climate changes issues.

The present Thesis is structured as follows:

Chapter 1 describes the conceptual background of social perception and main attributes defined in the literature.

Chapter 2 illustrates the theoretical foundations of the Theory of Value and practical applications of Stated Preferences, with particular attention to CE analysis.

Chapter 3 considers a picture of recent international, national and regional issues on renewable energy with particular emphasis on wind energy. The chapter also employs pilot studies to support the construction of the experimental design. These pilot studies are mainly investigated through an empirical analysis conducted at regional level and a Focus Group approach.

Chapter 4 illustrates the CE which includes testing for hypothetical bias and innovativeness scales. This Chapter also describes the experimental design and the survey analysis.

Chapter 5 discusses the obtained results at the light of the research questions outlined above and draws some policy discussions.

Finally, Chapter 6 concludes the Thesis. This chapter also presents the limitations and further research perspectives of this Thesis.

CHAPTER 1
CONCEPTUAL BACKGROUND

The present Chapter aims to review the main recent literature on the pros and cons of wind energy. Firstly, the chapter highlights the different facets of perception and psycho-social characteristics affecting social acceptance of wind energy. Secondly, a general examination of impacts and issues are presented. Thirdly, the chapter details individual attributes which are generally used to calibrate case studies. Finally, the concluding section illustrates potential solutions to overcome the drawbacks that emerged in the literature.

1.1. The study of wind energy perception

Potential barriers to renewable energy development has been deeply debated starting in the late 1970s. Nonetheless, only the last 15 years have seen an intensification of the international literature on the implications of public acceptance.

The debate, so far, strongly focuses on empirical evidence worldwide and critical assessments of the conceptualization of acceptance, including, for example, economic (markets), regulatory and technological (innovation) aspects (Longo et al. 2008).

As discussed by Wolsink (2012), a process of innovation produces, among actors and markets, two segments of willingness to accept its key aspects. Firstly, the acceptance of creation of socio-economic conditions needed for implementation; and secondly the acceptance of all innovation consequences.

A particular stream of international scientific evidence is based on the evaluation of public or social acceptance (Bergmann et al. 2008) as one of the main factors affecting the success of renewable projects. On the one hand, there is evidence of largely approved benefits such as competitiveness, sustainability, lower energy costs, and energy independence. On the other hand, local communities often tend to contrast the development of renewable energy due to relevant costs incurred by the society. For example, the relative aesthetic impacts and impacts on the territory in relation to the spatial localization of installations can undermine the viability of some projects (Bujdosó et al. 2012). Information asymmetries toward stakeholders, policy makers and citizens about landscape issues and socio-economic benefits, always distorts renewable energy perception (D. Caporale & De Lucia 2015).

A further issue in terms of public perception is the understanding of the existing trade-off between landscape conservation and renewable energies installation in particular spatial contexts.

Wind energy is the most criticised renewable technology. Potential issues are debated to the point that a good part of the literature focuses on the importance of 'public acceptance' (Krohn & Damborg 1999; Ekins 2004; Bergmann et al. 2008; Longo et al. 2008; Strazzera et al. 2012) as one of the main factors to evaluate the success of wind projects.

Since the 1980s, some studies have introduced the existing relationship between wind technology developments and their relative public acceptance (Thayer & Freeman 1987; Lee et al. 1989).

In her pioneering work, Carlman (1985) defines the issue of public acceptance for wind energy. She argues that siting wind turbine is also a matter of public, political, and regulatory acceptance. Krohn and Damborg (1999) and Ek (2005) have also contributed to refining the analysis of perception and global wind energy attitude.

On this line, Wüstenhagen et al. (2007) distinguish three dimensions of social acceptance, namely:

- Socio-political acceptance. This is the public acceptance at a general level and relates to both policies and technologies;

- Community acceptance. This is the specific acceptance of siting decisions and renewable energy projects by local stakeholders, particularly residents and authorities;
- Market acceptance. It relates to the process of market adoption and innovation diffusion.

Further research (Devine-Wright 2007; van Os et al. 2014) identifies specific determinants such as:

- Personal factors (demographic and socio-economic factors);

- Psychological and social factors (consciousness/awareness/information, environmental awareness, cultural identity, knowledge and direct experience, environmental and political beliefs, place attachment);

- Contextual factors (procedural judgements and trust levels, equal distribution of benefits, technology type and scale, institutional structure and spatial context) influencing wind energy acceptance.

This classification builds upon environmental psychological theory in examining psychological and non-psychological influences upon environmental attitudes and behaviours (Daniel & Meitner 2001; Devine-Wright 2007).

The most common effect of the above factors on public acceptance is the NIMBY (Not in My Back Yard) phenomenon, which may results in social conflict and economic losses.

Enevoldsen and Sovacool (2016) identify four types of social opposition to wind energy:

- NIMBY 1, as a positive attitude to wind power installations in general, but negative attitude to installations in the immediate proximity;
- NIMBY 2, as a generally negative attitude towards wind power;
- NIMBY 3, as a positive attitude towards plans to develop wind power, which may change to negative when installations are planned nearby the residence place;
- NIMBY 4, as a negative attitude towards the planning process rather than wind power.

Devine-Wright (2005) concludes that there is limited empirical support for the NIMBY hypothesis. Indeed, many studies indicate higher levels of support for development at local level in comparison to a regional or national level. In this case, the phenomenon is named PIMBY (Please in My Back Yard). It occurs when a project is regarded as beneficial and viewed positively by neighbouring communities.

In terms of PIMBY, trust is a key issue in all facility siting issues. The perceived fairness is, to a large extent, dependant on how potential risks are defined, how information about those risks is produced, and how and by whom they are managed.

Risk research has revealed the 'asymmetry principle' (Wüstenhagen et al. 2007). This principle defines trust as fragile feeling, as it is typically slowly created but can be rapidly broken. It depends on perceived competence and intentions, particularly when decisions are made with benefits for some members of the community at the perceived expense of others.

Social impact implies a change in individual well-being and interaction among individuals. It aspires to different levels of needs, which G. Ã. Assefa and Frostell, (2007) classify according to: way of life (how they live, work, play); culture (shared beliefs, customs, values); community (stability, cohesion, services, and facility); political systems (participation in decisions); environment (availability, quality, and access); health and well-being; personal and property rights; fears and aspirations (perception of safety, and future).

In order to assess the above social indicators, the authors aggregate them into three indicators, namely knowledge, perception, and fear about future energy technology. The result of this setting is, in general, a positive opinion of respondents toward energy technologies. However, it has also been observed an evident difficulty for respondents to engage in basic discussions and decisions about specific technologies because of a low level of information and knowledge. In this case, consumer preferences remain attached to the current (i.e. fossil fuel) technologies.

In order to identify the main inputs to the planning and decision-making process, Stigka et al. (2014) argue about the relationship between environmental attitude and behaviour. They establish the importance to know the attitudes of electricity consumers since their attitudes are the foundations of their resulting behaviour. Three specific parameters appear to underscore public behaviour: (a) information by the public, (b) public perceptions and positions, and (c) fear, danger or anxiety that intensifies with ignorance.

Numerous parties appear to be involved in renewables projects, including local communities, local agencies, investors, nongovernmental organizations, and local information networks. Although these actors have different attitudes and conflicting interests, they should find ways to cooperate and reach a general consensus on public acceptance to wind energy.

1.2. Attributes argued in the literature

Wind energy has seen a rapid development worldwide. Sustainability issues of this particular type of renewable energy has sparked, over the years, several controversies in terms of social impacts and acceptance. This is particularly true in Northern Europe (Ejdemo & Söderholm 2015; Ladenburg 2015; Jung et al. 2016) as well as Southern Europe (Jobert et al. 2007; Walker et al. 2014; Walter 2014) and other continents (Gross 2007; Petrova 2013; Guo et al. 2015). Similarly, in Italy, the existence of a well-developed national market for renewable energy and several potential perspectives for future developments still leaves unsolved questions mainly related to the social sphere.

Local communities often tend to contrast the development of renewable energies due to the relevant impacts inflicted on the society. For example, the relative aesthetic impacts and effects on the landscape in relation to the spatial location of installations can undermine the viability of some projects (Wüstenhagen et al. 2007; Meyerhoff et al. 2010; Leung & Yang 2012; D. Caporale & De Lucia 2015).

The main factor affecting social perception and, consequently, the success or failure of wind energy projects is the environmentally-sensitive development of wind technology. Environmental impact of wind turbine is a critical issue affecting ecological integrity and ecological risk (e.g. avian collisions) (Ardente et al. 2008;

Nunneri et al. 2008; Masden et al. 2009; Eichhorn et al. 2012; Masden & Cook 2016).

Bonar et al. (2015) provide an interesting review of social and ecological impacts of wind energy. They consider noise as a further feature of wind problems because it may cause health risks. Also, Solomon et al. (2009) and Feder et al. (2015) compare health-related quality of life of individuals residing in the proximity of a wind farm to those residing far from wind turbines.

As described above, social acceptance is often affected by the 'not in my backyard' (Nimby) syndrome (Bidwell 2013; van Os et al. 2014). Aitken (2010) argues about the NIMBY phenomenon as explanation of individuals or communities against wind power developments. However, some works (Fokaides & Miltiadous, Irene-Chrysovalanto Neophytou, Marina K.-A. Spyridou 2013; Janhunen et al. 2014) show a trend for a positive attitude to wind energy as a general and abstract concept. Nonetheless, when the issue for the selection of a particular site comes into play, an active public opposition is still evident (Bell et al. 2013; Kontogianni et al. 2014). To explain this trend, other essential factors need to be considered, which go beyond the NIMBY phenomenon affecting public behaviour. For instance, public participation (Zoellner et al. 2008; Jami & Walsh 2014); lack of information and knowledge (Claudy et al. 2010); past experiences (Ladenburg et al. 2013); perceived fairness (Gross 2007; Bidwell 2013) and self-interests (Bell et al. 2013); and reliability of technology (Evans et al. 2009; Feder et al. 2015; Polzin et al. 2015).

Although wind turbines installation represents a sustainable alternative to fossil fuels (Raadal et al. 2011) it involves a considerable cumulative impact on landscape (Bergmann et al. 2006), especially in terms of visual impact (Feder et al. 2015), noise (Ek 2002) and climatic impacts on wildlife and birdlife (Meyerhoff et al. 2010; Álvarez-Farizo & Hanley 2002).

The economic point of view cannot be underestimated because it usually drives human behaviour. Several studies (Claudy et al. 2011; Caporale & De Lucia 2015) emphasize the importance of benefits for local community compared to costs incurred to install a wind farm, to assure a correct management and operation.

A further issue emerged in the literature is the efficiency of wind energy transformation as well as the availability and limitations of wind technology (Fokaides et al., 2013)

To reach the second purpose mentioned in the Introduction, it is firstly necessary to examine attributes features. *Table 1* summarises the main attributes and their related features as argued by the literature of sustainability of wind power. The attributes are as follows: aesthetic impact, environmental sustainability, economic sustainability, functional efficiency, noisiness, inadequacy of institutions.

Table 1 - Previous studies on attributes affecting wind energy perception.

Attribute	Study	Identified aspects
Aesthetic impact	Gong 2004; Devine-Wright, 2005; Bergmann et al., 2006; Bishop and Miller, 2007; Meyerhoff et al., 2010; Katsaprakakis, 2012; Ladenburg et al., 2013; Stigka et al., 2014; Dai et al., 2015; Sunak and Madlener, 2016	Turbine color; turbine size; farm size and shape; proximity to turbine; landscape context.
Environmental sustainability	Devine-Wright, 2005; Bergmann et al., 2006; Larsen and Guillemette, 2007; Meyerhoff et al., 2010; Dai et al., 2015; Masden and Cook, 2016.	Effects on flight behavior and collisions; biodiversity; ecological integrity.
Economic sustainability	Devine-Wright, 2005; de Araùjo and de Freitas, 2008; Burguillo and del Rio, 2008; Claudy et al., 2011; Stigka et al., 2014.	Shareholding; costs; local or community benefits; job creation; operational and maintenance.
Functional efficiency	Devine-Wright, 2005; de Araùjo and de Freitas, 2008; Herbert et al., 2010; Claudy et al., 2011; Stigka et al., 2014.	Performance uncertainty; Generation capacity; existent technology; Possibility of lack of wind; difficulty to store wind energy for later use.
Noisiness	Van Den Berg, 2004; Devine-Wright, 2005 Pantazopoulou 2009; Møller and Pedersen, 2011; Pedersen, 2011; Stigka et al., 2014.	Turbine acoustic; noise pollution.
Inadequacy of institutions	Bell et al., 2005; Devine-Wright, 2007; Agterbosch et al., 2009; Wolsink, 2012, 2007; De Lucia and Caporale, 2013; Stigka et al., 2014; Enevoldsen and Sovacool, 2016.	Energy policy support; Political self-efficacy; public participation and consultation; knowledge; lack of information; perceived fairness and levels of trust.

1.2.1. Aesthetic impact

Changes in the aesthetic of landscape and visual disturbance of facilities are an important disadvantage of wind installations (Meyerhoff et al. 2010; Sunak & Madlener 2016).

To reduce the negative impact and relative perception of a wind farm, a technical evaluation plan should be adequately conceived to consider local issues such as: geographical location, site-selection and related planning problems and impacts on residents in relation to the distance from the wind power plant (Ladenburg et al. 2013; Stigka et al. 2014). Bishop (2002) argues that turbines could be seen from as far as 30 km during the day and in condition of clear sky.

Moreover, people's positive or negative perception of visual impact is subjective and may depend on the visual characteristic of the environment, personal feeling and general attitude about wind energy industry (Johansson & Laike 2007).

Wind energy is considered as a useful alternative to reduce the external social cost due to fossil fuels use (Diana Caporale & De Lucia 2015). While other people consider wind turbines as machines that changes the beauty of the landscape (Wolsink 2007).

Jami and Walsh (2014) showed that people living close-by to a wind farm and which are familiar with the original landscape are more affected from its impact. Generally, this impact may be mitigated with neutral colours turbines, larger in size but with smaller density per unit of land area.

Visual impacts of wind turbines are influenced by scenic background, local topographies and local landscape. Katsaprakakis (2012) identifies different perceptions in accordance to location and planning of wind turbines. In particular, the author shows that people perceive wind turbines as visual pollution if they are located near to a scenic spot or an archaeological area and the visual impact appears more intensive if they are located in limited spaces or closed areas such as valleys. The location of wind turbines on a hill may produce an intense and direct impact, that, from a high altitude, can be weakened. An irregular layout creates a sense of chaos; in contrast, a regular layout produces more symmetry and consistency (Dai et al. 2015).

However, the intensity of the visual impact decreases with distance from turbines and the rotation of the blades reduces the magnitude of negative visual effects (Bishop & Miller 2007).

Usually, the observation of turbines from different directions and elevation points changes the magnitude of the perception.

To mitigate wind farms' visual impact on landscape, the Irish Department of the Environment, Heritage and Local Government suggests interesting planning guidelines. These guidelines consider four factors to take into account during the design phase (Dai et al. 2015). Firstly, it recommends valuing the acceptance of changing the landscape. Then, it considers the degree of visual dominance of wind turbines on landscape and the relationship between aesthetics and wind energy development. Finally, it advises to ponder the importance of the impact.

Generally, a good solution to reduce negative visual impact is to create a visually balanced, simple and consistent image using a regular and simpler layout with a low number of turbines (Gong 2004). In addition, a specific turbine colour is advised to reduce the visual impact. People perceive a sense of cleanliness and efficiency with white, off-white or light grey colour turbines (Dai et al. 2015).

Some studies also assess people perception of landscape and wind energy impacts using verbal measures and qualitative description (Álvarez-Farizo & Hanley 2002; Warren et al. 2005; Zoellner et al. 2008). However, this method is not always adequate for visual assessment (Tahvanainen et al. 2001; Jones & Richard Eiser 2010).

Instead, the use of photographic assessment appears valid and a more realistic tool to evaluate visual preferences. Many studies have used computer-generated images(Daniel & Meitner 2001; Johnson et al. 2009; Berry et al. 2011). In this case images should be highly realistic because the increasing level of abstraction reduces the correlation between the evaluation of images and landscape (Daniel & Meitner 2001).

Other studies consider valuing preferences of actual landscape in person or through photographs as well as using computer simulations (Molnarova et al. 2012).

1.2.2. Environmental sustainability

Wind power offers a great potential for sustainability and is emerging as greener alternative for energy generation reducing dependence from fossil fuels.

Wind energy production is not a polluting source as is coal, gas and petroleum based fuel. The current source of conventional energy produces several emissions - in particular carbon dioxide, nitrogen oxide and sulfur dioxide – that are responsible for acid rain and global warming which, in turn, affect greenhouse gases, sea-level rise and weather conditions (Saidur et al. 2011).

Wind energy, as alternative to conventional sources, allows saving carbon dioxide and greenhouse gas emissions shrinking the share of fossil fuels, and accompanied by an increase in renewable energy generation.

The VI assessment report of the Intergovernmental Panel on climate Change (IPCC, 2018), released that human activities caused the warming of the Earth over the past half century and the main culprits are the greenhouse gas emissions produced by burning of fossil fuels, especially carbon dioxide (CO_2).

The Assocarboni Association estimates the amount of polluting emissions in Italy from coal-fired power plants with EMAS certification (European standard environmental certification) as described in *Table 2.* The total emissions of greenhouse gases during the entire lifecycle of energy production using gas is between 510 and 670 grams of CO_2-equiv./kWh (420 grams if gas is produced in Italy). As for coal, the estimate of total emissions is between 780 and 910 grams of CO_2-equiv./kWh (Assocarboni 2018).

Table 2 - Amount of gases emissions using conventional energy source.

Gases	mg/Nm$_3$
SO_2	100
NO_x	100
Dust emissions	15

In contrast, wind energy presents almost zero direct air pollution with the exception of a small amount of CO_2 emissions related to construction and maintenance phases (Saidur et al. 2011). This amount of CO_2 is much less than fossil-fuels power plant and can actually be absorbed by the photosynthesis process (Saidur et al. 2011).

Table 3 shows CO_2 savings due to wind energy production proposed by two energy reports such as Casale (2009) and IEA (2017).

Table 3 – Comparison of the amount of CO_2 savings between two studies.

Study	CO_2	NO_X	SO_2	Particulate
Casale (2009)	560 g/kWh	0.560 g/kWh	1.460 g/kWh	0.300 g/kWh
IEA 2017	1000 g/kWh	1.900 g/kWh	1.400 g/kWh	

A further positive impact of wind turbine is the reduction of water consumption.

Conventional power plants use large amounts of water for the condensing portion of the thermodynamic cycle. Saidur et al. (2011) highlights the relevant difference of water consumption of conventional power plants and renewable energy sources. In particular, nuclear, coal and oil power plants are the major consumers of water (with 2.30, 1.90, 1.60 liter/kWh, respectively), followed by combined cycle gas (with 0.95 liter/kWh) and renewables sources (with 0.110 liter/kWh for solar and 0.004 liter/kWh for wind).

Environmental risks due to the construction of a wind farm should also be considered. Some activity may affect the local bio-system. In particular, foundation excavation and road construction alter soil surface producing soil erosion Dai et al. (2015). Similarly, the use of heavy machinery results in a local eco-balance disturb (Varun et al. 2009).

The primary environmental risk related to wind turbine include wildlife safety (Masden & Cook 2016). In particular, Dai et al. (2015) argued about effects on birds and conducted a review including mortality and disturbance risks that wind turbines induce to birds. However, different land contexts and predator removal rates make difficult the estimation of a bird fatality rate. Usually, the number of bird collisions varies by different locations or different groups of wind turbines. *Table 4* summarizes bird mortality induced by wind turbines in the literature.

Table 4 – Main studies on avian mortality due to collisions with wind turbines.

Study	Location	Avian mortality (fatalities/turbines/years)
KUNZ et al. (2007)	United States	1.3 - 38.2
Kuvlesky, William P. et al. (2007)	Europe and United States	0 - 30
Marsh (2007)	Spain	0.2
Aschwanden and Liechti (2016)	Switzerland	20.7
Lekuona e Ursùa, (2007)	Spain	0.74
Everaert and Kuijken (2010)	Belgium	16 - 24
Everaert e Kuijken (2007)	Belgium	21 - 44
Follestad et al. (2006)	Norway	0.13

The causes of bird mortality are different, such as the wind turbine design and arrangement, bird species, climatic variables, wind farm location and layout, turbine orientation.

Larsen and Guillemette (2007) demonstrate that common birds avoid flying close-by and within the wind farm. This behavior is caused by the structure of the entire turbine rather than the movement of the blade only; and implies the reduction of habitat use within and around wind farms.

Consequently, wind turbines installation may cause destruction of local birds' habitat and can create physical barriers obstructing birds from accessing their natural feeding grounds and roosting locations.

Pesticides and collision with several other human-made structures, including fossil fuels infrastructures, generally contribute to kill birds. In particular, Sovacool (2013) shows that building windows are the largest source of bird mortality, accounting between 97 and 976 million deaths per year. Moreover, attacks to birds from domestic and feral cats accounted for 110 million deaths; poisoning from pesticides accounted for 72 million deaths and collisions with communication towers accounted between 4 and 50 million deaths. The existence of several risks for birds' life is deeply argued comparing avian deaths to non-energy related fatalities such as collision with buildings, brightly lit office towers, single television towers, communication towers, glass windows, transmission lines to conventional power plants, hunting, cars and trucks, and agriculture.

The National Academy of Sciences estimates that less than 0.003% of anthropogenic bird deaths per year is attributed to wind turbines in four eastern states in the United States.

Another interesting data is fossil fuel's assessment of avian mortality. U.S. Energy Information Administration estimates 5.18 avian mortality per GWh, based on real world operating experience for two coal facilities as well as the indirect damages from mountain top removal coal mining, acid rain pollution on wood thrushes, mercury pollution and anticipated impacts of climate changes.

However, bird mortality remains a moderate perceived issue. To limit birds' fatalities, several plans should be taken into account. Structural design improvements can reduce birds mortality. Recent literature shows some possible mitigation strategies. In particular, it suggests enlarging the blades and slowing the rotational speed of wind turbines, night illumination to increase visual acuity of raptors, mechanisms of automatic stop when birds approach seem effective as well as turbine design optimization, efficient site selection and monitoring and modeling birds habitats and migration routes (Marsh 2007; Sovacool 2009; Smallwood & Karas 2009; Baerwald et al. 2009; Foote 2010; Arnett et al. 2011; Liechti et al. 2013).

Besides technical improvements, international cooperation is needed to reduce ecological/environmental effects due to global wind farms (Busch et al. 2013).

1.2.3. Economic sustainability

Economic effects of a wind investment project generally play a great role in terms of market and management structure.

On the one hand, Burguillo & del Rio (2008) define monetary benefits for nearby communities such as the sharing of project profits, new employment opportunities, tourism and other socio-economic effects to boost the regional / local economy. Moreover, wind power can benefit from decreasing operating costs which, contrary to conventional fuels, seem not affected by the state of the global economy (Stigka et al. 2014).

The Italian National Association of Wind Energy (2017) estimates the most significant benefit of wind energy production for electricity consumption such as the reduction of national unify price (named PUN). A reduction of the PUN has, in fact, increased benefits of about 6.6 billion Euros during the period 2018-2030. The breakdown of this amount comes from the production of new wind capacity (3.9 billion euros) and the renovation of existing plants (2.7 billion euros) (ANEW 2017). Furthermore, ANEW (2017) estimates the PUN reduction trend for consumers of 0.15 €/kWh in 2019, which will increase to 3 €/kWh.

Further benefits for the public concern a major tax revenue estimate of 260 billion Euros and more local financial aid (290 billion Euros) from royalties to municipalities hosting wind power plants (ANEW 2017).

On the other hand, high installation costs appear a relevant obstacle for wind investments. The International Renewable Energy Agency (2012) estimates 2010s installation costs of a new on-shore wind farm between 1,850 and 2,100 USD/kW in Europe. Wind turbines account from 64% to 84% of total installed costs, with grid connection costs, construction costs and other costs ‘rounding’ the balance.

Similar to other renewable technologies, the high upfront costs of wind power would represent a barrier to their uptake, despite the fact that there is no fuel price risk upon building the wind farm.

The capital costs of a wind power project is composed by: the turbine distribution cost – which represents 64% of capital cost – including blades, tower and transformer; foundation costs that represents 16% of capital cost; planning and miscellaneous costs consisting by 9% of capital cost; grid connection that includes 11% of capital cost; and other capital costs, which can include the construction of buildings, control systems and project consultancy costs (IREA 2012).

The literature recognises a relevant contribution on the debate about sustainability of wind farms associated with maintenance and operations costs. A turbine installation implies an investment between 0.013 and 0.025 USD/kWh in Europe for operation and maintenance costs. These costs can account from 11 to 30% of on-shore wind projects levelized cost of electricity (LCOE) (IREA 2012). However, considering best practice levels, the benefit could rise the opportunities of cost reduction.

The LCOE assumes 10% capital costs from wind farms depending on the resource and project costs. The LCOE can be very competitive at good wind sites and, for a typical new onshore wind farm, it is estimated between 0.08 and 0.14 USD/kWh in Europe (IREA 2012).

The potential for renewed cost reduction is good because supply bottlenecks have been removed and increased competition among suppliers will put downward pressure on price in the next few years.

In the medium and long-term, reductions in capital costs in the order of 10-30% could be achievable from learning-by-doing experience such as improvements in the supply chain, increased economies of scales from the manufacturing side, competition and more investments in research and development (IREA 2012).

Varun et al. (2009) define three sustainability indicators of renewable energy technologies. The first one is the energy pay-back time (EPBT), that is the period of time needed to recover primary energy consumption throughout the life cycle of the energy produced by the employed renewable technology. The period 1997-2007 has seen an increase of the EPBT from 0.39 to 1.4 years (Schleisner 2000; Celik et al. 2007). The second one is the greenhouse gas emissions. These are estimated according to the full operational life cycle of each renewable energy source from the manufacturing of the plant to full operation of the system. The indicator varies around 16 and 40 gCo_{2eq}/kWh over a 10-year time span (Proops et al. 1996; Schleisner 2000; Nomura et al. 2001; Celik et al. 2007). The third one concerns the cost of electricity generation, i.e. the average cost of production of electricity over the full life cycle of each generation technology accounting for construction, installation, operation, maintenance, decommissioning and recycling/disposal. The cost of generated electricity accounts between 5 and 74 US cent/kWh (Celik et al. 2007).

1.2.4. Functional efficiency

Stigka et al. (2014) introduce some important energy features of wind turbines. In particular, the energy supply from wind power is considered safe, the electric power systems are reliable and highly performant.

Herbert et al. (2010) carry out an analysis of performance, reliability, failure and spare parts of wind energy technology. According to these authors, performance analysis of a wind farm help to remedy the failure and improve the reliability of the system. Wind turbine performance is proportional to Wind Power Density and it varies with different locations. Energy generation varies also in relation to wind speed and technical factors. Aerodynamic characteristics of the rotor is the first factor determining the performance of wind turbine generator.

Herbert et al. (2010) collected data pertaining to wind power generation, machine failure, wind speed and maintenance for five years, from 2000 to 2004. They discover the existence of a fluctuation of generation from year to year due to climatic and technical factors. Moreover, power generation of wind turbine would appear, through time, slightly impaired and reduced because of accumulated dirt, grime and insect deposits on the blade.

The authors underline that the down time due to low wind would be higher than the down time due to grid failure. Similarly, turbine fault time and maintenance time are minor compared to grid failure time.

They also infer that the technical and real availability is very high and the capacity factor reaches about 25%. In particular, the technical availability would result in the figure of 94% and the real availability would fall to about 83%. These results are due to part-time operation of the turbines due to wind availability.

A mechanism of wind turbine stoppage is implemented in circumstances of low wind, grid failure, mechanism failure as well as preventive maintenance, electrical failure and control panel failure. The average stoppage time of wind turbines is evaluated around 21% of total time (Herbert et al. 2010).

Wind turbine generator has a different impact on the reliable performance of a generating system and is directly related to equipment failure rate.

The reliability of a wind farm is high during the first year of operation while it drastically decreases over time beyond economic viability. These risks may be classified as functional risks because of the product uncertainty in terms of trustworthiness, maintenance and expected benefits.

Failure analysis could be a useful tool to reduce functional risks. It is an attempt to determine the causes for which an item does not perform its required functions within the specified limits, and under specified conditions.

External load conditions compromise the number of failures, which is not constant, reduces the overall generation, and causes excessive stoppage time.

Herbert et al. (2010) estimate 79% failures due to mechanical components, which include the blades, gearbox, hydraulic unit, yaw unit and brake pad; and 21% failures due to electrical and electronic component including control panel, capacitor panel and generator failures.

The main causes of blade rope failure could be the inflexibility of the blade rope and the improper crimping, rubbing of the blade rope against its support and lack of lubrication of the rope causing erosion.

The spare part management is vital for wind turbine efficiency and maintenance and its optimization is essential for ensuring high operational readiness. A delay in replacement of failed components will result in a huge loss of power generation. Herbert et al. (2010) have undertaken a scientific spare parts optimization analysis and highlight that typical failures would result in the figures of 33% for the blades, 19% for the gearbox; 10% for the yaw and hydraulic unit, 5% for the brake pad, and 24% for others spare parts.

However, Pareto analysis reveals that, considering a failure-free blade unit, 27% of total failure problems can be reduced; and a 50% decrease of blade and gearbox, and hydraulic and yaw units, would reduce the total failure rate by about 11 and 14%, respectively (Herbert et al. 2010).

Wind turbine production depends on the average wind speed per year. In Italy, the average wind speed varies around 3-5 m/s in the Northern regions; 4-6 m/s in the center regions; and 6-8 m/s in the Southern regions (Casale 2009). Specific energy production in Italy is estimated around 2000 MWh/MW. Considering the typical turbine power – that in Italy varies between 1 and 3 MW (ANEW 2017) – and per-capita energy consumption of 1,185.9 kWh/year (ISTAT 2012 census), a wind turbine of 1 MW can satisfy the energy requirement of 1,700 people per year.

Alternatively, a coal power plant of 500 MW generally produces energy for 8,000 hours per years. Considering these figures, the yearly energy production of such a coal power amounts to 4,000,000 MWh, satisfying the energy requirements of 3,400,000 people per year (Laboratorio Scienza, 2010). This would be the equivalent of a wind farm including 667 wind turbines of 3 MW.

Several good practice solutions could be implemented to increase the functional efficiency of wind turbines:

- Periodical cleaning of blades with silicon-based solution to decrease bug accumulation and generate constant power;
- Reducing technical failures and failures due to grid and components of a wind turbine to increase the technical and real availability and to improve the reliability factor;
- Adopting proper maintenance procedures to increase availability of the wind turbine generator;
- Using of proper heat treatment of the blade rope for strengthen, using of adequate lubricants to avoid high temperature in the gearbox, maintaining of an adequate stock of high quality gear oil for periodical replacement;
- Increasing of quality level of components to reduce the repair rate.

1.2.5. Noisiness

The study of Van Den Berg (2004) argues that during quiet nights, in a buffer zone of 1900 m surrounding wind farms people experience annoyance in the range of 500 m.

Pantazopoulou (2009) distinguishes two types of noise produced by wind turbines: the tonal noise (defined by discrete frequencies due to non-aerodynamic instabilities and unstable airflows) and the broadband noise (non-periodic with a frequency of more than 100Hz generated by the interaction of wind turbine blades and atmospheric turbulence).

A wind turbine also produces mechanical noise that comes from the turbine's internal gears, the generator and other auxiliary parts (Lowson 1996;Møller and Pedersen, 2011). This type of noise generally does not increase with turbine dimension, as is the case with the aerodynamic noise. Moreover, it can be controlled through proper insulation during manufacturing operations (Alberts 2006;Longo et al. 2008).

The ambient and background noise can also increase the perception of wind turbine noise. For instance, at night times when low human-made and stable atmosphere noise are generated, wind turbine noise can be perceived differently than during day times. According to Van Den Berg (2004), the perception of wind turbine noise at night times for a person living 1.5 km away from a wind farm would be similar to the noise of an "endless train".

Governments and medical institutions usually recommend a minimum distance between the location of wind farms and the surrounding buildings because high frequency noise can induce sleep disturbance and hearing loss, headaches, irritability, fatigue, arteries constriction, immune system weakening, annoyance and dissatisfaction (Dai et al. 2015).

Kamperman and James (2008) argue that a single A-Weighted (dBA) noise descriptor would appear inadequate to limit wind turbine noise with significant low frequencies. For this reason, the authors propose the adoption of a C-Weighting (dBC) noise and to limit it within L_{90} + 20 dB and 50 bBC maximum.

Pedersen (2011) explores, with three field studies, the relationship between sound levels of wind farms and aspect of health and well-being. He remarks a consistency across all considered studies about the perceived feeling of tension, stress and annoyance. However, further scientific and experimental studies investigating the influence of wind turbine noise during sleep times and in different contexts are advised as well as the interaction occurring between sound exposure, noise annoyance and stress.

A recent study carried out by Mroczek et al. (2015) points to an interesting conclusion. The presence of wind farms near residential area would have no negative influence on the quality of life of residents; in fact, considering a distance within the range of 1km a high quality of life to nearby residents is evident. The quality of life would worsen in case of construction works of wind farms near residential areas.

Issues highlighted by the above studies call for adequate policy action and further research in order to implement proper regulations and mitigation strategies.

For instance, blade design can be a key strategy to reduce wind turbine noise and increase the productivity of energy production (Klug 2002). Aerodynamic noise can be explored and reduced during an appropriate blade design phase and low frequency noise can be mitigated with upwind turbines (Frey and Kollman 2008). Mechanical noise during turbine operation can be isolated inside the turbine tower using special gearboxes for wind turbines (Frey and Kollman 2008).

1.2.6. Inadequacy of institutions

A measure that could eliminate barriers and benefit wind investments includes mandatory binding emission reduction targets at national level with the aim to reduce the gap between local and national policy making.

Financial incentives and the simplification of bureaucratic licensing practices and processes would add a positive signal to stimulate the development of renewable energy. To achieve this aim, inadequacy of institutions is the key to coordination activities of the parties involved and the building of trust across stakeholders would favour social acceptance by local communities (Stigka et al. 2014).

Efficient means are the transmission of information about wind projects and transparency of management in order to re-address the fear of uncontrolled profits at the expense of the public (Agterbosch et al. 2009).

Agterbosch et al. (2009) shows some aspects characterizing a typical project for energy distribution that could affect the good performance of a wind farm. One of these aspects is the authorization trajectory and the long ‘formal’ period to implement a wind farm project. Often, administrative and public opponents denote an inconsistency of policy or incorrect implementation of legal norms. Facilitation of authorization procedures could be implemented through the intensification of communication processes between the respective local authorities involved in the planning and implementation of the wind farm (Zollner et al. 2008).

Local and national government initial support is an important precondition for the revision of the land use plan (Wolsink 2012). Usually, inconsistency at provincial and municipal level planning turned out in objections for several administrative stakeholders at different levels of authority.

Moreover, the lack of an active involvement of residents produces a negative opinion because they can feel that the project would solely serve to satisfy external private interests (Bell, T. Gray, et al. 2005). As a consequence, mistrust for institutions decreases due to strengthening the perception that local authorities would pass over the interests of the local community (Agterbosch et al. 2009).

A complex normative framework (i.e. including different procedures and different competent authorities) induces a series of social conditions:

- The energy supplier and competent authorities prepare an informal strategy;
- The external private mismatches with the local common interest;
- Decision making powers would be dispersed, the interests fragmented and the knowledge base limited;
- The lack of intergovernmental coordination denotes an inconsistent administrative behaviour which could cause an incorrect implementation of procedures;

- Administrative and public resistance increase and opponents would widely argue about an improper implementation of legal norms. This background would cause insecurity about changing the current legislation and deviation from institutional conditions (Agterbosch et al. 2007).

A collaborative arrangement between citizens and the local authorities in the form of active participation processes and/or a continuing information mechanism would enable knowledge on wind farms developments and/or the adoption of other renewable sources (Bell, T. I. M. Gray, et al. 2005). The shared economic interest in wind power exploitation is the main driver for public collaboration and acceptance.

1.3. Chapter conclusions

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 chapter should be considered during the design and development phases of a wind farm.

Bell et al. (2005b) define three explanations for social gap in wind farm siting decisions:

1. the democratic deficit explanation, i.e. why opponents of wind power, despite being the minority, are able to dominate the permitting process;
2. the qualified support explanation, i.e. when the failure of particular wind developments reflects a general principle of qualified support for wind energy; in this case people make an exception to their general support for a particular case that has a direct effect on them;
3. the self-interest explanation, i.e. when people support wind energy but actively oppose any developments in their own area for self-interested reasons.

A positive perception of local residents may be encouraged promoting some involvement and information initiatives. In particular, Dai et al. (2015) suggest working together to find solutions which meet the following needs:

- public participation in the early stages of the planning and implementation of wind power projects;
- early communication to avoid conflicts with the public;
- incorporation of social and environmental psychological aspects into the wind energy project;
- replacing the feelings of selfishness with equity and fairness by the institutions;
- promotion of a sense of environmental citizenship.

Advance of technology and adoption of more recent wind turbines will also improve functional efficiency and environmental sustainability, if supported by adequate governmental strategies and local plans.

CHAPTER 2
METHODOLOGY: THEORY AND APPLICATION

Individuals or decision makers are involved in recognizing the necessity to solve problems, make choices, or obtain benefits. For this reason, these agents search and learn to find out 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, based on social perception of environmental and economic attributes, are taken into account. It is on these attributes that individuals make their evaluations and comparisons.
Based on the above, the present chapter explains the use of stated choice methods under a theoretical and applied point of view.
Starting from a description of the Theory of Value and non-market good valuation, the chapter deeply discusses advantages and limitations of stated preference models. Subsequently, a special emphasis is given to CEs (including how these are built and estimated). Furthermore, some supporting techniques to CEs are introduced, such as Focus Groups, survey distortion reductions, and innovativeness scales.

2.1. Stated Choice Methods use for non-market valuation

Natural resources, such as air quality and environmental attributes, are valuable assets that yield flows of services to people. Creation of benefits and costs can be led by public policies and the actions of individuals and firms.

Freeman (1982) and Kneese (1973) define people's view on the environment as an asset or a kind of non-reproducible capital good that produces a stream of various services.

There is a potential role for public policy in the management of resource and environmental systems and a need for information on the values of the service flows.

The concept of value is founded 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 valued in a given situation (Freeman et al. 2014).

Individuals' well-being is strictly linked to the endowment of all resources available and values received from any environmental change or use of resources, in terms of benefits. The benefit value is compared with the cost value, which indicates to what individuals give up to take resources and factor inputs from other uses.

Freeman's standard economic theory (1979) 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.

This theory is based on two assumptions:

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 can be substituted with other 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).

Willingness to pay (WTP[1]) and willingness to accept compensation (WAC[2]) are value measures based on sustainability.

Generally, individuals may gain utility from the natural environment directly (i.e. direct uses of environmental goods) or indirectly (i.e. passive uses of the environmental goods).

Use values are typically associated with direct uses of the resource. Instead, indirect use values consider other aspects of the environment that are linked to direct use activities like recreation values and property values. Passive uses may be explained by preferences over habitats and ecological services and their use values are not easily observable through individual behaviours.

The discussion about the utility arising from these different types of environmental benefits explains the distinction between use and passive use values.

These two types of values are related to each other because preferences over habitat, through ecological relationships, may also affect direct use values.

Utility theory (Fishburn, 2006) helps to represent quantitatively people's preferences and choices and it offers a basis for the analysis of decision making under uncertainty. It provides the conceptual basis for resource compensation measures since all attributes of ecological services can be represented as entering an individual's utility function. In this case, there exists a utility tree/function of products/services – corresponding to components of a separable utility function – that are affected by subsets of environmental attributes.

Knowledge is an essential factor to capture information on either the attributes of the alternatives or the preferences of direct and indirect uses. Often, the information retrieved to determine resource compensation seem not adequate to fully understand the socio-economic and environmental effect of an attribute on a set of alternatives. For this reason, knowledge of the utility tree structure will also be required.

Stated Choice Method (SCM) is a flexible approach to collection of preference data from subjects in hypothetical situations. SCM are an evolution of conjoint analysis paradigm, usually used in marketing research (Louviere 1988). Louviere & Hensher (1982) and Louviere & Woodworth (1983) represent pioneering works of SCM applications to well-established revealed preference choice models.

While conjoint analysis is a very popular approach to understand and predict consumer trade-offs and choices, it is not a theory of choice behavior (Adamowicz & Louviere 1998). Similarly, SCM is not a theory of behaviour although it is considered as a tool to generate behavioral data from consumers (Adamowicz & Louviere 1998).

The foundations of SCM include the consumer theory of Lancaster (Lancaster 1966) which proposes a new assumption of the utility function. This function considers a decomposition into separable utilities based on their characteristics/attributes. Further SCM's behavioral foundations are based on judgments and decision making from Psychology (Hammond 1955; Anderson 1970,1982) as well as Economics, and in particularly the random utility theory (RUT) (Thurstone 1927; McFadden 1974).

2.1.1. Stated Choice Model specification and Random Utility Theory

There exist multiple variants of SCM. One of these, is Discrete choice contingent valuation (CV). It is based on survey analysis which represents consumer behaviour for or against a proposed change or set of changes at a given cost.

A further variant of SCM is the discrete choice experiment (CE), where respondents are asked to indicate their preference among two or more multi-attribute alternatives.

CV versus CE distinction consists on non-attribute versus attribute-based alternatives.

Stated Preference Methods are a well-known approach to estimate values for changes of public goods, environmental services, human health effects and other fields without the availability of revealed preferences data. This approach has the objective of placing the respondent in a realistic framework to compare a number of alternatives, each described in terms of specific attributes. It also considers the stimuli, which is the decision context and product descriptions from the elicited response. This latter is the individual's decision and may consist in a choice, a ranking, or a quantity.

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.

RUT and utility maximization represent the conceptual framework to analyse choice and 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 to be the same as the preferred alternative.

To explain the above, let us consider the following utility function which includes a random element:

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

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 bias, 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:

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

where l is the attribute level. In relation to the distribution of the error term ε, and in particular to the differences between group 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 a preliminary qualitative research including focus groups and interviews of experts tailored to a particular project; 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 a vector x of explanatory variables. Thus, equation (2) can be rewritten as:

$$\begin{aligned} P_{ij} &= Pr\left[\left(\beta x_{ij} + \varepsilon_{ij}\right) > (\beta x_{il} + \varepsilon_{il})\right] \\ &= Pr\left[\left(\beta x_{ij} - \beta x_{il}\right) + \left(\varepsilon_{ij} - \varepsilon_{il}\right) > 0\right] \; for\ each\ j \neq l \end{aligned} \tag{4}$$

Choice model estimation has the ultimate purpose of obtaining unbiased estimates of the taste parameter vector β containing marginal utilities of attributes.

Choices may differ systematically from individual to individual. Therefore, explanatory variables may include individual difference measures z, such as demographic and psychographic, with an associated vector of coefficients γ. These individual difference measures may be thought to influence utility levels via the intercept and/or slope coefficients in the β vector.

In accordance to the distribution of the error term, a specific probabilistic choice model can be used. Thurstone (1927) suggests the use of a binary probit model for a bivariate normal distribution of the error term. McFadden (1974) and

Ben-Akiva & Lerman (1985) indicate the use of a Conditional or Multinomial Logit (MNL) model in the presence of a Gumbel distribution of the error term. Alternatively, in the presence of a Generalized Extreme Value distribution, Nested MNL (McFadden 1981) and Ordered GEV (Small 1981) models can be used.

MNL models are generally used in choice model applications. A MNL model assumes that the error term is independent and identically distributed (IID3) across alternatives and individuals.

2.1.2. Stated vs Revealed Preferences model

Environmental valuation considers two methods:

- Revealed Preference method (RP) assesses the value of non-market goods by studying actual behavior on a closely related market;
- Stated Preference method (SP) as described in the previous section, assesses the value of non-market goods by using individuals' stated behaviour in a hypothetical setting.

Table 5 summarizes the characteristics of RP and SP typical data.

RP can be used to construct, to a certain extent, resource compensation and to determine how specific alternatives of a choice set can be used to compensate for damages the attributes defined in another alternatives.

Braden and Kolstad (1991) describe the most common revealed preference methods, which are the hedonic pricing method and the travel cost method.

RP approach has the advantage of considering individuals' actual choices. However, it may suffer some limitations. In particular, the presence of missing data. In this case, the behaviour of interest cannot be observed because valuation is conditional on current and previous levels of the non-market good. As a consequence, non-use values are impossible or difficult to measure (Alpizar et al. 2001). Thus, model development and compensation measurements would not be accurate (Adamowicz et al. 1994).

SP approaches can be represented in terms of conjoint analysis, contingent valuation methods (CVM) and choice experiments.

Table 5 – Characteristics of RP and SP typical data (Louviere et al. 2000).

Revealed Preference data	Stated Preference data
World shown as it currently is (current market equilibrium)	Uses hypothetical or virtual decision context (flexibility)
Inherent relationship between attributes (fixed technological constrains)	Control of relationship between attributes mapping utility functions with inexistent technologies
Inclusion of observable existing alternatives	Inclusion of existing and/or proposed and/or generic choice alternatives
Decision maker embodies market and personal constraints	Decision maker does not embody market and personal constraints
High reliability and face validity	Reliability is present when respondents understand, are committed to and can respond to tasks
Considers one observation per respondent at each observation point	Considers multiple observations per respondents at each observation point

SP methods are useful to control the stimuli applied to the experimenter compared to those gained from real markets. Thus, SP is the result of the application of a wider range of attributes compared to those considered in the real market. It also considers the introduction and/or removal of products and services or new attributes.

Being based on hypothetical markets, SP may not correspond to real choices and real consequences of making a choice are not verified.

Whether data are revealed or stated from an experiment, specification analyses and model fitting adopt the same strategy. However, RP data suffers a lack of variability, limited range or similar conditions. This explains why hypothetical choice experiments often allow for the definition of parameters that cannot be identified in RP models, such as higher-order effects, interaction between variables and individual difference variables.

Ben-Akiva & Lerman (1985) underline that a choice set is a key issue to examine for choice model specification; and Louviere et al. (2000) show the reasons behind the use of SP data as follows:

- Demand side estimation for new products with new attributes and features;
- Low variability in the marketplace of explanatory variables;
- High collinearity in the marketplace of explanatory variables;
- Introduction of new variables explaining choices;
- Lack of satisfaction of model assumptions and/or presence of statistical ‘biases’ due to latent relationships of real world data;
- Consumption of time and expensive collection of observational data with RP;
- Lack of trading commodities in real markets (i.e. environmental goods, public goods).

Therefore, the limitation of RP models is linked to preferences within an existing market and technology structure.

In contrast, the use of SP models highlights problems and choices involving shifts in technological and innovative frontier. Their main limitation is the well-known hypothetical bias. De-Magistris et al. (2013) 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”.*

Usually, in hypothetical settings individuals overstate their willingness to pay (List & Gallet 2001; Murphy et al. 2005).

However, it is not clear why people provide different WTP values in hypothetical and non-hypothetical settings. Generally, respondents may not have an incentive to reveal their true WTP values because they do not pay for the good in an hypothetical setting (Harrison 2006).

A solution to these problems may be using non-hypothetical or real choice experiments (RCE) incorporating an incentive compatible mechanism and/or real products.

However, real products may not be available on the market or may not yet have been fully developed. Furthermore, RCE may be expensive and time-consuming because participants have to pay a participation fee and the price of good during the experiment.

The lack of rewards during the experimental phase is a further critical aspect of hypothetical experiments (De-Magistris et al. 2013). Salient conditions would appear absent and respondents would not take the experiment seriously into account or would not make the sufficient cognitive effort to answer accurately.

Recent literature purposes various ex-ante calibration methods to apply in hypothetical experiments to mitigate the hypothetical bias:

- The cheap talk script (Cummings & Taylor 1999), which explains the problem of hypothetical bias to respondents before proceeding to question valuation and preference elicitation;
- The solemn oath (Joule et al. 2008; Jacquement et al. 2013), which is a truth-telling device where participants are asked to swear on their honor and provide honest answers before proceeding to a second-price auction;
- The honesty priming (Jacquement et al. 2011), which is an approach derived from Psychology (Bargh 1990,1997, 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 (Kay & Ross 2003; Chartrand et al. 2008).

Jacquemet et al. (2013) suggest that the solemn oath improves the revelation of true preferences in hypothetical experiments. However, it is feared that certain people do not take this honesty measure seriously into account (Jacquemet et al. 2013).

The experimental phase of this Thesis will make use of honesty priming – proposed by De-Magistris et al. (2013) – as ex-ante calibration in the same spirit as the honesty pledge, for eliciting honest answers and mitigate hypothetical bias during choice experiments. Other hypothetical bias measures are not considered due to their limited consensus in the renewable energy field (Lusk et al. 2003; Brummett et al 2007).

2.1.3. Best-practice recommendations for SP application

Johnston et al. (2017) propose five recommendations to reduce uncertainty in the design, implementation, and estimation of a SP study.

The first recommendation aims to increase the validity and reliability of the estimated values during survey development and implementation. In particular, validity considers the minimization of bias estimates; and reliability denotes the minimization of variability. To this purpose the authors suggests that SP questionnaires should clearly illustrate the baseline (i.e. status quo) and the alternatives. Furthermore, alternatives should be clear and respondents should be able to understand, accept and consider credible all information provided by each alternative.

A pre-test can also be conducted for an efficient survey design. Generally, focus groups and/or cognitive interviews are considered useful tools. Johnston et al. (2017) recommend to undertake a minimum of four, six or larger focus groups whether the good under study is considered as new, unfamiliar, or difficult to quantify, respectively. Similarly, pilot studies, when feasible, would facilitate attribute designs, help to calibrate survey and item response rate and produce preliminary statistical test of hypotheses. Preliminary studies have to be addressed to the target audience and their records should include: i. script reports used for focus groups or interviews; ii. socio-demographic characteristics of the participants, as well as subject-selection method; iii. field test results; iv. key survey-design insights, and v. results which are useful for the implementation of the adequate design.

The use of an attribute approach (i.e. choice experiment) *vs* a non-attribute method (i.e. contingent valuation) to describe the behavioural change of the respondent depends on his/her perception, the objective of the study and the information content of the scenarios. The most appropriate method to use during the experimental phase is also determined with a pre-test study.

The fundamental prerogative of the experimental design is to build an efficient design and unbiased estimates of preference parameters and values. Relevant attribute interactions are allowed and should be identified. Moreover, it should also consider the statistical efficiency of design, cognitive ability and attention of respondents, implausible attribute levels and combinations that needs constraints definition, robust design for alternative model specification, and the influence of attribute levels on design properties.

The sources of a priori information should also be provided. These will be used to develop the design and support the final chosen design.

Ethic protocols in data collection are important in all aspects of an SP study to receive consent. It involves procedures to avoid negative consequences for respondents and impairment of study results to support decision-making.

Data collection should be context specific. The sample should be randomly selected from a population. Nonresponse bias should be mitigated using survey-design features, and in extremis, during collection data.

The second recommendation by Johnston et al. (2017) is the value elicitation. In this case, the use of WTP or WTA depends on the decision context, but it should also be supported by theoretical and empirical considerations. Usually, WTA estimation faces practical challenges, while WTP estimation leads to evaluations with empirical properties.

Generally, the valuation of public goods is based on incentive-compatible response formats, for example using a single binary-choice question consisting of a baseline (or status quo) scenario vs an alternative choice. In case of multiple valuation questions, additional trade-offs due to efficiency issues, bias, and evolution of choice heuristics should also be taken into account. Furthermore, questions should be randomized across respondents.

Preferably, the response format should not include a no-answer option to avoid response bias. Similarly, the decision rule across alternatives should be realistic and binding.

The payment vehicle should result in a realistic, credible, familiar, and binding tool. Respondents would need to view the payment vehicle as a fixed element and to minimize unintended effects on estimated values a pre-test considering the above options would be a viable solution.

Auxiliary and supporting questions would be a further mechanism to enhance the validity of an SP study. These supporting questions should have a specific purpose and their effectiveness can be assessed with the pre-test study.

The pre-test study is generally considered as an ex-ante procedure to improve the validity of the SP study, incentivise compatibility and encourage truthful responses.

The third recommendation is represented by data analysis. In particular, the selection of econometric estimators should concern three aspects: the type of data; the hypothesis to investigate, and the use of estimated results to support decision-making. Observed and unobserved preference heterogeneity should also be taken into account for the decision-making process.

Parsimony and complexity should be as balanced as possible in the model specification. On the one hand, data analysis should include the simplest specification in which hypotheses are consistent with axioms of choice theory and properties of data. On the other hand, it should include a degree of difficulty which takes into account the complexity of socio-economic and environmental interactions in the structure of responses.

Any anomalies captured during prior research and pre-test studies, should be further investigated to determine their effects on SP responses. Should this case occur, it is important to distinguish response anomalies which merely add random noise to estimated values from systematic effects that can produce biased estimates.

Estimates should also include central tendency and dispersion and welfare measures to ensure well defined indicators both theoretically and statistically.

Data from auxiliary and supporting questions should be clearly described and should justify the survey design and empirical application. Moreover, analysis should consider potential endogeneity and related concerns (e.g. measurement of error).

To develop decision or policy relevance for the community, the sample should be as representative, aggregate and generalised as possible to produce unbiased estimates.

The fourth recommendation by Johnston et al.'s work (2017) is validity assessment. That is, validity and reliability of value response data. Core internal validity assessments of SP data includes formal test of construct validity and evaluations of content validity. Results from validity should be interpreted in the light of proper theoretical and empirical contexts. They should include a recognition of potential confounding influences, the effect of design and the role of assumptions.

Besides, validity assessment should consider the weight of the available evidence and include study-specific design and analysis of procedures and outcomes, as well as knowledge assumption prior to the investigation.

Finally, the fifth recommendation concerns the study reporting. Each methodological or applied study should be well documented in the design, implementation, analysis and results phases. Credibility of the study is strictly linked to transparency and appropriate interpretation and use of results.

Recommendations mentioned above may be less reasonable, applicable or relevant in case of a private-good application. On the contrary, the same recommendations may emphasize the estimation of benefits and costs of public goods or services. Their application also needs to take into account the cultural and institutional context of the study.

For this reason, a best-practice would be represented by reviewing the existing literature on previous applications; consulting with local or context-specific experts; and carefully addressing the pre-test, study and design.

2.2. Choice Experiments

The present Thesis uses an SP approach expressed in hypothetical markets with particular focus on CEs analysis (Haab and McConnell, 2003; Signorello & De Salvo 2010). CEs combine the theory of value (Lancaster, 1966) and the random utility model (RUM) proposed by McFadden (McFadden 1974). It is a combination of these two theories and an extension to the dichotomous contingent valuation method.[4] Furthermore, CEs are a valid tool to estimate the economic value of non-market goods, their shadow-prices and attributes.

CEs have been extensively used in literature in the field of environmental economics to estimate consumer's willingness to pay (WTP)/willingness to accept (WTA) to protect natural resources/environmental amenities, the economic value of recreational activities and the trade-offs across non-market goods' attributes (Liu et al. 2012; Scarpa & Willis 2010; Adamowicz & Louviere 1998). In addition, CEs have been recently used to value the impact of renewable energies on households (Scarpa & Willis 2010; Ek & Persson 2014; Franceschinis, Scarpa, et al. 2017).

In the practical implementation of CEs, the interviewee expresses his/her preference (which gives him/her the highest utility level) among the options obtained in the choice sets. This technique provides a large portfolio of information on attributes and socio-economic variables affecting consumer choice and a better understanding of consumer preferences and alternative scenarios of costs and benefits (Jung et al. 2016). Formally, the econometric analysis solves the problem that each individual i maximises his/her utility level associated to an alternative profile j subject to his/her income level. The alternative j is chosen within the preference basket if and only if $U_{ij} > U_{il}$ *for* $j \neq l$. This is the case of Discrete Choice Models (Louviere J.J. et al. 2010; Hensher D. A. et al. 2015).

Consumer preferences analysis also refers to estimate the marginal value/effect of single attributes and their trade-offs characterizing the good under study. The definition and description of the attributes and their levels are essential for efficient CEs. The number of attributes will affect the degree of complexity of the experimental design. The higher the number of attributes and their levels, the higher will be the distortions due to framing of the survey analysis. Therefore, it is essential to select an adequate range of (quali-quantitative) attribute levels consistent with the good under study and consumer preferences. The experimental design is structured through a design such that it determines all possible alternatives (collective or full factorial) among attributes and attributes' levels. The full factorial design reveals all efficient alternatives of an experimental design (Louviere, et al., 2000), omitting irrational and dominant alternatives.

Given the relatively exponential sensitivity of the collective design to the number of attributes and attribute levels it is often useful to opt for a fractional factorial design which reduces the number of alternatives for the respondent. Alternatively, the blocking technique provides splitting the full factorial design into combination blocks.

Through the use of a blocking experimental design each respondent faces a given block of questions/choices. This is to assure that the alternatives from the orthogonal design are included in the survey (Hensher D. A.et al. 2015). In each case, the orthogonality condition should be satisfied. Furthermore, the alternatives within each choice set can be randomly extracted from the orthogonal design or follow specific rules such as the foldover technique. With the foldover technique each alternative from the experimental design is obtained by increasing one of the attributes by a level unit (Hensher D. A.et al. 2015).

Finally, the choice sets may include the status quo or the no-choice alternative option. In the former case, the alternative is a base-case alternative and therefore considered as hypothetical policy scenario. The status quo (or no-choice option alternative) does not vary across sets/alternatives.

2.2.1. Building CEs

The process of CEs is summarized in *Fig.1* by adapting the work of (Mazzanti & Montini 2001). It considers four phases: Phase 1. Definition of attributes and attribute levels; Phase 2. Construction of CE design and survey development; Phase 3. Sampling and pre-testing; Phase 4. Data collection and evaluation.

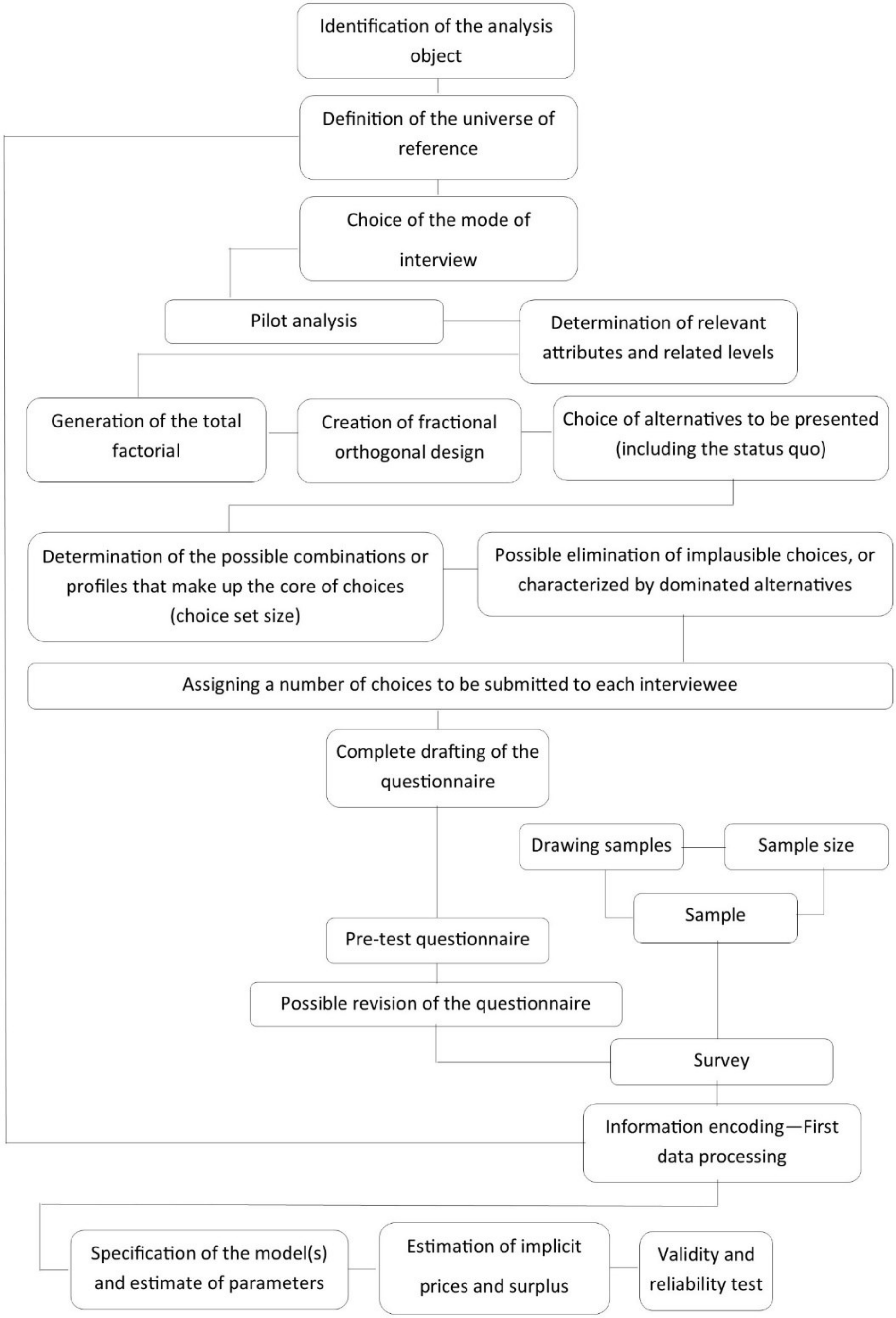


Fig.1 – Phases of a structured analysis with CEs.
Source: adapted form Mazzanti & Montini (2001).

PHASE 1: Definition of attributes and attribute levels

This phase is the most important of the entire process and starts with the characterization of the decision problem.

Some tools such as focus groups, literature review and interviews with experts generally help to define the decision problem, highlighting the main issues as follows:

- How to involve individual's awareness of making the decision in question;
- How to search for information on the evaluation of the product and service;
- How to search for information on alternatives and attributes;
- How to construct choice sets;
- How to let individuals make decisions.

Unfamiliarity of respondents with the choice under study should be identified during phase 1. In this case, further spread of information should be provided to respondents before undertaking the choice (Johnston et al. 2017).

Important behavioral differences could be justified by individual heterogeneity – in terms of income, education, attitudes toward environmental issues – and it should be identified accordingly.

Based on the above, the aims of the Phase 1 would define: (i) choice set size and composition; (ii) relevant attributes; (iii) individual differences, and (iv) relevant sampling for the study.

Attribute identification is widely discussed in literature (Louviere & Hensher 1982;Hensher D.A. et al. 2015; Johnston et al. 2017) and requires the support of prior experiences, secondary and exploratory research. Attribute identification also provides for the definition of attribute levels.

Attribute levels may be shown in CEs in word, number, pictures (static or dynamic), charts and computer graphics formats.

PHASE 2: **Construction of CE design and survey development**

The second phase concerns the development of the experimental design. It is based on developing the alternatives provided that a particular set of statistical properties that determines the utility function is satisfied. Orthogonal design is typically used to generate the combination of attribute levels as well as the adoption of an efficient design (see section 3.2.3).

The main results of an orthogonal design provide orthogonal subsets of the full factorial design that allows to estimate a strictly additive utility function. The orthogonal design assumes that all interaction effects between attributes are non-significant and the dissatisfaction of this assumption could lead to unknown and potential bias in the estimated parameters.

The questions to include in the survey are usually developed as self-administrated tasks, or presented through an interview. The survey can include one or more choice scenarios as well as proper sections concerning socio-demographic, psychographic, attitudinal and past behavioral data.

One of the aims of this phase is to establish the adequate number of choice scenarios to present to the interviewee. Task length could affect the quality of data provided by respondents. Carson et al. (1994) suggests submitting not more than eight choice scenarios to an individual. A similar effect could arise from the number of alternatives.

Usually survey design includes several sections. These provide basic information about the context, attributes, and attribute levels. Proper instructions on the task, its objective, context and the presentation of choice scenarios are also provided to respondents.

Generally, the survey's tasks should be designed to simulate the actual choice. The choice set could consider a simple yes/no response with single alternatives, or multiple alternatives plus the no-choice option, and other variations. The order of appearance of choice sets is typically random and could be the same or otherwise across all subjects.

The order of choice sets does not affect reliability (Louviere et al. 2000).

PHASE 3: Sampling and pre-testing

Pre-testing of the questionnaire is a fundamental step to reach a high accuracy of results. Furthermore, accuracy is strictly linked to sample size and representativeness.

PHASE 4: Data collection and evaluation

The most common model estimation of stated choice experiments in the literature is the Multinomial logit (MNL) which is based on maximum likelihood estimator.

However, other choice estimations are used as well as estimation using parametric or non-parametric criteria.

2.2.2. Empirical analysis

The MNL model is characterised by three or more choice alternatives and is useful to study the effects of independent variables from the choice-invariant characteristic on the probability to choose j. The MNL model considers the utility level as a function of specific individual variables, but those considered as alternative specific, as follows:

$$U_{ij} = z_i y_j + \varepsilon_{ij} \tag{5}$$

The present study considers the error term satisfying the IID (independently and identically distributed) condition with a Gumbel-distribution type (McFadden, 1974) and implies that the probability function is:

$$P_{ij} = e^{V_{ij}} / \sum_j e^{a' Z_{ij}} = e^{a' Z_{ij}} / \sum_j e^{a' Z_{ij}} \tag{6}$$

where *Zij* represents the independent variables and a indicates a vector of estimated parameters and assumes a linear-in-the-parameters specification for the deterministic component of the utility function.

The scale factor affects the values of the estimated taste parameters. The larger (smaller) the scale, the bigger (smaller) the coefficients.

This means that even if two choice data sources are generated from the same utility function, they have the same taste weights, but different scale factors.

In the MNL model the scale factor is inversely related to the variance of the error term. Thus in this case the higher the scale, the smaller the variance. This implies that high-fits models have larger scales.

As Ben-Akiva & Lerman (1985) show (see *Fig.2*), when the scale is zero the choice probabilities are equal; in this case the estimated choice would follow a step function (black dots) as scale grows from there. This is to say that it perfectly discriminates between two alternatives.

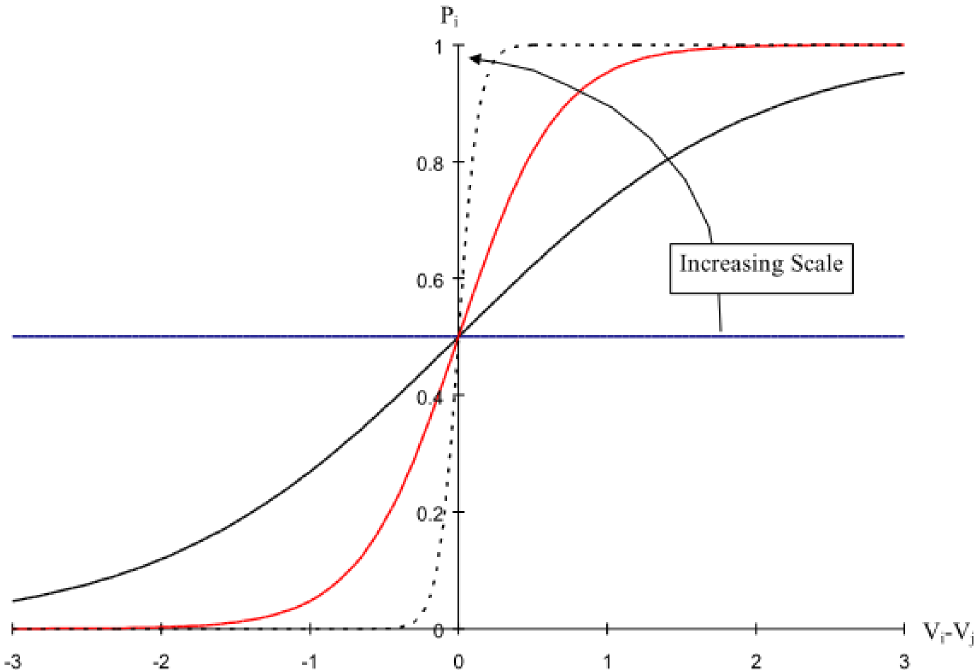


Fig.2 – The effect of the scale parameter on choice probability.

The above observations imply that in choice models – differently from other models – the taste weights and characteristics of the error terms are related.

For this reason, the variance of the error term can be considered as an integral part of the specification of MNL model, rather than a nuisance parameter.

In the same way Nested MNL model and Multinomial Probit model presents this relationship between mean and variance.

Considering all general issues of SC models that can affect reliability – such as survey design, information presentation, context, etc. – also the estimated mean and variance of the utility function may be affected from these issues. Should this case arise, potential biases could also affect the scale parameter.

In the context of policy analysis, discrimination between preferences for different alternatives (shown by a steeper choice probability function) is more preferable. Thus analysts tend to produce survey instruments to increase the scale.

The MNL model is structured on the IIA (Independence of Irrelevant Alternatives)/IID (Independent and Identically Distributed) hypothesis which needs to be tested to evaluate data consistency.

IIA/IID hypothesis implicate that the probability linked to the choice of an option is independent by the introduction/removing of others alternatives.

The most consistent procedure to test this hypothesis is the Hausman test (Hahn et al. 2011).

In case of IIA hypothesis violation, different econometric models can be considered. For example, the Alternative Specific Conditional (ASC) logit model can be used to include socioeconomic variables. This model allows measuring the delta-change due to the introduction of socioeconomic variables.

Other alternative models could be considered such as Nested logit Model (McFadden 1981), Heteroskedastic extreme value model (Bhat, 1995), Random parameter logit or Mixed Logit (Train 1998; McFadden & Train 2000), Multinomial probit (Hausman & Wise 1978) to internalize and/or include the structural heterogeneity of the sample.

2.2.3. Orthogonal design vs D-error

The most general class of available designs is the full factorial design. It is a design in which all possible combinations are computed.

A high number of combinations produces a significant level of cognitive burden on respondents, which, in turn, affects the response rate and/or response reliability.

Therefore, different strategies to reduce the number of choice sets should be adopted such as the fractional factorial design, blocks, and fractional factorial design combined with a blocking strategy.

Fractional factorial designs are designs in which partitions of the total number of the combinations of choice questions are used. Respondents are randomly assigned to a block and answer the choice questions in the assigned block instead of the full design. It produces sub-optimal designs.

Fractional factorial designs require the following assumptions: First, the orthogonality concept, which is a mathematical constraint requiring that all attributes are statistically independent to one another. In practice, it requires that each pair of attribute levels appears an equal number of times over the design and it implies zero correlations between attributes. Under the assumption of multicollinearity in linear multiple regression, non-orthogonal designs negatively affect the contribution of each independent attribute on the estimation of utility parameters.

The second assumption is provided by the main (ME) and interaction effects (IE). The effect is defined as the impact due to a particular attribute level on some(the?) response variable (i.e. choice), so the effect in the experimental design is the difference of attribute level means.

Therefore, the ME can be considered as the direct independent effect of each attribute upon the choice. That is, the difference in the means of each attribute level and the overall mean.

In contrast, the IE is defined as the effect upon a choice obtained by combining two or more attributes that would not have been observed and each of the attributes being estimated separately.

Finally, the concept of degrees of freedom represents the extent to which information is both required and available to estimate the model. Degrees of freedom are captured in the model such that S*(J-1), where S is the number of the choice sets and J is the number of alternatives in each choice set.

During the modelling phase, all main effects are generally taken into account while any possible interaction effects are ignored. Hence, the smallest number of effects to be estimated is equivalent to the number of main effects. This type of design is designated as orthogonal main effect only design.

Experimental design theory is based on two common objectives. On the one hand the ability to independently detect the effects of multiple variables on some observable outcome; on the other hand, the improvement of the statistical efficiency of the experiment.

Statistical efficiency in experimental design is related to an increased precision of parameter estimates for a fixed sample size. Otherwise, it is linked to the standard errors obtained from the experiment. Statistical efficiency is expected to yield lower standard errors given a sample size, or the same standard errors given a smaller sample size.

In the context of SC, experimental design theory is concerned with standard errors and covariates of parameters obtained from the models to be estimated and the data collected. Therefore, the primary consideration for design generation is the relationship between the design and the resulting model variance-covariance matrix.

The use of logit models to analyse discrete choice data requires a prior information about parameter estimates. This information is required in the form of priors to compute the expected utilities for each alternative.

As a result, the asymptotic variance-covariance (AVC) matrix, including expected standard errors, is obtained. The design efficiency comes from the AVC matrix with the aim to minimize the efficiency 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.

Based on the available information about the prior parameters β, three different types of *D-error* can be identified such as: i. D_z*-error* (z=zero) if no information is available and not even the sign of the parameters ($\beta=0$); ii. D_p*-error* (p=priors) if information is available with good approximation of β; iii. *D_b-error* (b=Bayesian) if information is available with uncertainty about the approximations of β.

D-errors are a function of the experimental design X and the prior values β, and are computed as follows:

$$D_z error = det\big(\Omega_1(X, 0)\big)^{1/H}, \tag{7}$$

$$D_p error = det\big(\Omega_1(X, \beta)\big)^{1/H}, \tag{8}$$

$$D_b error = \int det\big(\Omega_1(X, \beta)\big)^{1/H} \Phi\ (\beta|\theta) d\beta. \tag{9}$$

Where *H* is the number of parameters to be estimated. The *D-error* is normalized with *1/H* such that it is independent by the size of the problem.

2.3. Prospect Theory as frontier of choice analysis

Random Utility Model (RUM) assumes that a representative individual acts as utility maximizer; therefore, he/she chooses the alternative that maximizes his/her utility.

In order to recognize that individual decisions are made under uncertainty or risk (i.e. the outcome is not deterministic), expected utility theory (EUT) and other non-linear behavioural frameworks such as Prospect Theory (PT) are considered.

EUT finds its roots in the Bernoulli theory since 1738. It assumes that an individual compares the expected utility values associated with particular options.

Mongin (1997, pp.342) shows that individuals are assumed to compare:

> "*the weighted sums obtained by adding the utility values of outcomes multiplied by their respective probabilities*".

Differently to RUM – which assumes a linear-additive utility function for the observed consumer component – EUT models propose a non-linear functional form:

$$E(U) = \sum_m (p_m * x_m^r) \tag{10}$$

where *E(U)* is the expected utility; $m\ (=1,\ldots,m)$ are the possible outcomes for an attribute with $m>1$; p_m is the probability associated with the mth outcome; and r is the parameter to be estimated which explains respondents' attitudes towards risk ($r < 1$ for risk averse; $r = 1$ for risk neutral that implies a linear function form; $r > 1$ for risk loving) (Hensher et al. 2015).

Kinght (1921) emphasized the importance of distinguishing between risk and uncertainty. In particular, the economic environment seems characterized by unmeasurable uncertainty and measurable risks. The stochastic nature of uncertainty makes it difficult to measure or quantify the risk. Nonetheless, risks could be measured using historical results or by observation (Mongin 1997).

However, the distinction between uncertainty and risk is not yet clearly defined in the literature.

The difference between attitudes towards uncertainty and risk is empirically identified by using an objective and a subjective choice task (Andersen et al. 2014). The former aims to estimate attitudes towards risks; the latter to estimate attitudes towards uncertainty.

Alternatively, Knight (1921) uses known and unknown probabilities to distinguish between risk and uncertainty. Savage (1954) suggests subjective expected utility theory to understand decision making under uncertainty through the use of subjective probabilities to weight utilities.

Subjective probabilities estimation would not be feasible in discrete choice analysis, which allows for multiple alternatives and attributes.

In addition, objective assessment may also be used when probabilities are provided by experts which are fully informed about all possible outcomes, or by asking for respondent perceptions (Slovic 1987). Nevertheless, the objective assessment implies a different design of the stated choice experiment.

In this light, Prospect theory proposed by Kahneman and Tversky (1979) would be an alternative to EU theory.

Hensher et al. (2015) shows five significant differences of Prospect theory relative to EUT:

1. The choice behaviour process implies that individuals first frame the offered prospects by assigning them gains and losses relative to a reference point, and then choose the prospect with the highest value among the proposed prospects.
2. In contrast to the EU theory which considers a utility function defined over a final wealth, PT assumes a reference point to assess a value function for gains and losses.
3. A diminishing sensitivity is associated with the decreasing marginal value of both gains and losses.
4. A loss aversion is defined as the disutility of a loss. It has a higher value than the utility of an equivalent gain.
5. A non-linear probability weighting is considered to transform original probabilities and explain Allais' paradox (Allais 1953) where probabilities of occurrence are directly used as weights.

In 1992 Tversky and Kahneman extended the original PT to a cumulative prospect theory (CPT) version, in which the transformed probabilities are affected by the rank of the attribute outcomes in terms of preference.

The authors provided parametric formulae for the value functions under a constant relative risk aversion assumption and a one-parameter probability weighting function. This implies that the value function in the gain domain for $x > 0$ is $V = x\alpha$; and in the loss domain for $x < 0$ is $V = - \lambda (-x)\beta$, where α and β are the exponents of the value function over gains and losses, respectively; and λ is the coefficient of loss aversion in which a loss assumes more importance than a gain of equal size.

Therefore, the probability weighting function suggested by Tversky and Kahneman (1992) becomes:

$$w(p_m) = \frac{p_m^{\gamma}}{[p_m^{\gamma}+(1-p_m)^{\gamma}]^{\frac{1}{\gamma}}} \tag{11}$$

where *w(p)* is the probability weight function; p_m is the probability associated with the mth outcome for an alternative with multiple possible outcomes; and γ is the probability weighting parameter to be estimated and measures the shape of the weighting function.

In the original PT model, the value function is given by a probability weighting function:

$$OP(V) = \sum_m w(p_m)V(x_m) \tag{12}$$

where the transformed probabilities are independent of outcomes.

In contrast, in a CPT model, the transformation (i.e. π (p)) referred to decision weights, is performed over the cumulative distribution probability function. This function ranks (from worst to best) all potential outcomes in terms of preference. The cumulative prospect value is:

$$CP(V) = \sum_m \pi(p_m)V(x_m)$$

$$\pi(p_m) = w\,(p_m + p_{m+1} + \ldots + p_n) - w\,(p_{m+1} + p_{m+1} + \ldots + p_n)$$
$$for\ m = 1, 2, \ldots, n-1; and\ \pi(p_n) = w(p_n) \tag{13}$$

The increase in monetary gains (losses) leads to more satisfaction (dissatisfaction). Thus, respondents tend to be risk averse over certain gains and risk lovers over certain losses for a very small niche sample.

2.4. Focus Groups

One of the specific objectives of the methodology employed in the present Thesis is to understand the importance (i.e. the weighted importance) that the user assigns to each attribute.

The goal is to identify the evaluation dimension carried out by consumers. In particular, the links between the evaluation dimension and engineering or physical attributes – and to identify which dimension should be included in the two components of the utility function (i.e. systematic and random components).

Focus groups (FGs) methodology dates back to the 1920s and was primarily aimed at retrieving information about product preferences (Bogardus, 1926). The majority of authors refined this technique between late 1980s and 1990s (Morgan 1988; Stewart and Shamdasani, 1990; Patton 1990; ; Kitzinger, 1996; Morgan 1997). It has continued to grow in popularity in the past decades and it has been applied to many different purposes such as marketing issues (Rook, 2003), sociology (Carter et al. 2014; Cyr 2015), urban transport mobility (Dell'Olio et al. 2011) and political science (Morgan 1997; Krueger & Casey 2000; Thompson 2008).

FGs are a qualitative investigation practise based on a meeting or a series of meetings with a group of individuals which are randomly or accurately selected according to the purpose of the study. Generally, a moderator conducts a one or two-hour collective interview with a group of 6-12 participants for a deep discussion about the issues under consideration (Klein et al. 2007). The FG approach provides information about participant opinions considering life experiences, expectations and knowledge about the specific matter to debate.

The discussion can be recorded on a tape or video. Prior to the discussion, the moderator welcomes the participants and introduces the scope of the research or issue under study.

The moderator also examines how opinions/decisions are debated during the discussion including nonverbal nuances and emotional contents identified through voice patterns, body movements, eye contacts and other physical gestures. All verbal and nonverbal expressions are finalised to develop a profile of participant's attitude.

To overcome the generalized statement of opinions collected with surveys with limited responses, participation to FGs ensures a certain degree of diversity among individuals to encourage group discussion (Klein et al. 2007). FGs allow to understand the underlying assumptions of people's knowledge and experiences about a particular issue. The group discussion brings out opinions that are not always readily available, but it can be open to group interaction. Opinions may change during the discussion phase and FGs help to uncover the reasons and circumstances of the change (Robinson 1999).

An important step of FGs technique is data collection. The standard approach is to undertake audio recordings, verbatim transcription and text analysis (Greenwood et al. 2017).

Significant time and resources are useful to transcribe, analyse and manage the obtained data. In addition, to support the qualitative analysis, AHP(Analitical Hierarchy Process)-based pairwise comparisons are also useful to obtain coherent judgments (Zaim et al., 2012).

The AHP approach is applicable to individual and group decision settings. In a group setting, Lai et al. (2002) identifies four ways to set the priorities: consensus; vote or compromise; geometric mean of individuals' judgments; and separate models or players.

Bentes et al. (2012) uses AHP during FGs as a group decision support tool that, according to Saaty (1987), promotes effective group interaction and participation. Moreover, the use of an agreement-building approach allows a more balanced perception of the importance of indicators and perspectives (expressed with weights). During the implementation of FGs, discussion among participants implies a further advantage providing an explicit justification for reasoning of their evaluation. However, the use of weights for group decision might influence individual opinions and over- or underestimate single judgments. For these reasons, the present Thesis adopts the AHP scale at the final stage of the discussion within each FG.

2.5. Clustering with innovativeness scales

Innovation was firstly focused on the behavior of firms (Shumpeter 1934). Since then, the contribution of innovation studies has reached a multidisciplinary approach such that it finds applications in social psychology, communication, public relation, advertising, marketing, consumer behavior, public health, and rural sociology (Rogers 2003).

Rogers' Theory of Diffusion of Innovation (2003) helps to explain a heterogeneous adoption behavior behind the effect of standard and ancillary variables. The theory suggests that innovation diffuses amongst people as a function of their preferences and attitudes. In particular, (Rogers 2003, pp.12) defines innovation as:

"an idea, practice or object perceived as new by the individual".

With this definition it is evident the role of perception of potential end users to define the degree of newness of a product. This key criterion underlines that a technological invention can be considered an innovation without people perception of being new. Otherwise, a discovery that no-one knows is considered a mere invention, not an innovation.

Furthermore, Rogers suggests that the innovation decision process begins when an individual or a decision-making is exposed to an innovation and understand how it works.

This implies the consideration of five stages of the innovation decision making by Rogers, as follows: knowledge, persuasion, decision, implementation and confirmation.

The knowledge stage is generally conditioned by personality variables and socioeconomic characteristics. Some people may be considered more sensitive to new ideas and they are often the strategic target group for marketers to diffuse an innovation.

The persuasion stage, instead, indicates the awareness of people for innovation after an evaluation of its characteristics, including advantages, complexity and price.

As a function of these characteristics, product's perception varies across subjects and depends both on personal attitudes and product attributes. In this case, personal attitudes would affect the WTP for innovation.

The WTP for an innovative product would, in turn, affect the decision stage, in which innovation is adopted or rejected.

During the implementation stage the subject purchases the innovation and assess its usefulness. As a consequence, in the confirmation stage individuals confirm using the innovative product or not.

During the decision process, subjects receive information or are exposed to communication, such as public policy campaigns. In accordance to Rogers, new technology may be subject to four diffusion dimensions.

The first dimension is the perception of innovation's characteristics and this is further declined into four measurable functional constructs such as: i) complexity (i.e. how much an innovation is perceived as difficult to use or understand); ii) compatibility (i.e. how much an innovation is perceived as consistent with existing practices or habits and routines); iii) trialability (i.e. how much an innovation may be experimented with before adoption); iv) relative advantage (i.e. how much an innovation is perceived as superior to current practice).

Furthermore, (Franceschinis, Thiene, et al. 2017) added four more functional constructs such as: performance risk (i.e. uncertainties about new product's performance); social risk (i.e. uncertainty about how innovation adoption might be perceived by relevant others); knowledge (i.e. how much familiar is the innovation); environmental friendliness (i.e. how much an innovation is perceived as environmentally-friendly).

The second diffusion dimension suggested by Rogers is the communication channel, which is defined as a process of information creation and sharing among participants with the aim of reaching a mutual understanding. This process requires three elements, as follows: an innovation, two subjects or other units of adoption, and a communication channel between them.

The third diffusion dimension is the timing of adoption, which is determined by the innovativeness degree of the individual adopter measured in terms of the time of adoption. Considering the above, adopters can be classified into innovators, early adopters, early majority, late majority and laggard (*Fig.3*).

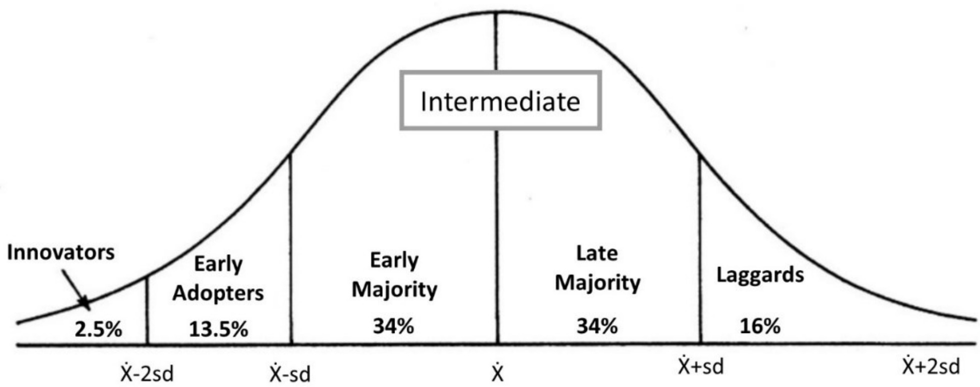


Fig. 3 – Rogers's adoption curve (2003).

Innovators are defined as subjects willing to experience new products and are not risk-averse of unprofitable and unsuccessful innovations.

Early adopters generally hold more likely a leadership role in the society system. Similarly, the early majority has a good interaction with other members of the social system, but with a minor leadership role.

Differently, members of the late majority are skeptical about innovation. Outcomes, economic necessity and peer could be an incentive to innovation adoption.

Finally, laggards are considered as the most conservative and skeptical about innovation.

According to (Franceschinis, Thiene, et al. 2017), the diffusion of innovation is a useful method to measure heterogeneity across respondents. First, behavioral classes are identified in terms of the average score of the innovativeness scale; and second, variations among individuals within the same group (i.e. within-group heterogeneity) are identified and analysed. The present Thesis will use

Rogers et al. (2003, 2005) insights to investigate social acceptance to wind energy and the degree of innovation diffusion of this technology across respondents.

2.6. Chapter conclusions

SPs present important advantages in comparison to contingent valuation methods.

However, preference analysis and price estimation of attributes, as defined in a multi-value space through CEs, may present more complexity.

The complex model of valuation through a choice modelling approach has potential for success in situations in which practical issues limit CV.

People are asked to choose their preferred alternative within a set of two or more alternatives and among different choice sets. Alternatives are different in relation to a combination of attribute levels and across attributes. It is interesting to investigate how people change their preferences in relation to the change occurred in attribute levels and determine variations of people's well-being.

Advantages of CEs could be summarized as follows:

- Disaggregation of the product in different value attributes;
- Avoiding of part-whole bias issues;
- Inclusion of the monetary measure (e.g. price) as implicit element, reducing distortions due to strategic behavior;
- Modelling of non-collinear attributes;
- Estimation of a high number of parameters through the use of a D-error method;
- Controlling the stimuli to which respondents are subject to;
- Evaluation of marginal variations related to hypothetical multi-dimensional scenarios;
- Multi-dimensional, multi-attribute and multi-value scenarios survey.

However, all of the above presents some drawbacks in terms of timing of the analysis such as: survey design, survey management, and data collection. Furthermore, the existing of hypothetical bias in the present CE application are supported by the honesty priming technique.

Finally, innovativeness scales help the present study to investigate heterogeneity within the sample.

In addition, to reduce the errors terms due to analyst limitations, the use of FGs and pilot surveys would be an advantage for a deeper investigation of the problem under study.

CHAPTER 3
PRELIMINARY STUDIES

The present Chapter provides the basis for the case study presented in this Thesis. It illustrates the pilot studies to retrieve useful preliminary results in terms of wind energy attributes. The pilot studies have been fundamental for supporting attributes selection and survey design. Firstly, the chapter highlights results from a desk analysis of wind energy market at national and regional level and motivates the choice of the Apulia Region as the area under study. Secondly, a general examination of attributes has been conducted through the implementation of a pilot survey to assess early perceptions of the general public. Thirdly, the chapter details the results of a further tool to understand public perception about wind energy such as FGs technique. Finally, the concluding section illustrates the attributes that will be considered for the construction of CEs based on the results obtained by early pilot studies.

3.1. Desk analysis of wind energy market

Nowadays energy is an essential factor for economic growth and prosperity. At global level, energy serves to satisfy human needs and improve the quality of life. Energy availability is a prerequisite for the functioning of current societies, and in the modern technological age, the demand for energy increases rapidly.

Requirements of energy resources affect policy decisions of countries in all stages of development.

In the last 10 years, despite a stable trend in energy consumption, the energy requirement amounts to about 1,200 kWh per person for domestic use (ISTAT census 2012).

In 2004, with the Treaty of Lisbon, the European Union sets the basis for a new European energy era providing guidelines for renewable energy policies.

Almost a decade after the Kyoto Protocol, the EU calls for the Energy Climate Package (also called 20-20-20 Strategy) with the objective of strengthening the environmental sustainability of the European economy. This regulatory package pursues three aims:

1. Greenhouse gas emissions (GHGs) reduction by at least 20%;
2. Increase the share of renewable energy consumption to at least 20%;
3. Improve the energy efficiency of 20%.

The 2020 energy strategy also establishes a further 10% share of renewable energy to be met by the aviation sector by 2020.

In October 2014, the European Council agreed on a new Framework for climate change and energy with a target for the period 2020-2030. The targets for 2030 are the following:

1. 40% reduction in GHGs compared to 1990 levels;
2. Increase the share of renewable energy consumption to at least 27%;
3. Improve energy efficiency by at least 27%;
4. Completion of a EU internal energy market by achieving an interconnection across Member States by 10% by 2020, subject to review by 2030.

To reach the above targets the EU energy policy highlights the strengthening and reforming of the existing Emission Trading Scheme (ETS); the establishment of new indicators for energy security and a new governance system to guarantee a sustainable energy in Europe.

In terms of long-term energy strategy, the EU with the Energy Roadmap sets the basis for a voluntary policy to reach a further reduction of GHGs by 80-95% compared to 1990 levels by 2050. The EU Energy Roadmap will primarily aim at decarbonising the EU economy, increase the share of renewable energy, increase investments in the power sector, and secure energy supply.

As a consequence of the above regulations and guidelines, Italy should increase its renewable energy content by 17%.

In 2016, 37% of total energy production in Italy was sourced from renewable sources (GSE 2016). Effective production of electricity from renewables was about 108 TWh (GSE 2016).

In this framework, wind energy appears as the top renewable energy source in Italy, with a total production of 17.7 TWh of electricity (+19.2% compared to 2015) and about 248MW of power installed (+2.7% compared to 2015) (GSE 2016).

Final gross consumption of renewable energy in Italy has grown from 0.76 Mtoe in 2010 to 1.42 Mtoe in 2016, with an 8% increase in the last year (GSE 2016).

With the above figures, Italy reached the target of 17.41% exceeding the target of 17% established in the Directive 2009/28/CE (GSE 2016).

The total national renewable power installed is in the figure of 52,273MW (GSE 2016). At the end of 2016, Lombardy, in the north of Italy, was the region with the highest concentration of installations providing 15.7% of total national power (GSE 2016). At sub-regional level, Brescia appears to be the province with the major power installed (5.4% of total national power) followed by the provinces of Sondrio (4.4%) and Bolzano (3.8%) (GSE 2016). The second and third region in the top three, are Apulia region in the south of Italy (10.3%) and Piedmont in the north of Italy (8.9%) (GSE 2016).

Apulia region is therefore the first region in the south of Italy ranked first in terms of renewable energy power. At sub-regional level in southern Italy, the province of Foggia ranks first with 4.7% of total national power mostly due to wind energy installations (GSE 2016).

At the end of 2016, Italy had a total of 3,598 wind platforms. 89% (3,203 installations) wind farms with a 1MW power or less (GSE 2016); 90% (8,426.3 MW) of national wind power is concentrated in 280 wind farms with a 10 MW power or higher (GSE 2016). All of the above provides a total of 9,410MW power (GSE 2016).

Wind energy production amounts to 17,689 GWh, which is 16.4% of total renewable energy production (GSE 2016). Electricity generated from wind platforms appears in the figure of 91% (16,096 GWh) from installations with 10 MW power or higher, 6% (1,051 GWh) from installations between 1 and 10 MW power, and 3% (541 GWh) from installations with 1MW power or less (GSE 2016).

Environmental and territorial characteristics of wind farms location – such as wind, orography and accessibility – are fundamental for wind platforms construction and operation. In southern Italy, the above conditions are particularly favourable such that 97% of national wind power and 89% of wind farms are installed in this regional context. Apulia region hosts the major number of wind energy installations, 892 in total, generating 2,440.9MW (GSE 2016). It means that about 25% of wind installations and about 26% of wind power, and about 27% of wind energy production is distributed by the Apulia region. Apulia region can be considered as representative of the national wind energy production. In particular, 22% of national production comes from the province of Foggia.

The above picture supports the case study developed in the present Thesis with a particular reference to this region.

3.2. A pilot survey to evaluate wind farm risk perception

A particular case of Italian wind development is the area of Apulia region with an extension to its neighbour region, Basilicata, in the south of Italy.

This area presents the greatest number of wind energy installations, which represents about 45% of national wind farms (GSE 2016).

It is reasonable to believe that this is also an area with controversial issues in terms of social acceptance to wind energy. On the one hand, there exists a high level of social consensus towards the technology under consideration, as well as towards other renewable sources. This is supported by the results of the "theoretical consensus" found in the investigations carried out at the national level. On the other hand, there also exists a latent or manifest - though not exclusively, local -

dissent and even conflict feeling in relation to the concrete installation of the plants in a specific territorial context.

As discussed in Chapter 1, the international literature has supported this view in terms of the NIMBY syndrome.

The first pilot survey investigates if dissent based behaviours appear exclusively on local interests or connected to more complex issues that arise with specific reference to the 'features' of the territory under investigation, its management and the relative choices of wind energy location.

The pilot study has the objective of investigating public perception for each attribute considered in the literature (see Chapter 1). The survey was structured to investigate the order of importance of all aspects affecting public perception grouped into macro-categories.

3.2.1. The survey

The survey was conducted considering residents of Apulia and Basilicata regions. The interviewees had to evaluate the importance of the main socio-economic and environmental impacts of wind energy developments.

Table 6 summarises the main attributes clustered into macro-categories.

Table 6 - Perceived attributes and sub-attributes of wind energy developments.

Macro-catego-	Aesthetic impact	Environmental impact	Economic impact	Functional efficiency	Noisiness	Inadequacy of institutions
Attributes	Number of turbines	Management impact	Maintenance costs	Useful life	Turbine distance	Misinformation
	Turbines distance	Implementation impact	Implementation costs	Amount of energy production	Turbine dimension	No transparency of public procurement
	Turbines dimension	Dismantling impact	Dismantling costs	Average daily operation	Number of turbines	Lack of benefit knowledge
	Turbines colour	Faunal alteration	Profit			
	Location	Agriculture production alteration				

Interviewees were asked to assign a value of importance according to psychometric Likert scale from 1 to 5, where 1=not important and 5=very important.

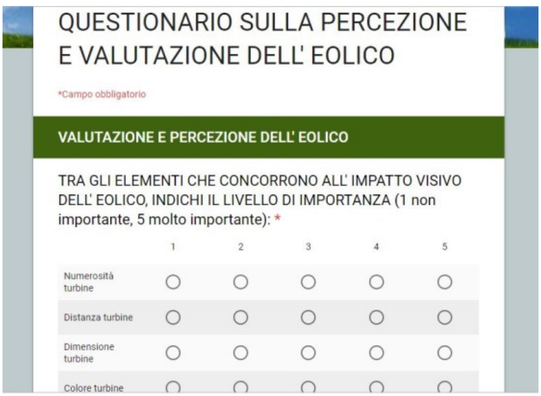


Fig.4 – Screenshot of the survey.

3.2.2. The sample

Our sample size is represented by 176 respondents as shown in *Table 7.*

Table 7 – Socio-demographic information of the sample.

Variable	Obs.	Freq.	Perc.	Mean	Std. dev.
Gender	176				0.5
Male		91	52		
Female		85	48		
Age	176			2.64	1.02
18-25		17	10		
26-35		76	43		
36-50		42	24		
51-65		35	20		
>65		6	3		
Education	176				0.75
Elementary/Junior high school degree		17	10		
High school degree		74	42		
Bachelor degree		74	42		
Post-graduate degree		11	6		
Employment	176				
Employee		103	58		
Self-employed/ Entrepreneur		16	9		
Student		26	15		
Unemployed		24	14		
Retired		7	4		

Interviewees show a medium-high perception relatively to the importance of wind issues (macro-categories) proposed in the survey. The participants' perception of 'Functional efficiency', 'Inadequacy of institutions' and 'Economic Impact' have been more important (*Table 8*).

'Environmental impact' and 'Aesthetical impact' seemed less 'perceived' factors compared to other factors (*Table 8*).

In other words, respondents would particularly care for the quality of wind technology and related economic costs. Consequently, landscape and environmental aspects would represent minor aspects in the presence of a well-managed wind farm.

Table 8 – Descriptive statistics of macro-categories evaluation.

Variable	Obs.	Mean	Std. Dev.	Min	Max
Aesthetic impact	176	3.22	1.208	1	5
Environmental impact	176	3.18	1.318	1	5
Economic impact	176	3.57	1.135	1	5
Functional efficiency	176	3.85	1.147	1	5
Noisiness	176	3.50	1.168	1	5
Inadequacy of the institutions	176	3.77	1.21	1	5

A critical issue of wind energy development in Italy is bureaucracy and the approval time of a plant. 87% of respondents perceive a long approval time as an obstacle to wind energy development.

However, more incentives and savings in the energy bill could compensate for long approval times.

Table A1 shows the correlation matrix of attributes considered in the survey. All attributes, but ‘Turbines colour’, result positively correlated to other attributes. ‘Turbines colour’ appears, in fact, correlated with other attributes of the same macro-category (Aesthetical impact).

‘Faunal alteration’ presents a high correlation value with ‘Implementation costs’ (0.60) and with the ‘Amount of energy production’ (0.62). This means that an increase of the importance of these two attributes would favour an increase in the perception of the faunal alteration.

An interesting aspect to note is the high correlation value between ‘Management costs’ and ‘Misinformation’ (0.62) and ‘Management costs’ and ‘Lack of benefit knowledge’ (0.60); and between ‘Dismantling costs’ and ‘Misinformation’ (0.61). These results would support the close link between economic aspects and public information and knowledge in terms of social perception. An efficient participation of citizens to the developments of local renewable energy policies could drive social perception to accurately ‘weigh’ public benefits relatively to the costs.

Moreover, ‘Misinformation’ and ‘Lack of benefit knowledge’ are positively correlated with ‘Useful life’ (0.63), ‘Amount of energy production’ (0.61 and 0.71, respectively) and ‘Average daily operation’ (0.61 and 0.63, respectively).

It can be argued that a positive perception of functional efficiency could be supported by public information about these aspects.

3.2.3. Analysis of variance

The present section illustrates an analysis of variance among group of respondents to explain potential differences of social perception. Respondents are grouped according to ‘genre’, ‘age’ and ‘Importance of location’. The creation of these sub-groups needs an aggregation of data to obtain unbiased results. In particular, the ‘genre’ group considers the sample split between male and female respondents. The ‘age’ group takes into account five classes of age as described in *Table 7*. The ‘Importance of location’ group considers the sample divided into ‘not at all important’, ‘slightly important’, ‘moderately important’, ‘very important’, ‘extremely important’. The analysis of variance (ANOVA) is used to test the differences existing between the mean values of two or more groups or the mean values within groups. The null hypothesis considers that all groups are random samples of the same population and it helps to test whether differences in respondents’ perceptions exist relative to the location and the wind farms under study.

Table 9 shows the main results of the ANOVA test. Each row indicates the relevant attributes provided to respondents during the survey and aggregated in macro-categories to carry out the ANOVA analysis. It also illustrates the statistical values of the Fisher test (F-test) and the Bartlett test.

The F-test tests the differences between or within sample means. The Bartlett test tests the null hypothesis of equal variance across groups. Each of the two tests are computed over the relevant groups (i.e. genre, age and importance of location).

Bartlett's test results are not statistically significant for the majority of considered attributes. In other words, the null hypothesis is not rejected and the ANOVA method is statistically valid.

Main results of the F-test suggest the existence of differences between or within groups in few cases only, except in the sub-group 'Importance of location'. This would suggest an overall homogeneity in respondent perception for wind farms in Apulia and Basilicata regions.

The perception of the remaining attributes is statistically significant at 95% confidence interval (C.I.) among different levels of importance of location.

No attribute is statistically significant among different age classes. This means that social perception would be somehow similar across age classes.

As for the perceived differences in the genre group, 'Turbine dimension' and 'Management impacts' appear both statistically significant (90% C.I).

Table 9 - Analysis of variance (including Bartlett's test) between groups in the sample: genre (male vs female), age (18-25 vs 26-35 vs 36-50 vs 51-65 vs >65), importance of location (not important at all, slightly important, moderately important, very important, extremely important).

		Fisher test			Bartlett test ($\chi 2$)		
		Genre	Age	Importance of location	Genre	Age	Importance of location
Aesthetic impact	Number of turbines	0.59 (0.44)	1.92 (0.11)	25.62 (0.00)**	1.25 (0.26)	2.78 (0.60)	24.12 (0.00)
	Turbines distance	2.10 (0.15)	0.79 (0.53)	21.56 (0.00)**	0.06 (0.81)	1.30 (0.86)	6.64 (0.16)
	Turbines dimension	2.95 (0.09)*	1.19 (0.32)	39.25 (0.00)**	0.67 (0.41)	3.68 (0.45)	15.70 (0.00)
	Turbines colour	0.35 (0.56)	0.33 (0.86)	11.88 (0.00)**	0.03 (0.87)	2.12 (0.71)	19.63 (0.00)
	Location	1.36 (0.25)	1.84 (0.12)		1.24 (0.27)	4.42 (0.35)	
Environmental impact	Management impact	2.73 (0.10)*	0.25 (0.91)	9.21 (0.00)**	0.02 (0.89)	1.19 (0.88)	11.13 (0.03)
	Implementa-tion impact	0.23 (0.63)	0.31 (0.87)	14.76 (0.00)**	0.53 (0.47)	1.65 (0.80)	8.34 (0.08)
	Dismantling impact	0.96 (0.33)	0.41 (0.80)	20.48 (0.00)**	0.01 (0.92)	1.11 (0.89)	12.15 (0.02)
	Faunal alteration	0.22 (0.64)	0.64 (0.63)	16.79 (0.00)**	0.10 (0.75)	1.07 (0.90)	15.24 (0.00)
	Agriculture production alteration	0.73 (0.39)	0.18 (0.95)	8.81 (0.00)**	0.01 (0.90)	0.71 (0.95)	7.94 (0.09)
Economic impact	Maintenance costs	1.21 (0.27)	0.57 (0.68)	8.03 (0.00)**	0.06 (0.80)	0.72 (0.68)	3.89 (0.42)
	Implementa-tion costs	0.22 (0.64)	0.08 (0.99)	7.61 (0.00)**	0.07 (0.79)	0.45 (0.98)	5.81 (0.21)

	Dismantling costs	0.08 (0.77)	0.23 (0.92)	12.90 (0.00)**	0.00 (0.98)	2.70 (0.61)	6.72 (0.15)
	Profit	1.63 (0.20)	1.71 (0.15)	3.82 (0.00)**	0.07 (0.80)	3.52 (0.48)	2.04 (0.73)
Functional efficiency	Useful life	0.24 (0.63)	0.20 (0.94)	10.77 (0.00)**	3.29 (0.07)	2.70 (0.61)	10.31 (0.04)
	Amount of energy production	0.13 (0.72)	0.39 (0.81)	13.01 (0.00)**	2.65 (0.10)	0.56 (0.97)	21.73 (0.00)
	Average daily operation	0.02 (0.88)	0.49 (0.74)	13.15 (0.00)**	0.08 (0.78)	2.08 (0.72)	11.72 (0.02)
Noisiness	Turbine distance	1.17 (0.28)	0.93 (0.45)	8.91 (0.00)**	0.16 (0.69)	4.52 (0.34)	6.10 (0.19)
	Turbine dimension	0.41 (052)	1.10 (0.36)	11.09 (0.00)**	0.00 (0.94)	1.42 (0.84)	2.70 (0.61)
	Number of turbines	0.00 (0.99)	0.59 (0.67)	12.69 (0.00)**	0.08 (0.78)	2.82 (0.59)	9.64 (0.05)
Inadequacy of the institutions	Misinfor-mation	0.17 (0.68)	0.05 (0.99)	13.33 (0.00)**	0.01 (0.90)	2.99 (0.56)	15.75 (0.00)
	No transpar-ency of public procurement	0.04 (0.83)	0.28 (0.89)	3.61 (0.01)**	0.05 (0.82)	1.89 (0.76)	3.89 (0.42)
	Lack of benefit knowledge	0.13 (0.71)	0.36 (0.84)	7.03 (0.00)**	0.62 (0.43)	4.13 (0.39)	9.32 (0.05)

Source*: Our elaborations. p-Value in brackets. ***Statistically significant at 99% C.I level; **Statistically significant at 95% C.I. level; *Statistically significant at 90% C.I. level.*

3.2.4. Ordered logit estimation

An Ordered Logit Regression has been computed with the aim to understand the relative importance of sub-factors to the 'location' variable. The model results statistically significant at 99% C.I.

However, one of the assumption of ordered logistic regression is that the relationship between each pair of outcome groups is the same. In other words, ordered logistic regression assumes that the coefficients that describe the relationship between the lowest versus all higher categories of the response variable are the same as those considering the relationship between the next lowest category and all higher categories. This is called the proportional odds assumption or the parallel regression assumption.

Because the relationship between all pairs of groups is the same, there is only one set of coefficients as well as only one model. In order to verify this assumption, a Brant test has been estimated to test the proportional odds assumption. In this case, the null test is that there is no difference in the coefficients between models.

The Brant test of the ordered logistic regression model rejects the null hypothesis. Based on this result, the assumption of the parallel lines is relaxed and the generalised ordered logistic model as described by Williams (2016) is considered.

The output of the generalised ordered logistic is analogous to a sequence of binary regressions and can be detailed as follows: the first panel of binary regression comprises class *1* which is run against *2,3, 4,* and *5;* the second panel of binary regression *1* and *2* is run against *3, 4*, and *5;* the third one *1, 2,* and *3* is run against *4* and *5*; and finally the last panel of binary regression *1, 2, 3,* and *4* is run against category *5*.

The estimated generalised ordered logistic model is statistical significant at 99% C.I. (*Table 10*).

The interpretation of the output in *Table 10* may look odd; nonetheless a positive coefficient indicates a higher value of the independent variable and therefore it is more likely that the respondent attitude will favour higher categories than lower ones, and viceversa.

The first panel of estimated regression is not statistically significant across all attributes; for this reason we exclude it in *Table 10.*

Table 10 – Generalised Ordered Logit model estimates. Dependent variable 'Location'.

Variable	Coefficient	p-Value	St.error
Aesthetic impact			
Number of turbines			
1&2 vs 3, 4 & 5	1.8983	0.053**	0.9807
1, 2 & 3 vs 4& 5	3.1292	0.132	2.0768
1, 2, 3 & 4 vs 5	0.8862	0.322	0.8951
Turbines distance			
1&2 vs 3, 4 & 5	0.5054	0.450	0.6695
1, 2 & 3 vs 4& 5	-4.3516	0.029**	1.9939
1, 2, 3 & 4 vs 5	0.0609	0.946	0.8983
Turbines dimension			
1&2 vs 3, 4 & 5	-0.4289	0.571	0.7561
1, 2 & 3 vs 4& 5	4.7690	0.005***	1.6847
1, 2, 3 & 4 vs 5	0.6431	0.396	0.7585
Turbines colour			
1&2 vs 3, 4 & 5	1.0492	0.037**	0.5033
1, 2 & 3 vs 4& 5	3.0565	0.003***	1.0438
1, 2, 3 & 4 vs 5	0.2553	0.551	0.4286
Environmental impact			
Management impact			
1&2 vs 3, 4 & 5	-1.2809	0.229	1.0646
1, 2 & 3 vs 4& 5	5.8339	0.023**	2.5683
1, 2, 3 & 4 vs 5	-0.3007	0.721	0.8417
Implementation impact			
1&2 vs 3, 4 & 5	-0.7176	0.502	1.0697
1, 2 & 3 vs 4& 5	2.8592	0.090*	1.6840
1, 2, 3 & 4 vs 5	0.0670	0.950	1.0738
Dismantling impact			
1&2 vs 3, 4 & 5	2.4569	0.005***	0.8796
1, 2 & 3 vs 4& 5	-1.5265	0.421	1.8952
1, 2, 3 & 4 vs 5	-0.5988	0.531	0.9558
Faunal alteration			
1&2 vs 3, 4 & 5	0.8618	0.480	1.2210

1, 2 & 3 vs 4& 5	-3.4273	0.010**	1.3230
1, 2, 3 & 4 vs 5	2.1516	0.004***	0.7432
Agriculture production alteration			
1&2 vs 3, 4 & 5	-0.9092	0.488	1.3120
1, 2 & 3 vs 4& 5	1.2403	0.199	0.9664
1, 2, 3 & 4 vs 5	-0.0739	0.895	0.5602
Economic impact			
Maintenance costs	-0.6908	0.278	0.6374
1&2 vs 3, 4 & 5	0.7722	0.456	1.0365
1, 2 & 3 vs 4& 5	-0.1825	0.865	1.0766
1, 2, 3 & 4 vs 5			
Implementation costs			
1&2 vs 3, 4 & 5	-0.0987	0.927	1.0743
1, 2 & 3 vs 4& 5	0.0859	0.940	1.1337
1, 2, 3 & 4 vs 5	-2.1817	0.078*	1.2391
Dismantling costs			
1&2 vs 3, 4 & 5	0.7438	0.396	0.8756
1, 2 & 3 vs 4& 5	-1.7565	0.043**	0.8661
1, 2, 3 & 4 vs 5	0.5417	0.488	0.7810
Profit			
1&2 vs 3, 4 & 5	-0.4536	0.382	0.5191
1, 2 & 3 vs 4& 5	1.7266	0.072*	0.9594
1, 2, 3 & 4 vs 5	0.9372	0.253	0.8192
Functional efficiency			
Useful life			
1&2 vs 3, 4 & 5	-0.0624	0.907	0.5364
1, 2 & 3 vs 4& 5	-2.7676	0.017**	1.1554
1, 2, 3 & 4 vs 5	0.2787	0.741	0.8441
Amount of energy production			
1&2 vs 3, 4 & 5	0.9977	0.176	0.7376
1, 2 & 3 vs 4& 5	-0.9372	0.493	1.3670
1, 2, 3 & 4 vs 5	1.2094	0.244	1.0388
Average daily operation			
1&2 vs 3, 4 & 5	0.1631	0.801	0.6481
1, 2 & 3 vs 4& 5	-0.2285	0.844	1.1617
1, 2, 3 & 4 vs 5	1.3378	0.262	1.1932
Noisiness			
Turbine distance			
1&2 vs 3, 4 & 5	1.0924	0.197	0.8461
1, 2 & 3 vs 4& 5	-2.3010	0.032**	1.0734
1, 2, 3 & 4 vs 5	0.3382	0.711	0.9145
Turbine dimension			
1&2 vs 3, 4 & 5	-2.2997	0.012**	0.9120
1, 2 & 3 vs 4& 5	-1.6937	0.295	1.6163
1, 2, 3 & 4 vs 5	-1.9103	0.022**	0.8310

Number of turbines			
1&2 vs 3, 4 & 5	0.7312	0.220	0.5956
1, 2 & 3 vs 4& 5	1.4801	0.088*	0.8680
1, 2, 3 & 4 vs 5	0.5818	0.522	0.9093
Inadequacy of the institutions			
Misinformation			
1&2 vs 3, 4 & 5	0.4826	0.489	0.6967
1, 2 & 3 vs 4& 5	2.4183	0.093*	1.4414
1, 2, 3 & 4 vs 5	4.4201	0.001***	1.3129
No transparency of public procurement			
1&2 vs 3, 4 & 5	-0.6232	0.358	0.6782
1, 2 & 3 vs 4& 5	1.5721	0.141	1.0687
1, 2, 3 & 4 vs 5	-2.3400	0.005***	0.8404
Lack of benefit knowledge			
1&2 vs 3, 4 & 5	0.0422	0.945	0.6085
1, 2 & 3 vs 4& 5	-2.9867	0.030**	1.3744
1, 2, 3 & 4 vs 5	-1.6183	0.059*	0.8556
Log-Likelihood	-78.673024		
Obs	176		

Source: Our elaborations. ***Statistically significant at 99% C.I level; **Statistically significant at 95% C.I. level; *Statistically significant at 90% C.I. level.

Table 11 shows the predicted probability of each attribute to the location of wind farms.

Table 11 – Margins of attribute 'Location', (1=not important; 2= very important).

	Predicted outcome 1, 2 & 3 vs 4& 5			Predicted outcome 1, 2, 3 & 4 vs 5		
Variable	Margin	p-Value	St.err.	Margin	p-Value	St.err.
Aesthetic impact						
Turbines colour						
_at						
1	0.91	0.00***	0.07	0.08	0.22	0.06
2	0.94	0.00***	0.06	0.06	0.32	0.06
3	0.29	0.08*	0.16	0.55	0.00***	0.09
4	0.29	0.13	0.19	0.55	0.00***	0.10
5	0.10	0.48	0.14	0.50	0.03**	0.22
Turbines distance						
_at						
1	0.20	0.59	0.37	0.57	0.00***	0.04
2	0.39	0.17	0.28	0.50	0.00***	0.04
3	0.59	0.00***	0.19	0.36	0.02**	0.18

4	0.79	0.00***	0.19	0.19	0.27	0.04
5	0.86	0.00***	0.19	0.12	0.46	0.26
Environmental impact						
Faunal alteration						
_at						
1	0.96	0.00***	0.06	0.03	0.65	0.06
2	0.93	0.00***	0.08	0.06	0.39	0.07
3	0.35	0.13	0.23	0.52	0.00***	0.14
4	0.18	0.35	0.20	0.56	0.00***	0.09
5	0.39	0.18	0.29	0.50	0.01**	0.19
Inadequacy of the institutions						
Lack of benefit knowledge						
_at						
1	0.93	0.00***	0.16	0.00	0.67	0.00
2	0.90	0.00***	0.17	0.00	0.64	0.00
3	0.51	0.07*	0.28	0.42	0.05**	0.21
4	0.21	0.21	0.17	0.57	0.00***	0.08
5	0.48	0.05**	0.24	0.44	0.01**	0.18

	Predicted outcome 1, 2 & 3 vs 4& 5			Predicted outcome 1, 2, 3 & 4 vs 5		
Variable	Margin	p-Value	St.err.	Margin	p-Value	St.err.
Environmental impact						
Implementation impact						
_at						
1	0.00	0.69	0.00	0.99	0.00***	0.03
2	0.00	0.59	0.00	0.99	0.00***	0.02
3	0.86	0.00***	0.13	0.01	0.38	0.01
4	0.93	0.00***	0.08	0.00	0.57	0.00
5	0.96	0.00***	0.06	0.00	0.57	0.00
Log-Likelihood	-78.673024					
Obs	176					

Source: Our elaborations. ***Statistically significant at 99% C.I level; **Statistically significant at 95% C.I. level; *Statistically significant at 90% C.I. level.

The predicted probability of considering 'Location' an important attribute increases by 0.91 or 0.94 if the perception of 'Turbines colour' is in the lowest categories of this independent variable.

The same behaviour is seen with the predicted probability of 'Location' with the predictors 'Faunal alteration' and 'Lack of benefit knowledge'.

The predicted probability of considering ‘Location’ as an attribute which is in the middle category of importance to wind farm developments increases by 0.86 if ‘Turbine distance’ is perceived as a very important predictor. On the contrary, the predicted probability of considering ‘Location’ an important attribute increases by about 0.50-0.57 if the perception of ‘Turbine distance’ is in the lowest categories (i.e. 1=not very important; 2=not important).

Indeed, the predicted probability of ‘Location’ is not important if ‘Lack of benefit knowledge’ refers to the middle category (0.93); and important if ‘Lack of benefit knowledge’ refers to higher categories (i.e. 0.48 and 0.51).

Finally the predicted probability of considering ‘Location’ an important attribute increases by about 0.99 if the perception of ‘Implementation impact’ is in the lowest categories (i.e. 1=not very important; 2=not important).

3.2.5. Discussion of results

The obtained results from the above pilot study reveal a certain degree of controversy. First, the homogeneity of the sample would explain a relatively common perception about issues and benefits of wind energy in the area of Apulia and Basilicata regions.

Second, differences in resident perception would result in terms of location of wind farms. This would support the emotional (i.e. the sentiment) attitude of residents to their territory (Jobert et al. 2007; Enevoldsen & Sovacool 2016). Aesthetical impact of wind farms would be considered a minor factor compared to other issues proposed. This result seems interesting because it contrasts the majority of literature (Strazzera et al. 2012; Sunak & Madlener 2016).

Local communities would care most about economic aspects and technological efficiency of wind farms rather than other aspects; and are eager to achieve more information about social benefits.

Third, the above results suggest relevant policy indications to drive and retrain wind energy markets. In particular, citizens’ participation and dissemination of information among the public could re-address bottom-up knowledge toward wind farms. To overcome the NIMBY phenomenon, local community would need to have adequate information on social costs and benefits of each wind energy project that the decision maker plans to implement on the territory. Furthermore, the generation of local economic benefits for the territory would create additional motivations to incentivise sustainable development initiatives.

Fourth, the obtained results also show that the environmental factor would be considered of minor importance compared to other aspects. In this case it can be argued that the adoption of turbines of modern technology could address or re-address current functional efficiency and environmental sustainability issues. The environmental impact assessment is a primary issue in order to preserve the identity of the territory and to promote innovation and sustainable initiatives to local communities.

Finally, the obtained results also show that the higher people's perception of turbine colour and dimension, the maintenance and implementation impacts as well as the profit and the disinformation, the higher is the importance of location.

This result may suggest a major attention of people living nearby a wind farm to attributes that are strictly linked to the territory and the interest of citizens.

3.3. Focus Groups on perception of wind energy

The present section provides a second pilot study with the use of FGs method. Two FGs are carried out in two cities of the Apulia region in Southern Italy: Bari (the capital of the region) and Foggia that it is ranked first at national level in terms of wind power installed (21%) (GSE 2016).

Both areas are characterized by wind farm developments and the present pilot study is useful to understand the acceptance of local population to wind energy in a spatial context.

The two FGs comprise a total of 15 participants, 7 in Foggia and 8 in Bari, respectively. Both groups are provided with the same guidelines.

Participants to the FGs are randomly chosen. The groups are equally distributed in terms of gender (50% males and 50% females) and age (from 21 to 51 years old) and participants are residents in the city were the FG was held.

The moderator of the FG starts with a brief introduction and presentation about the purpose of the pilot study. Then, opinions and personal perceptions were asked taking into account the level of knowledge and information about the topic. At this stage, no correct or incorrect answers are provided. The information retrieved can only be of right or wrong type including the related impacts.

After the above introduction, the moderator induces and guides a 45 minutes debating session, with a focus on retrieving information on the following aspects:

- Perceived wind energy diffusion and utilisation;
- Perceived role of information about wind technologies;
- Perceived quality of existing wind installations and technology efficiency;
- Perceived strategies for future developments of wind energy;
- Preferences for renewable *vs* non-renewable energy.

The final part of the FG meeting asked participants to write, on a card, their opinions in terms of advantages and disadvantages of wind energy. In addition, participants were asked to rank on a scale from 1 (=the most important) to 3 (=the least important) (*Fig.5*) the following statements:

- Wind farms are located inadequately;
- Wind farms ruin the landscape;
- Wind farms alter the ecosystem and the nearby agricultural activities;
- Turbines are too noisy;
- Wind farms are too expensive;
- Wind farms produce no economic return;
- Wind farms do not work properly;
- There is a lack of information/transparency on wind farm projects.

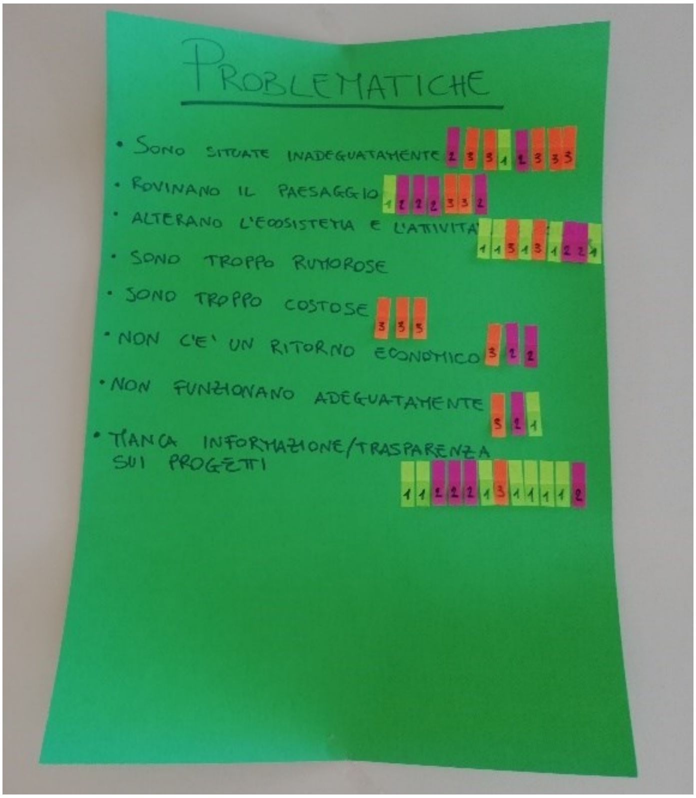


Fig.5 – Ranking of wind energy issues by FGs participants.

Finally, participants were provided with Analytical Hierarchy Processes cards to evaluate the sustainability of wind energy developments.

In *Fig.6*, the ranking of the top three most important attributes can be observed as follows: 1. 'Lack of information/transparency on wind farm projects'; 2. 'Ruin the landscape' and 'Lack of information/transparency on wind farm projects'; and 3. 'Located inadequately'.

Each participant also filled in a card providing his/her perception of advantages and disadvantages of wind farm developments.

The most perceived advantage was the term 'sustainability', because wind is considered as clean source of energy supply. The second most perceived advantage are savings in the energy bill. Heterogeneity of perception in terms of advantages and disadvantages between participants of Bari and Foggia is also evident.

Specifically, participants of the Foggia FG also consider favourable local climatic conditions, and the unlimited energy supply that wind energy can offer at local as well as global level. As for participants of the Bari FG another important element of wind energy is pollution savings.

In terms of disadvantages, the most perceived ones in both FGs are aesthetical impact on landscape, damages for the ecosystem and environmental impacts during building and dismantling of wind farms; slow payback times and damages for agricultural system. In addition, the lack of information about benefits and risks and the functional inefficiency of turbines are drawbacks only emerged within the Foggia FG. In contrast, participants of the Bari FG perceive an un-equal distribution of turbines across the region.

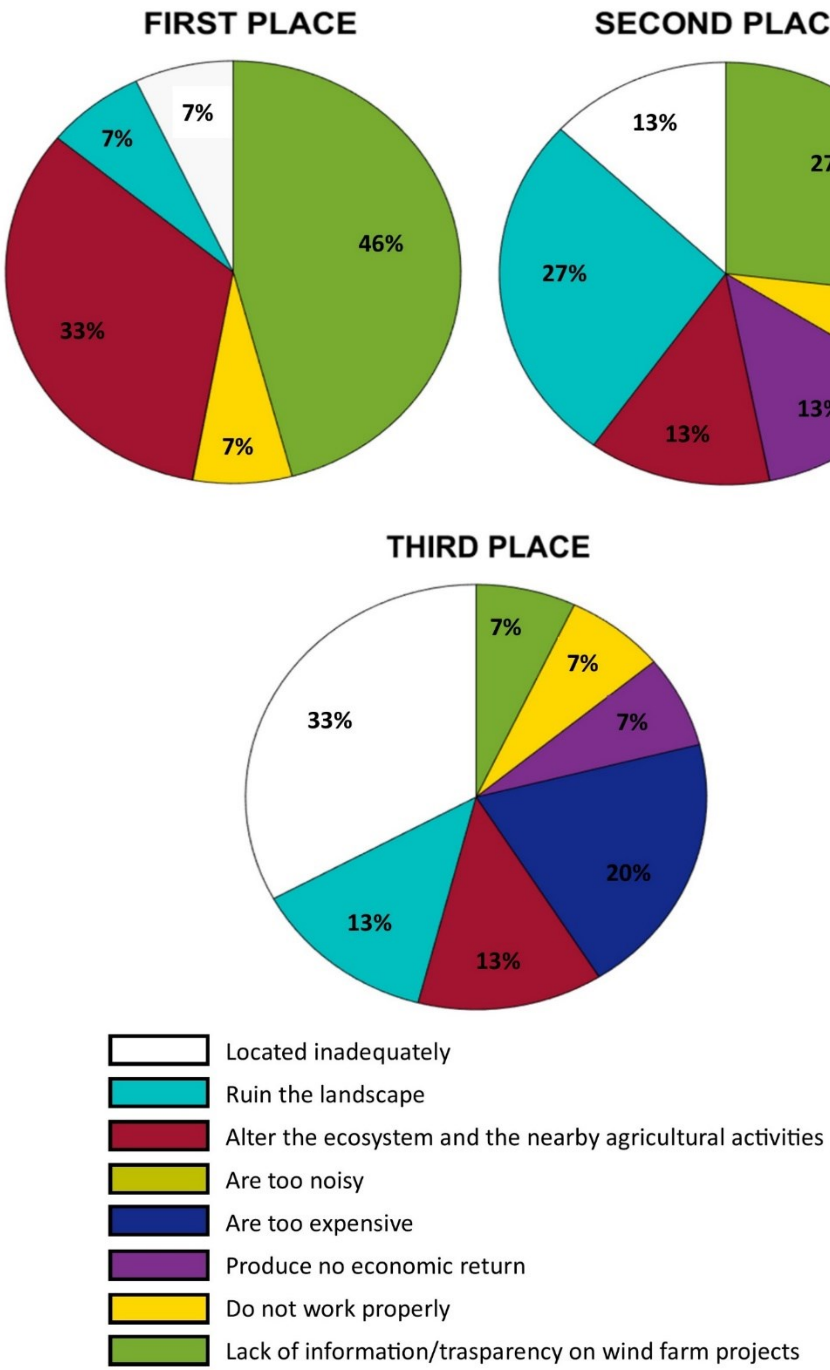


Fig.6 – Distribution of the top three wind energy issues.

3.3.1. Text mining analysis

A transcription of audio-tapes recording during the discussion groups was carried out both in Bari and Foggia FGs. These transcripts aimed to carry out a text-mining analysis to further support the results obtained during group discussions. To implement a text mining analysis, the present pilot study uses Rapidminer (https://rapidminer.com/), an open source platform to perform several machine learning, data preparation and predictive model predictions operations.

Table 12 summarizes the most frequent items discussed during FGs held in Foggia and Bari. The majority of items tend to reveal a negative perception of wind energy.

Heterogeneity of text-mining analysis between FGs also arises. Participants in Foggia would be more sensitive to the following items: costs, production, environmental impact and dismantling. In contrast, participants in Bari would seem particularly sensitive to: location, visual, big dimension, perception, beautiful aspect and nuisance.

Moreover, *Table 12* also shows the weights of the items. The top five items weighted the most are the following: integration (100%), nuisance (98%), nature (89%), landscape (84%) and knowledge (72%). In contrast, the top-five items weighted the least are the following: information (0%), ground (6%), impact (10%), benefits (10%) and visual (19%).

Table 12 – Word list deriving from test mining analysis of FGs.

Attribute	Weight	Frequencies	Foggia	Bari
Impact	0.10	28	14	14
Environment	0.23	26	16	10
Ground	0.06	25	11	14
Information	0.00	24	12	12
Costs	0.44	22	18	4
Location	0.52	18	3	15
Production	0.28	17	14	3
Renewable	0.52	16	12	4
Visual	0.19	15	3	12
Big	0.53	12	0	12
Perception	0.61	12	0	12
Beautiful	0.45	10	2	8
Environmental impact	0.40	10	9	1
Integration	1.00	10	5	5
Aesthetical impact	0.19	9	3	6
Nature	0.89	9	3	6
Landscape	0.84	9	4	5
Issue	0.31	9	4	5
Nuisance	0.98	8	1	7
Favourable	0.23	8	6	2
Dismantling	0.62	8	7	1
Planning	0.53	7	5	2
Knowledge	0.72	6	3	3
Interests	0.36	6	3	3
Benefits	0.10	4	2	2

Items or attributes from the text-mining analysis present a certain degree of correlation (see Table A2).

The highest correlation value is given by ‘Location’ and ‘Beautiful’ (0.95); followed by ‘Issues’ and ‘Beautiful’ (0.91), ‘Production’ and ‘Environmental impact’ (0.90), ‘Planning’ and ‘Dismantling’ (0.90), ‘Visual’ and ‘Big’ (0.89), ‘Interest’ and ‘Impact’ (0.88).

3.3.2. Results of AHP cards

AHP approach is applied to quantify the main attribute(s) involved in social perception of wind farms. Bell et al. (2013) discuss the importance of defining criteria and sub-criteria and evaluate their related weights in view of planning strategies for new wind power plants (Bell et al. 2013). In the present section, an extension of the AHP, namely Optimized-AHP process as mentioned in *Fig.7*, is adopted to further support early results obtained by the FG analysis (Sangiorgio et al. 2018).

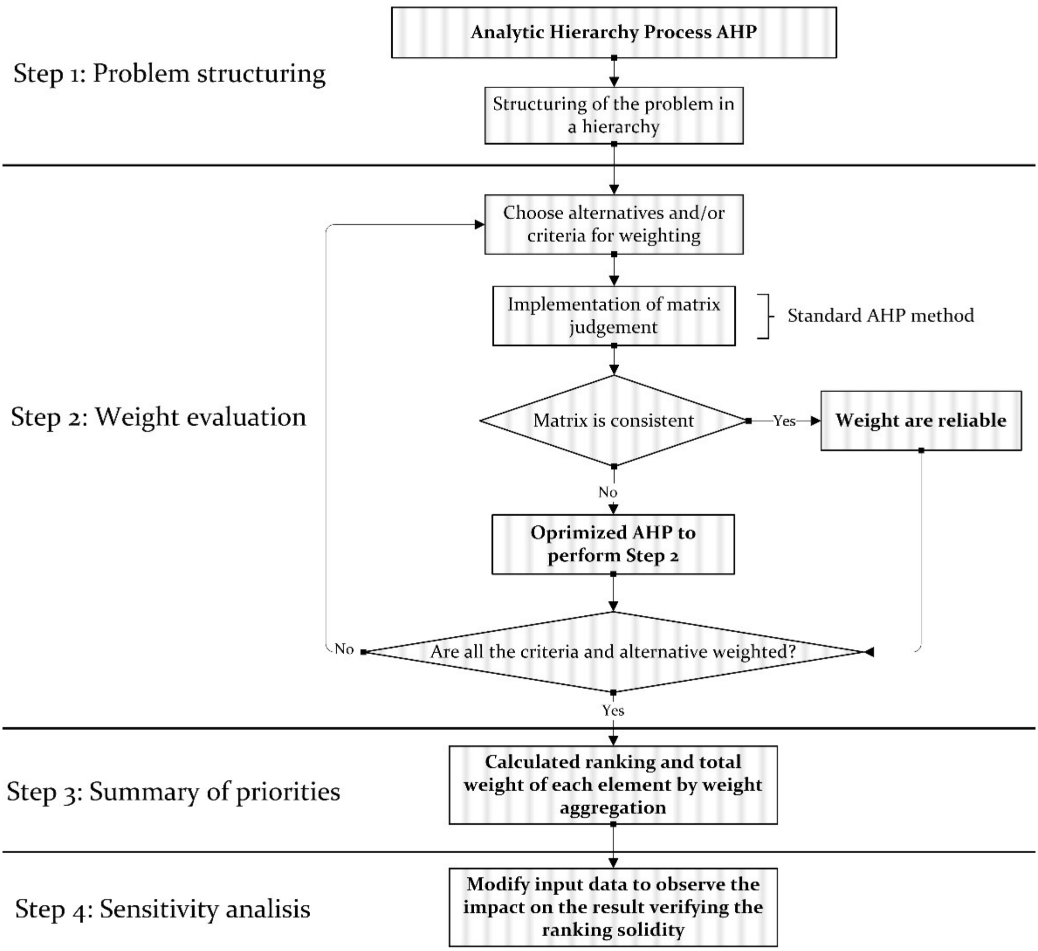


Fig. 7 – Steps of Optimized-AHP (Sangiorgio et al. 2018).

First, Step 1 in *Fig.7* defines the goal of the O-AHP study in terms of evaluation of the perception of wind energy sustainability. To this aim, the problem is structured according to the main issues discussed in literature (see *Table 1*). In particular, six criteria are identified to carry out the O-AHP such as: aesthetic impact, environmental sustainability, economic sustainability, functional efficiency, noisiness and inadequacy of institutions. Each criteria includes sub-criteria. *Fig.8* shows a schematic view of the main criteria and sub-criteria applied to the perception of wind energy sustainability.

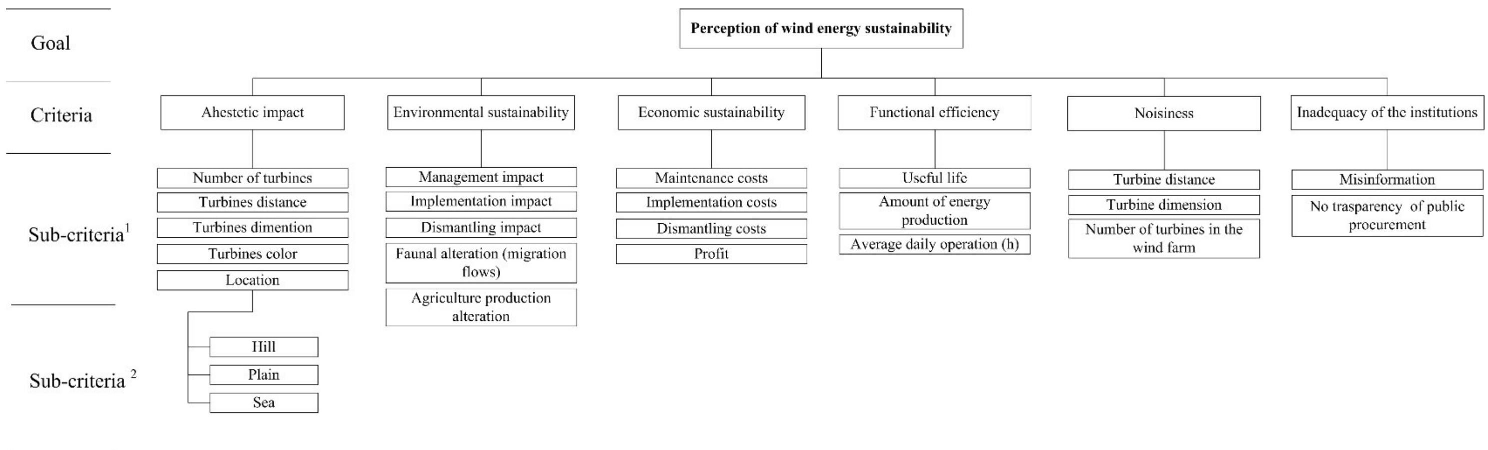


Fig. 8 – Structure of the problem: Criteria and sub-criteria to perform a perception assessment of wind farm.

Second, Step 2 in *Fig.7*, illustrates weight evaluation for each criteria and for each user. For example, *Fig.9* shows the AHP cards for aesthetic impact filled in by user #1 of the Foggia FG. It is shown that the criteria 'Aesthetic impact' includes sub-criteria such as the number of turbines, the distance between turbines, the dimension, colour and location of turbines. Following the standard AHP, the user assigned 10 judgments based on the pairwise comparisons across sub-criteria to obtain the matrix of judgment and the related weights.

Perception of wind energy sustainability

Evaluation: Aesthetic impact User 1 City:Foggia

Number of turbines	9	8	7	6	5X	4	3	2	1	2	3	4	5	6	7	8	9	Turbines distance
Number of turbines	9	8	7	6	5	4X	3	2	1	2	3	4	5	6	7	8	9	Turbines dimention
Number of turbines	9	8	7	6	5	4	3	2X	1	2	3	4	5	6	7	8	9	Turbines color
Number of turbines	9	8	7	6	5	4	3X	2	1	2	3	4	5	6	7	8	9	Location
Turbines distance	9	8	7	6	5	4X	3	2	1	2	3	4	5	6	7	8	9	Turbines dimention
Turbines distance	9	8	7	6	5	4	3	2X	1	2	3	4	5	6	7	8	9	Turbines color
Turbines distance	9	8	7	6	5	4	3X	2	1	2	3	4	5	6	7	8	9	Location
Turbines dimention	9	8	7	6	5	4X	3	2	1	2	3	4	5	6	7	8	9	Turbines color
Turbines dimention	9	8	7	6	5	4X	3	2	1	2	3	4	5	6	7	8	9	Location
Turbines color	9	8	7	6	5	4	3	2	1	2X	3	4	5	6	7	8	9	Location

Fig.9 – AHP cards of user #1 of the Foggia FG for 'Aesthetic impact'.

Step 2 is carried out for all criteria and sub-criteria and across all users to obtain the local weights (*Table 13* and *Table 14*).

Table 13 - Weights of criteria for Foggia users.

Criteria	User 1	User 2	User 3	User 4	User 5	User 6	User 7	Median weights
Aesthetical impact	4,70	7,28	21,62	22,08	5,89	6,11	29,53	13,89
Environmental sustainability	31,80	34,94	11,17	24,85	26,25	21,56	18,21	24,11
Economic sustainability	16,40	15,72	4,99	15,76	17,11	18,39	16,32	14,96
Functional efficiency	29,80	11,25	7,32	17,61	21,22	34,34	20,82	20,34
Noisiness	3,10	8,31	5,80	9,85	17,11	10,27	6,95	8,77
Inadequacy of istitutions	14,30	22,50	49,10	9,85	12,42	9,33	8,17	17,95

Table 14 - Weights of criteria for Bari users.

Criteria	User 1	User 2	User 3	User 4	User 5	User 6	User 7	User 8	Median Weights
Aesthetical impact	19,08	8,90	18,00	3,87	8,69	16,55	9,27	36,64	15,12
Environmental sustainability	31,08	34,60	15,30	26,03	15,65	40,60	4,32	23,43	23,88
Economic sustainability	18,85	3,30	10,20	13,78	27,94	10,82	15,50	15,02	14,43
Functional efficiency	16,96	20,80	9,00	26,14	19,73	24,36	15,50	7,90	17,55
Noisiness	6,67	6,50	9,00	20,71	23,85	5,12	30,92	12,56	14,42
Inadequacy of istitutions	7,36	25,90	38,50	9,48	4,13	2,55	24,50	4,45	14,61

In each FG the highest weights are assigned to ‘Environmental sustainability’ and ‘Functional efficiency’. Instead, ‘Noisiness’ results the attribute with the lowest weight.

Third, Step 3 in *Fig.7* performs the summary of priorities according to the standard AHP. The resulting global weights of each sub-criteria are shown in *Fig.10.* Such a global weight is obtained by multiplying each criteria weight to the sub-criteria weight (Saaty, 1987).

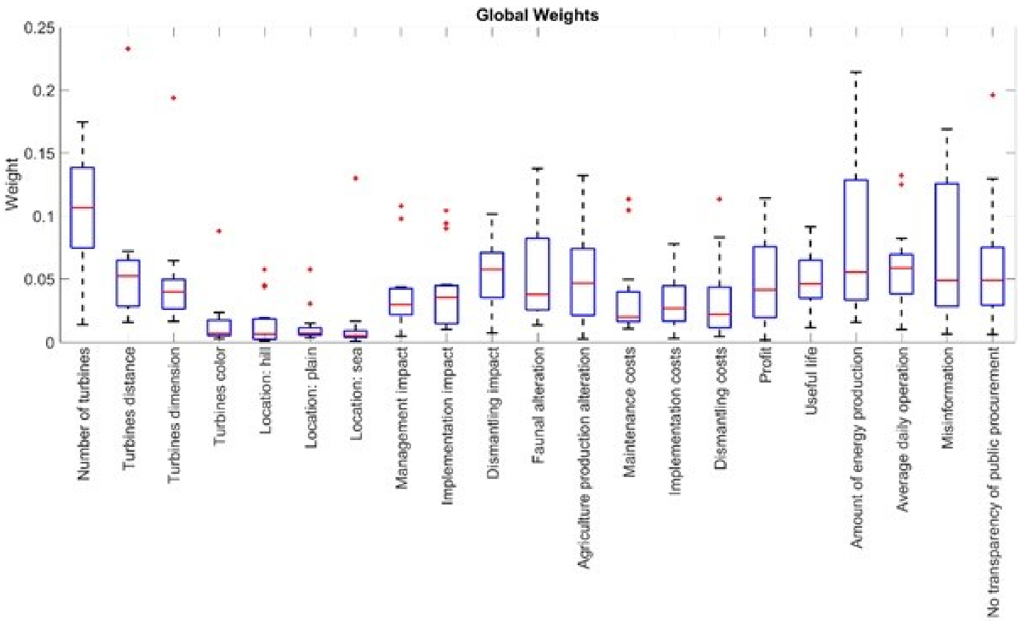


Fig.10 – Global weights of sub-criteria for all users.

The boxes represent the distribution of the 15 final weights obtained by each criterion, after the procedure is run for each user. In particular, the red line inside the boxes denote the median of the sample, while the box contains all elements within the 25th and 75th percentile of the population. The dashed line contains all elements not considered as outliers.

As it can be seen, although being affected by a large variance, the Number of turbines criterion presents the highest median value: this means that in most cases it is considered by the users as the most important criterion. On the other hand, the ‘Colour of turbines’ and the three criteria relative to their position (Hill, Plan and Sea) are generally characterized by a small weight, which means that users fairly uniformly consider them as less important criteria.

Finally, Step 4 in *Fig.7* evaluates the robustness of the above conclusions: apparently, the users globally consider the ‘Number of turbines’ as the most important criterion and their location as the least important one. However, factors such as inconsistencies, subjectivity or low attention may negatively affect the result, bringing the decision maker to draw wrong conclusions.

To take into account the above factors and obtain a more complete evaluation of the user’s preferences, a sensitivity analysis has been performed.

A set of 5000 Monte-Carlo simulations has been run for the sub-criteria weights which are computed by the O-AHP procedure; the criteria weights have been randomly selected according to a uniform distribution.

Fig.11 summarizes the above-mentioned sensitivity analysis, presenting the results of the Monte-Carlo simulations performed on the entire set of users. In other words, each box contains the entire population of 5000 simulations for each of the 15 users. Once again, the ‘Number of turbines’ criterion presents the best median ranking, followed by the ‘Turbines distance’ and ‘Turbines dimension’ criteria. All other criteria present similar values of median ranking with the exception of ‘Turbines colour’, the three ‘Location’ criteria, ‘Misinformation’ and ‘No transparency of public procurement’ that are the worst-ranked criteria.

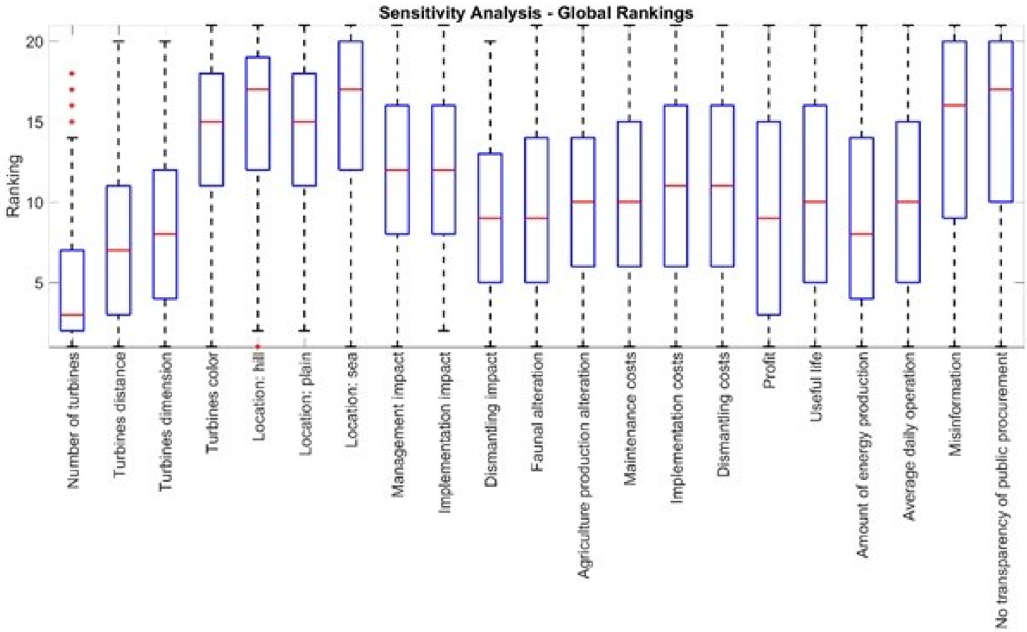


Fig.11 – Global ranking of sub-criteria for all users resulting from sensitivity analysis.

3.3.3. Discussion of results

Nowadays wind energy perception is one of the most important aspect that drives renewable energy developments. The pilot study focussed on quantifying the main features perceived by the public in terms of wind energy impacts.

Through the use of an FG approach, the analysis uncovered the pros and cons of wind energy developments. In particular, a high level of misinformation emerged that undermines 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. Nevertheless, participants to FGs have shown a positive and proactive general opinion of wind developments provided that wind project management is transparent, contributes to the distribution of collective benefits and determines a careful environmental assessment. Generally, participants to FGs consider environmental attributes such as decarbonisation and/or green energy one of the main factors affecting wind energy developments. Economic aspects would play a secondary role. These results are in line with current literature (Jobert et al. 2007; Enevoldsen & Sovacool 2016).

In contrast, the impacts on landscape and the ecosystem emphasised by a lack of trust for institutions are the main issues affecting a contrasting view to public acceptance of wind energy.

Considering these contrasting aspects of wind energy perception, an O-AHP method was further implemented to define all criteria and sub-criteria affecting the problem (as structured in *Fig.8*) and to assign them a level of importance. The O-AHP method allowed reaching coherent results.

Global weights of criteria highlight that environmental sustainability (i.e. faunal alteration and dismantling impact), functional efficiency (i.e. the amount of energy produced) and inadequacy of institutions (i.e. misinformation and dis-trust) exhibit the highest value of importance in terms of perception of wind energy market. In contrast, noise of turbines seems the least important criteria. The obtained results are in accordance with the outcomes of the FG discussion and the international literature (Cohen et al. 2014; Diana Caporale & De Lucia 2015; Enevoldsen & Sovacool 2016).

The obtained global ranking results (in *Fig.12*) also help to understand social acceptance to wind energy in terms of willingness to accept social costs. In particular, the costs attributed to maintenance, implementation and dismantling are significantly less important compared to the profits. This means that users are willing to accept such costs if they could rely on an adequate economic incentive.

Another interesting result is the relative importance of the dismantling impact compared to other criteria within the same rank. Dismantling impact appears among the top five factors against wind energy developments. Participants to FGs were particularly active to discuss this aspect. It emerged that a lack of information and regulation on who has the right to invoke the dismantling of turbines heavily affect social acceptance to wind energy. In addition, changes and adaptation of agricultural production and yields are ranked higher than the potential impacts on fauna. It can be argued that wind farms are generally installed in agricultural areas of Apulia region. In this respect, public acceptance would then be in favour of agricultural than faunal preservation. A reduction of agricultural production means loss of occupation and profits for the local community. Conversely, faunal risks seem to be underestimated provided it is not directly perceived.

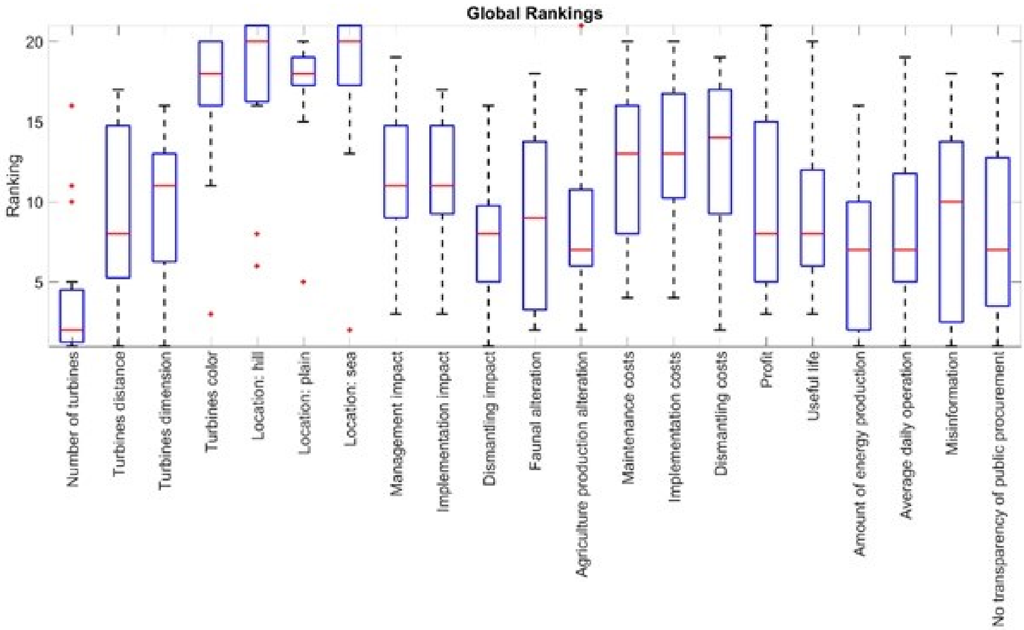


Fig.12 – Global rankings of sub-criteria for all users.

Mistrust for policy makers and stakeholders is an issue widely argued during FGs. This result also appears in accordance with global rankings. Users generally emphasise the lack of transparency of institutions. This aspect seems to rise doubts of fairness, honesty and self- interest and contributes to a negative public perception of wind energy. Less important would appear the contribution of misinformation.

To deepen the understanding of the above aspects, a comparison of results between the two FGs was carried out. It is interesting to note that the sub-criteria ‘Misinformation’ and ‘No transparency of public procurement’ are considered more important for participants living in Foggia than those living in Bari (*Fig.13*). Intuitively, Foggia residents live nearby turbines and this aspect would mostly affect the magnitude of the residents’ distrust to local institutions.

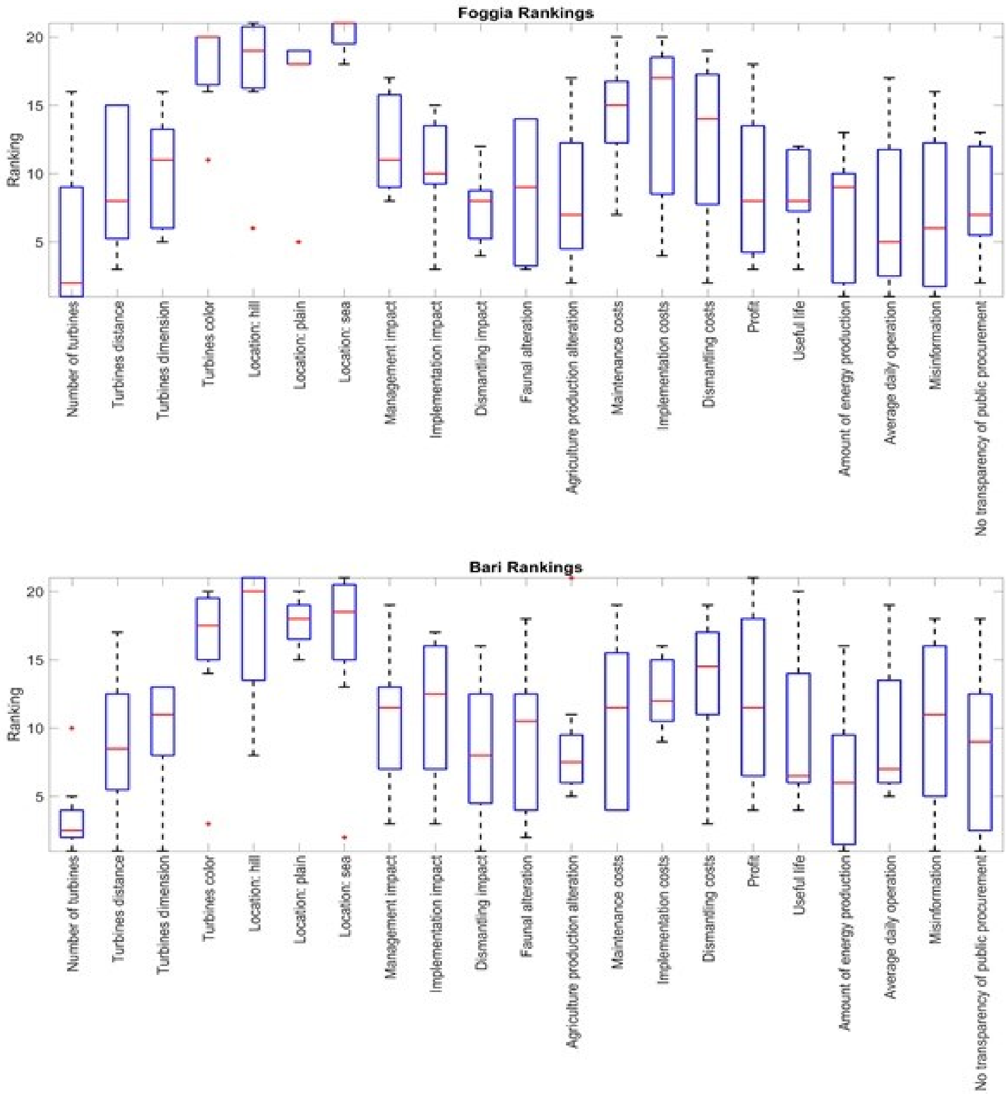


Fig.13 - Rankings of sub-criteria for all users coming from Foggia and Bari.

In addition, the ranking of criteria appears similar between the two groups. Nonetheless, the weights attributed to each criterion, for the reasons explained above, are in general higher for the Foggia group, except for the 'Noisiness' criterion that weights 9 for the Foggia users and 14 for the Bari users (see *Table 12 and*

Table 13). Noisiness, as argued by the literature (Chapman 2014; Yamani Douzi Sorkhabi et al. 2016), would, in the Bari FG, be dis-linked to the distance between the place of residency (where people live) and the turbines.

To conclude, it can be argued the existence of small differences on the perception of wind energy across groups. Agent perception is affected by experience and contiguity of the phenomenon. People living nearby wind energy developments assume a critical behaviour and consider information and transparency of public administrations and regulatory procedures important factors to favour public acceptance to wind energy. In contrast, these aspects appear underestimated by people living far from wind farms which take into account economic related aspects (e.g. the possibility to make profits).

3.4. Chapter conclusions

The pilot studies shown in the present Chapter present similar results. In particular, all considered attributes seem to significantly affect public perception of wind energy.

An interesting aspect is that the perception of 'Aesthetical Impact' as is, although frequently discussed during FGs, loses its importance with respect to the arguments raised by the literature. In particular, this attribute would be more important as far as the number and location of turbines are taken into account.

A further attribute widely mentioned during group discussions and further supported by text mining and O-AHP analyses is 'Environmental impact', which is generally considered one of the major issue of wind farms development. Relevant importance is attributed to the faunal impact and the dismantling impact as well as greenhouse gas savings. Similarly, the term 'sustainability', which, in the case of wind energy perception, is seen as unlimited and clean energy production.

Economic attributes would seem less important than the above ones. Clearly, people would weigh benefits more than costs conditional to transparent and well-defined social benefits (and costs) for the local community.

Functional efficiency is another important attribute which has received attention in the present pilot studies. It is mostly considered in terms of energy produced and also supported by the literature.

Crucial aspects are disinformation and lack of knowledge. These two attributes often induce to mis-informed opinions which disrupt the success of wind energy projects. To conclude, the majority of people generally perceive wind energy in terms of its drawbacks than its benefits and asymmetry of information is key to develop this general view.

Next, based on the findings of the present chapter, the CE will be set up. The attributes that will be included in the experimental design are the following: visual impact, amount of energy production, CO_2 savings, faunal impact (i.e. number of died birds at turbines), costs, savings in the energy bill, dismantling and information. The design will not take into account the attribute 'Noisiness' since it has received limited attention by FGs.

CHAPTER 4
THE CASE STUDY

The present Chapter proposes a case study estimating the public perception of wind energy adoption in the Apulia Region. As depicted in the previous chapter, the region is representative of wind national production. The present chapter pursues two objectives: the first is to understand public attitudes towards fossil fuels and wind energy plants for energy generation; the second is to investigate the existing trade-offs between all factors (pros and cons) characterizing wind energy installation.

In the light of the issues of wind acceptance we launched a survey that provides a series of interesting results in terms of correlation among knowledge, risks and wind perception. This study opens the door to new outcomes in the field. Choice Experiment application is the core of the case study and is useful to indirectly estimate the relationship between energy risks and territorial impact of wind source.

Firstly, the Chapter shows the construction of CEs for the case under study. Secondly, the main results of model estimates are shown. Thirdly, it proposes a comparison and discussion between two CE treatments. Fourthly, it shows the estimated results of clustering according to innovativeness scales. Finally, it describes a general discussion of results to conclude the Chapter.

4.1. The construction of the Choice Experiment

CE method is a particular statistical tool for the analysis of people's behaviour for a given hypothetical market, which in the case of the present case study is represented by wind energy.

Choice sets construction consists of the identification of relevant attributes that affect people's choice. In line with current literature cited in Chapter 1 and preliminary results shown in Chapter 3, the attributes considered in the experiment are the following:

- Aesthetical impact. This attribute has four levels. The first one is represented by a picture of the coal power plant sited in Brindisi (the status-quo). The second, third and fourth picture consider a wind farm with different turbine densities and perspectives, respectively.
- 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 plant energy capacity and annual energy consumption per person (see Chapter 1). 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 number of persons for which the energy can be produced.
- CO_2. This attribute considers four levels. In the case of the status quo, it is represented by the amount of CO_2 emissions. In the 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 (in the case of wind energy) and per plant (in the case of 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.

- Bill savings. This attribute presents four levels each of which considers savings in the energy bill due 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 case.

Table 15 summarises the attributes and the relevant levels.

Table 15 – 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
CO2 savings	800 gr/kWh	500; 750; 1,000 gr/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

In order to implement a D-error experimental design, the following is 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.

Step 1. Given that no information is available on the priors, these should be estimated. This initial step uses NGENE 1.2 software. Considering the number of parameters the software needs to estimate (i.e. 9 parameters), a minimum number of 18 rows (i.e. choice sets) is set to obtain an Optimal Orthogonal Design.

However, 18 choice sets may appear a large number to submit to respondents and missing responses may arise. To avoid this, a *blocking* technique is employed. The obtained two blocks of 9 choice sets each seems an adequate number that can be handled by respondents.

The utility functions defined for the experimental design are:

U(coal) = b_1 ;

U(wind1) = b_2 + β_1 * aesthetical_impact [0,1, 2] + β_2 * energy_production [1700, 3400, 5000] + β_3 * CO2 [500, 750, 1000] + β_4 * avifaunal_death [0.003, 0.005, 0.012] + β_5 * costs [0.02, 0.04, 0.06] + β_6 * bill_savings[180, 1900, 3560] + β_7 * dismantling[0,1] + β_8 * information[0,1,2] ;

U(wind2) = β_1 * aesthetical_impact + β_2 * energy_production + β_3 * CO2 + β_4 * avifaunal_death + β_5 * costs + β_6 * bill_savings + β_7 * dismantling + β_8 * information[0,1,2].

Table 16 shows the estimated cards of the Optimal Orthogonal Design used in the pilot survey.

Table 16 – Optimal orthogonal design.

Choice set	Alt.	Aesthetical Impact	Energy production	CO2	Avifaunal death	Costs	Bill savings	Dismantling	Information	Block
1	1	Img.3	1,7	500	1000	0,02	180	no	none	2
	2	Img.3	1,7	750	7000	0,06	1900	yes	full	
2	1	Img.2	3,4	750	4000	0,04	1900	no	none	1
	2	Img.3	3,4	500	7000	0,04	3560	no	full	
3	1	Img.1	5,1	1000	7000	0,06	3560	no	none	2
	2	Img.3	5,1	1000	1000	0,04	1900	no	partial	
4	1	Img.1	3,4	750	7000	0,02	180	no	partial	1
	2	Img.2	1,7	1000	7000	0,04	180	yes	none	
5	1	Img.2	1,7	1000	7000	0,04	180	yes	none	1
	2	Img.2	3,4	1000	1000	0,02	3560	yes	full	
6	1	Img.2	1,7	500	4000	0,06	3560	no	partial	1
	2	Img.1	1,7	750	1000	0,04	3560	yes	partial	
7	1	Img.1	1,7	1000	4000	0,02	1900	no	full	2
	2	Img.2	3,4	750	4000	0,04	1900	no	none	
8	1	Img.3	3,4	500	7000	0,04	3560	no	full	2
	2	Img.3	5,1	750	4000	0,02	3560	yes	none	
9	1	Img.2	5,1	750	1000	0,06	180	no	full	2
	2	Img.1	1,7	1000	4000	0,02	1900	no	full	
10	1	Img.3	5,1	750	4000	0,02	3560	yes	none	1
	2	Img.3	3,4	1000	4000	0,06	180	yes	partial	
11	1	Img.2	1,7	1000	7000	0,04	180	yes	none	2
	2	Img.2	1,7	500	4000	0,06	3560	no	partial	
12	1	Img.1	3,4	500	1000	0,06	1900	yes	none	2
	2	Img.1	3,4	750	7000	0,02	180	no	partial	
13	1	Img.2	5,1	500	7000	0,02	1900	yes	partial	2
	2	Img.1	3,4	500	1000	0,06	1900	yes	none	
14	1	Img.1	1,7	750	1000	0,04	3560	yes	partial	1
	2	Img.1	5,1	1000	7000	0,06	3560	no	none	
15	1	Img.3	3,4	1000	4000	0,06	180	yes	partial	1
	2	Img.3	1,7	500	1000	0,02	180	no	none	
16	1	Img.2	3,4	1000	1000	0,02	3560	yes	full	2
	2	Img.1	5,1	500	4000	0,04	180	yes	full	
17	1	Img.1	5,1	500	4000	0,04	180	yes	full	1
	2	Img.2	5,1	500	7000	0,02	1900	yes	partial	

18	1	Img.3	1,7	750	7000	0,06	1900	yes	full	1
	2	Img.2	5,1	750	1000	0,06	180	no	full	

4.1.1. Pilot survey

Each choice set includes three alternatives: the status quo and two alternatives of wind energy as described in *Table 16*. Respondents were asked to order their choices from the first to the third order of preference the alternatives proposed within each choice set.

Two behavioural information can be obtained by this pilot study:

1. The preference between coal power plant and wind energy;
2. The preference between two different wind energy scenarios.

In relation to the above, two databases are computed, one for each behavioural information. For the pilot study, a sample of 28 respondents has been collected.

The utility functions to express the preference between coal power plant and wind energy are the following:

U(coal) = β_{coal} ;

U(wind1) = β_1 * aesthetical_impact + β_2 * energy_production + β_3 * CO2 [+ β_4 * avifaunal_death + β_5 * costs + β_6 * bill_savings + β_7 * dismantling+ β_8 * information.

Table 17 shows the estimated results of the MNL logit.

Table 17 - Multinomial logit model estimates of 'coal' vs 'wind' energy.

Variable	Coefficient	p-Value	St. error
Constant	-0.910	0.251	0.7927
Aesthetical impact	0.057	0.711	0.154
Energy production	0.260*	0.093	0.155
CO_2	0.096	0.536	0.154
Avifaunal death	-0.030	0.846	0.154
Costs	-0.051	0.740	0.154
Bill savings	0.055	0.721	0.154
Dismantling	0.061	0.808	0.251
Information	0.017	0.911	0.154
Log-Likelihood	*-211.92*		
Obs	*504*		

Source*: Our elaborations. ***Statistically significant at 99% C.I level; **Statisticall significant at 95% C.I. level; *Statistically significant at 90% C.I. level.*

Energy production appears the only attribute which is statistically significant at conventional 90% C.I. This result may be due to the small sample as well as a distribution of preferences which would favour wind energy (i.e. 85%).

A further step is to estimate the utility functions to express the preference between the two wind energy scenarios as follows:

U(wind1) = β_{wind} + β_1 * aesthetical_impact + β_2 * energy_production + β_3 * CO2 + β_4 * avifaunal_death + β_5 * costs + β_6 * bill_savings + β_7 * dismantling + β_8 * information;

$U(wind2) = \beta_1 * aesthetical\_impact + \beta_2 * energy\_production + \beta_3 * CO2 + \beta_4 * avifaunal\_death + \beta_5 * costs + \beta_6 * bill\_savings + \beta_7 * dismantling + \beta_8 * information.$

Table 18 shows the estimated results of the MNL logit.

Table 18 - Multinomial logit model estimates of wind energy scenarios.

Variable	Coefficient	p-Value	St. error
Aesthetical impact	-0.090	0.545	0.149
Energy production	0.461***	0.002	0.146
CO_2	0.243*	0.097	0.146
Avifaunal impact	-0.255**	0.019	0.109
Costs	-0.134	0.189	0.102
Bill savings	0.438***	0.002	0.141
Dismantling	0.255	0.235	0.215
Information	0.112	0.334	0.116
Log-Likelihood	*-162.66*		
Obs	*252*		

Source: Our elaborations. ***Statistically significant at 99% C.I level; **Statistically significant at 95% C.I. level; *Statistically significant at 90% C.I. level.

In this case, three attributes such as Energy production and Bill savings and Avifaunal impact are statistically significant at 99, and 95% C.I. respectively. All these three coefficients present the correct sign. As for the remaining variables, provided that these show correct signs, their estimated coefficients can be used as priors for the computations of the D-error experimental design.

4.1.2. Experimental design using D-error

The Efficient Design has been computed with NGENE software considering the following utility functions with priors taken by the pilot study above:

U(coal) = β_{coal} (-0.91);

U(wind1) = β_{wind} + β_1 (-0.09) * aesthetical_impact [0,1, 2] + β_2 (0.46) * energy_production [1700, 3400, 5000] + β_3 (0.24) * CO2 [500, 750, 1000] + β_4 (-0.26) * avifaunal_death [0.003, 0.005, 0.012] + β_5 (-0.13) * costs [0.02, 0.04, 0.06] + β_6 (0.44) * bill_savings[180, 1900, 3560] + β_7 (0.25) * dismantling[0,1] + β_8 (0.21) * information[0,1,2];

U(wind2) = β_1 * aesthetical_impact + β_2 * energy_production + β_3 * CO2 + β_4 * avifaunal_death + β_5 * costs + β_6 * bill_savings + β_7 * dismantling + β_8 * information.

Table 19, 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 19 – Efficient design estimation (D-error).

MNL efficiency measures								
D error	0.214782							
A error	0.266777							
B estimate	16,123170							
S estimate	83,961577							
Prior	Aesthetical Impact	Energy produc.	CO2	Avifaunal impact	Costs	Bill savings	Dism.	Inform.
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	0.214	0.857	0.492	0.554	0.305	0.804	0.346	0.461

Design

Choice sets	Alt.	Aesthetical Impact	Energy production	CO2	Avifaunal impact	Costs	Bill savings	Dism.	Inform.	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

Sample estimates (i.e. S-estimate in *Table 19*) suggests the optimal number of observations needed for each block (84). The experimental design obtained above was included in the final survey and distributed to consumers randomly chosen through face-to-face interviews.

4.2. The survey

The survey was carried out during the period August-October 2018. The survey is structured in four sections: The first one comprises socio-demographic information of respondents; the second section includes the Honesty Treatment to check for hypothetical bias; the third section describes the Choice Experiment in which the interviewee indicates his/her preferred choice among three alternatives (including the status-quo); the last section identifies consumer knowledge on wind energy and investigates for innovativeness scales.

4.2.1. Honesty Treatment application

Chartrand et al. (2008) argue that when people come across with a text or sentences in an unrelated task are motivated to reach different goals influencing their subsequent decisions in a non-conscious manner.

The use of priming techniques activates the concept of cooperation in a social dilemma game by increasing contribution levels (Drouvelis et al. 2010)

The Honesty Treatment version used in De-Magistris et al. (2013) was applied to the survey. In particular, before completing their choices, respondents were asked to develop a series of 10 grammatically correct sentences.

Fig.14 shows the Honesty Treatment section included in the survey.

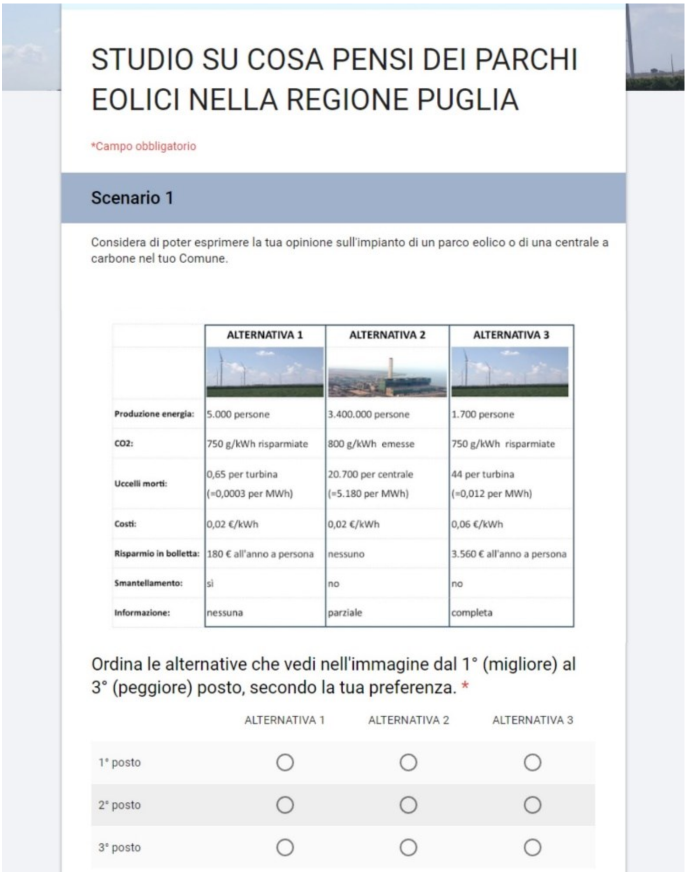
Fig.14 –Honesty Treatment section.

4.2.2. Choice Experiment section

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.

There are 5 choice sets for each block. Each choice set includes three alternatives including the coal power plant (i.e. the status-quo) and two alternatives of wind energy. Respondents were asked to order their choices from the first to the third order of preference (see Section 2.4.1.1.).

Fig.15 shows an example of choice set.



STUDIO SU COSA PENSI DEI PARCHI EOLICI NELLA REGIONE PUGLIA

*Campo obbligatorio

Scenario 1

Considera di poter esprimere la tua opinione sull'impianto di un parco eolico o di una centrale a carbone nel tuo Comune.

	ALTERNATIVA 1	ALTERNATIVA 2	ALTERNATIVA 3
Produzione energia:	5.000 persone	3.400.000 persone	1.700 persone
CO2:	750 g/kWh risparmiate	800 g/kWh emesse	750 g/kWh risparmiate
Uccelli morti:	0,65 per turbina (=0,0003 per MWh)	20.700 per centrale (=5.180 per MWh)	44 per turbina (=0,012 per MWh)
Costi:	0,02 €/kWh	0,02 €/kWh	0,06 €/kWh
Risparmio in bolletta:	180 € all'anno a persona	nessuno	3.560 € all'anno a persona
Smantellamento:	sì	no	no
Informazione:	nessuna	parziale	completa

Ordina le alternative che vedi nell'immagine dal 1° (migliore) al 3° (peggiore) posto, secondo la tua preferenza. *

	ALTERNATIVA 1	ALTERNATIVA 2	ALTERNATIVA 3
1° posto	○	○	○
2° posto	○	○	○
3° posto	○	○	○

Fig.15 – Choice sets in the Choice Experiment section.

4.2.3. Use of Innovativeness scales

The innovativeness scales (proposed by Rogers) described in the last section of the survey needs a further detail.

A psychometric Likert scale was adopted to a series of attitudinal questions proposed by Franceschinis, Thiene, et al. (2017), where 1=completely disagree and 5=completely agree, as follows. The attitudinal questions refer to the perception of: i. A general knowledge on wind farms; ii. Communication channels on information of wind energy; iii. Innovativeness scales.

i. As for general knowledge of wind farms, the attitudinal questions were the following:

- ‘Complexity’:
    - It is hard to install a wind farm.
    - It is hard to use energy generated by a wind farm.
- ‘Compatibility’:
    - The use of wind energy is compatible with current energy network.
    - To install a wind energy in my municipality would require minor changes.
- ‘Trialability’:
    - I know someone who could give me information about wind energy.
    - I know places where I can see wind installations functioning.
- ‘Relative advantage’:
    - Energy production by a wind farm pollutes less than current thermoelectric power plants.
    - Energy production by a wind farm is more convenient than current thermoelectric power plants.
    - A wind farm can adequately produce energy for the municipality where I live.
- ‘Performance risk’:

- I am concerned about maintenance and dismantling required by a wind farm.
- ‘Social risk’:
  - I am afraid that a wind farm nearby my municipality could be badly considered by my neighbours and the people I know.
- ‘Knowledge’:
  - I have the necessary knowledge to evaluate the installation of a wind farm.
  - I am aware of the installation requirements of a wind farm.
- ‘Environmental friendliness’:
  - A wind farm would improve the local environment.
  - A wind farm would reduce GHGs.

ii. As for communication channels, the attitudinal questions were the following:

- I am aware of wind energy;
- What is the main source of information among ‘People known to you and that live in a municipality with a wind farm’, ‘Mass media’, ‘Organizations’.

iii. Finally, as for innovativeness scales, the attitudinal questions were the following:

- I love to use innovations that inspire others.
- I like to own an innovative product that makes me different from others.
- I prefer to try innovative products with which I can introduce myself to other people.
- If a new product makes me more comfortable I do not hesitate to buy it.
- If a new product makes my work easier, then it is ‘a must-buy’.
- If a new time-saving product is launched, I will buy it right away.

- When I buy an innovative product it makes me happier.
- Innovative products make my life exiting and stimulating.
- Innovative products that are intellectually stimulating are ‘a must-buy’.
- I often buy new products that I consider hard to use.
- People I know often asks for my help to choose the best innovative product available on the market.
- People I know think it is important that I like the product they buy.

4.3. Empirical analysis and results

The survey comprises a total sample of 239 interviews collected among Apulia citizens. Block 1 comprises a total of 114 responses while block 2 contains 125 responses.

Table 20 summarizes useful socio-demographic information of the sample.

Table 20 – Socio-demographic information of the sample.

Variable	Obs.	Freq.	Percentage	Mean	Std. Dev.
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 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		

4.3.1. Fossil vs Wind energy: choice behaviours

The present sub-section deals with the behavioural analysis of fossil vs wind energy. 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 of 4,780 observations. More than 70% responses are towards a wind energy scenario, compared to just about 30% responses for fossil fuels (i.e. status quo).

4.3.1.1. Logit regression

To model fossil vs wind energy behaviour, a Binary Logit Model has been estimated as shown in *Table 21*.

Table 21 – Binary logit model estimates of 'coal' vs 'wind' choices.

Variable	Coefficient	p-Value	St. error
Aesthetical impact	0.135***	0.015	0.056
Energy production	-0.010	0.829	0.047
CO_2	0.129***	0.010	0.050
Avifaunal impact	0.043	0.385	0.049
Costs	0.147***	0.004	0.051
Bill savings	0.122**	0.011	0.048
Dismantling	-0.046	0.611	0.091
Information	-0.108**	0.034	0.051
Log-Likelihood	*-3092.176*		
Obs	*4,780*		

*Source: Our elaborations. ***Statistically significant at 99% C.I level; **Statistically significant at 95% C.I. level; *Statistically significant at 90% C.I. level.*

The estimated coefficients are statistically significant at 99% C.I. and 95% C.I. with the exception of ‘Energy production’, ‘Avifaunal impact’, and ‘Dismantling’ attributes. Looking at the sign of coefficients, it emerges that a positive sign increases the probability to prefer wind energy vs fossil fuels. As for the positive sign of aesthetical impact, these results would imply to favour a landscape with wind farms rather than coal power plants. 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 a minor energy source to satisfy consumer needs.

The computation of the marginal rate of substitution (MRS) between ‘Aesthetical impact’ and ‘Costs’ would provide an indication of the willingness to pay for wind energy. In this context, Scarpa & Rose (2008) shows that the unit WTP for an attribute can be derived as a function of the coefficient attributes:

$$WTP_K = \frac{\beta_k}{-\beta_{cost}} \tag{14}$$

By applying eq. (10) to the estimated coefficients of ‘Aesthetical Impact‘ and ‘Cost’, the trade-off between these two attributes is obtained as follows:

$$WTP_{aesthetical\_impact} = \frac{\beta_{aesthetical\_impact}}{-\beta_{costs}} = \frac{0.135}{-0.147} = -0.918 \tag{15}$$

Eq. (15) 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 0.92 units more to have a wind energy installation, rather than a coal power plant.

4.3.2. Wind energy alternatives: choice behaviours

Given the results obtained from the previous section, the present sub-section 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 sets of blocks 1 and 2 of the survey and comprises of 1,195 observations.

4.3.2.1. Multinomial logit regression

Table 22 shows the estimates of the Multinomial logit (MNL) model.

Table 22 – Multinomial logit model estimates of wind energy alternatives.

Variable	Coefficient	p-Value	St. error
Aesthetical impact	0.176***	0.000	0.041
Energy production	0.131***	0.004	0.045
CO_2 (savings)	0.341***	0.000	0.044
Avifaunal impact	0.151***	0.000	0.042
Costs	0.356***	0.000	0.041
Bill savings	0.275***	0.000	0.046
Dismantling	0.109	0.105	0.067
Information	-0.012	0.782	0.043
Log-Likelihood	*-742.477*		
Obs	*1,195*		

*Source: Our elaborations. ***Statistically significant at 99% C.I level; **Statistically significant at 95% C.I. level; *Statistically significant at 90% C.I. level.*

The estimated coefficients are statistically significant at 99% C.I., except for 'Dismantling' and 'Information'. The sign of coefficients suggests that respondents prefers wind farm alternatives more densely distributed, producing more energy, and CO_2 savings.

Considering the 'Avifaunal impact', the number of birds killed seems to be acceptable. 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.

4.4. HT use vs non-HT use: empirical analysis and results

The present sub-section deals with the analysis of results obtained to mitigate hypothetical bias in CEs. The survey, as described in Section 2.4.2., has been constructed with an Honesty Treatment section randomly submitted to respondents.

In particular, the analysis aims at testing two hypothesis.

Hypothesis #1: The first hypothesis is defined as follows:
$H0_1 : (MNL^{HHP} – MNL^{HB}) = 0$, and
$H1_1 : (MNL^{HHP} – MNL^{HB}) < 0$

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

If $H0_1$ 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 $H0_1$ is rejected the honesty priming task could have some effects on hypothetical WTP values. To test this assumption,

Hypothesis #2, is defined as follows:
$H0_2 : (WTP^{HHP} – WTP^{HB}) = 0$, and

$$H1_2 : (WTP^{HHP} – WTP^{HB}) < 0$$

Table 23 reports the socio-demographic characteristics of the participants in the two treatments.

Table 23 – Sample: Socio-demographic characteristics, 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 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

[15a] number of observations

Because of comparison of results, participants with similar socio-demographic characteristics across the two treatments were randomly recruited by age, gender, province, educational level, employment and income for each hypothetical honesty treatment.

A chi squared Person's test was performed to determine differences in socio-demographic profiles across treatments. The result of this test suggested 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 was successful across the two hypothetical honesty treatments.

4.4.1. Multinomial logit regression

A Multinomial logit regression is estimated for each of the two hypothetical honesty treatments considering the two types of choice: i. coal power plant versus wind energy, and ii. wind energy alternatives. *Table 24* summarizes the MNL model estimates.

Table 24 – Estimates of binary logit regression and MNL logit regression.

	Coal vs Wind power plan Binary Logit regression		Wind energy alternatives MNL logit regression	
Variable	HB	HHP	HB	HHP
Aesthetical impact	0.093 (0.243)	0.148* (0.069)	0.150*** (0.001)	0.199*** (0.001)
Energy production	0.003 (0.963)	-0.007 (0.916)	0.110* (0.061)	0.180** (0.014)
CO_2	0.226*** (0.002)	0.034 (0.630)	0.345 (0.000)	0.369*** (0.000)
Avifaunal impact	0.079 (0.275)	0.024** (0.734)	0.105* (0.070)	0.212*** (0.001)
Costs	0.134* (0.057)	0.136* (0.077)	0.310*** (0.000)	0.400*** (0.000)
Bill savings	0.103 (0.135)	0.144** (0.0.34)	0.210*** (0.001)	0.361*** (0.000)
Dismantling	-0.133 (0.294)	0.049 (0.720)	0.068 (0.45)	0.156 (0.137)
Information	-0.157** (0.026)	-0.044*** (0.562)	-0.050 (0.400)	0.031 (0.638)
Log-Likelihood	*-1588.20*	*-1500.99*	*-384.12*	*-355.642*
Obs	*2,460*	*2,320*	*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.*

Differences arise between the two hypothetical honesty treatment regression estimates (*Table 25*).

The likelihood ratio (LR) test for the joint equality between the two hypothetical honesty treatment estimates was implemented. *Table 25* reports the results of the estimated Log-likelihood as well as the LR tests for the coal vs wind energy choice.

Table 25 – 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	4,780	-3,092.18			
Hypothetical baseline CE (HB)	2,460	-1,588.20			
Hypothetical CE with honesty priming (HHP)	2,320	-1,500.99			
$H0_{1coal}$ = Test of equality across hypothetical treatments		0.01	0.920		
Wind energy alternatives					
All treatments	1,195			-742.477	
Hypothetical baseline CE (HB)	615			-384.120	
Hypothetical CE with honesty priming (HHP)	580			-355.642	
$H0_{1wind}$ = Test of equality across hypothetical treatments				0.05	0.827

*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.*

The obtained results indicate that the joint null hypothesis of equality between hypothetical and non-hypothetical treatments (LR=0.01 p-value=0.920 and LR= 0.05 p-value=0.827) are accepted.

In terms of estimated Log-Likelihood values, hypothetical CEs with honesty priming (-1,500.99 and -355.642) converge at better fit than hypothetical CEs without honesty priming (-1,588.20 and -384.120), respectively.

It can be argued that hypothetical choice experiments with honesty priming tasks can mitigate the hypothetical bias arising in CEs.

Table 25, illustrates the obtained results from testing hypothesis #2 across WTPs computed according to Eq. (14).

Table 26 – 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}	-1.088	-
WTP^{HB}	-0.694	-
HO_{2coal} $(WTP^{HHP} – WTP^{HB}) = 0$	-1.782	-
Wind energy alternatives		
WTP^{HHP}	-	-0.497
WTP^{HB}	-	-0.484
HO_{2wind} $(WTP^{HHP} – WTP^{HB}) = 0$	-	-0.981

The results of WTP hypothesis tests indicate that the null hypothesis $H0_2$ is rejected, suggesting that the WTP is generally affected by the honesty priming task in hypothetical CEs.

4.5. Innovativeness scales

One of the main hypothesis emerging from Rogers' theory is that the perception of characteristics and sources of information about wind energy affect consumer preference toward the adoption of such technology. The use of innovativeness scales in the survey would help to identify innovator types defined in terms of 'innovators', 'early adopters', 'early majority', 'late majority', and 'laggards'.

Through the analysis of innovativeness scales, the following assumptions are analysed through the use of a cluster analysis (see below):

1. *An adequate good perception of wind energy features*. An argument in favour of this assumption would be obtained through a low value scale for wind energy complexity, performance risk and social risk; and a high value scale for compatibility, trialability, relative advantage, knowledge and environmental friendliness.
2. *An adequate perception of communication channels (i.e. information).* According to Rogers, the 'word of mouth' counts in social system. Given that wind energy is a hot topic in Apulia region, a high value scale can be expected for this energy type innovation diffused through word of mouth. Generally, information from mass media is particularly influent in the first period of the adoption. In contrast, the scenario of Apulia region would show a well-defined adoption of this technology diffused across mass-media. Therefore, a medium-high innovativeness scale is expected for wind energy diffusion through mass media channels. Finally, information provided by organizations would be the least influential and is expected to have a lower impact in terms of innovator types than other sources.

Table 27 reports some descriptive statistics about dimensions of innovation for the final sample.

Table 27 – Descriptive statistics of dimensions of innovation.

Dimension of innovation	Obs.	Mean	St.err.	Min.–Max.
A.Perception of characteristics				
Complexity				
A1.It is hard to install a wind farm.	239	2.53	1.103	1 – 5
A2.It is hard to use energy generated by a wind farm.	239	1.94	0.992	1 – 5
Compatibility				
A3.The use of wind energy is compatible with current energy network.	239	3.66	1.158	1 – 5
A4.To install a wind energy in my municipality would require minor changes.	239	3.18	1.150	1 – 5
Trialability				
A5.I know someone who could give me information about wind energy.	239	3.02	1.495	1 – 5
A6.I know places where I can see wind installations in function.	239	4.02	1.341	1 – 5
Relative advantage				
A7.Energy production by a wind farm is less polluting then by the current thermoelectric power plant.	239	4.31	1.114	1 – 5
A8.Energy production by a wind farm is more convenient then by the current thermoelectric power plant.	239	3.76	1.169	1 – 5
A9.A wind farm can product energy adequately for my Municipality requirements.	239	3.54	1.229	1 – 5
Performance risk				
A10.I am concerned about maintenance and dismantling required by a wind installation.	239	2.81	1.294	1 – 5
Social risk				
A11.I am afraid that installation in my Municipality of a wind farm could be badly considered by people I know.	239	2.89	1.253	1 – 5
Knowledge				
A12.I have the necessary knowledge to evaluate the installation of a wind farm.	239	2.46	1.279	1 – 5
A13.I am aware of the installation requirements of a wind farm.	239	2.15	1.244	1 – 5
Environmental friendliness				
A14.Wind farm installation would improve my local environment.	239	3.73	1.150	1 – 5
A15.Wind farm installation would reduce greenhouse gases.	239	4.08	1.151	1 – 5
B.Communication channels	239			

B1.How much respondents think to be informed about wind energy		2.84	0.964	1 – 5
B2.From other people	8[a]			
B3.From mass media	81[a]			
B4.From organizations	11[a]			
C.Timing of adoption				
C1.I love to use innovations that impress others.	239	2.65	1.297	1 – 5
C2.I like to own an innovative product that distinguishes me from others who do not own this new product.	239	2.64	1.370	1 – 5
C3.I prefer to try innovative products with which I can present myself to other people.	239	2.21	1.312	1 – 5
C4.If a new product gives me more comfort than my current product, L would not hesitate to buy it.	239	3.11	1.222	1 – 5
C5.If a new product makes my work easier, then this new product is a "must" for me.	239	3.39	1.102	1 – 5
C6.If a new time-saving product is launched, I will buy it right away.	239	3.20	1.104	1 – 5
C7.Acquiring innovative products makes me happier.	239	2.92	1.274	1 – 5
C8.Innovative products make my life exiting and stimulating.	239	2.34	1.184	1 – 5
C9.I find innovations that need a lot of thinking intellectually challenging and therefore I buy them instantly.	239	2.91	1.183	1 – 5
C10.I often buy new products that I consider hard to use.	239	2.05	1.140	1 – 5
C11.People I know often consult me to help choose the best innovative product available on the market.	239	2.71	1.285	1 – 5
C12.People I know think it is important that I like the product they buy.	239	2.32	1.234	1 – 5

[a] variable frequency, percentages

As shown from the results above, some aspects do not fully satisfy the above expectations and could justify some negative perceptions of wind farms. In terms of 'Complexity' a low mean value scale (A1=2.53 and A2=1.94) is obtained; Alternatively, 'Performance' and 'Social risk' show high mean values such as A10=2.81 and A11=2.89, respectively. Risk averse consumers would, in this case, negatively affect the perception of wind energy resulting an obstacle to its adoption and diffusion. It can be argued that ‘Performance’ and ‘Social risks’ would have differences among classes of innovation because a risk adverse behaviour is typical for laggards rather than for innovators. The relatively high value of standard deviation would be support this assumption.

Wind energy would be perceived an efficient technology in terms of its ‘Compatibility’, ‘Trialability’, ‘Relative advantage’ and ‘Environmental friendliness’. In particular, trialability is subject to a high standard deviation such that potential differences among classes of innovators may arise.

‘Knowledge’ (A12-A15) about wind energy shows, on average, a low mean scale value. This could probably support the negative perception of wind energy.

Finally, communication channels would not seem as adequate as expected. Responses show a medium-low scale of awareness for wind energy. Surprisingly, information through word of mouth would not benefit technology diffusion as suggested by Rogers.

4.5.1.Sample clustering with K-Means

To investigate innovator types of wind technology diffusion, the present sub-section adopts a cluster analysis. Three motivations arise:

1. Cluster analysis is a useful tool to group the sample into classes of adopters with similar attitudes for innovation.
2. Cluster analysis is a useful tool to uncover common characteristics within groups.
3. Cluster analysis is an adequate tool to investigate latent variables affecting groups.

A K-Means Clustering has been estimated to obtain the groups. K-Means is useful for minimizing the distance within clusters and maximizing it between clusters. With K-Means Clustering, adopters (or consumers) are split into disjointed subsets, such that each adopter is member of one cluster only. Each cluster is associated with a centroid such that each adopter is assigned to the cluster closest to the centroid.

The initial number of clusters is equal to 5 according to the classes of innovator types defined by Rogers (i.e. innovators, early adopters, early majority, late majority, and laggards).

4.5.1.1. Analysis of clustering outputs

Table 28 reports the distribution of the final sample among clusters. In particular, 57 adopters belong to the first cluster, 17 belong to the second cluster, 16 to the third cluster, 76 to the fourth cluster, while 50 adopters are part of the fifth cluster.

Table 28 – Number of cases in each cluster, percentages.

Cluster	1	24
	2	17
	3	7
	4	32
	5	21
Valid		239[a]
Missing		0

[a] number of observations

In order to understand the features of the five clusters, a final cluster centers analysis is carried out in *Table 29*.

Table 29 – Final cluster centers.

Dimensions of innovation	Cluster				
	1	2	3	4	5
Complexity A1	2,3	2,2	2,1	2,7	2,9
Complexity A2	1,5	1,9	2,1	2,0	2,3
Compatibility A3	4,0	3,7	2,2	3,7	3,8
Compatibility A4	3,5	3,4	2,0	3,2	3,0
Trialability A5	4,3	2,2	2,1	2,3	3,5
Trialability A6	4,7	3,4	2,8	4,2	3,8
Relative advantage A7	4,8	4,7	2,1	4,4	4,0
Relative advantage A8	4,2	4,5	2,0	3,5	3,6
Relative advantage A9	4,1	4,2	1,8	3,4	3,2

Performance risk A10	2,4	2,4	2,4	3,2	3,2
Social risk A11	2,9	2,9	2,3	2,9	3,1
Knowledge A12	3,4	1,8	2,2	1,7	3,1
Knowledge A13	3,0	1,4	2,3	1,4	2,8
Environmental friendliness A14	4,1	4,3	2,2	3,8	3,3
Environmental friendliness A15	4,6	4,6	1,8	4,3	3,5
Communication channels B1	3,7	2,5	2,9	2,4	2,8
Communication channels sources	2,2	1,9	2,1	2,0	1,9
Timing of adoption C1	2,0	3,4	1,8	2,0	4,0
Timing of adoption C2	2,0	3,5	1,6	1,9	4,1
Timing of adoption C3	1,4	3,1	1,4	1,5	3,8
Timing of adoption C4	2,6	3,6	2,2	3,2	3,5
Timing of adoption C5	3,1	3,9	2,4	3,4	3,7
Timing of adoption C6	2,9	3,6	2,3	3,0	3,7
Timing of adoption C7	2,1	3,9	2,1	2,5	4,0
Timing of adoption C8	1,6	3,1	1,9	1,8	3,6
Timing of adoption C9	2,7	3,2	2,3	2,6	3,7
Timing of adoption C10	1,8	2,0	1,5	1,6	3,3
Timing of adoption C11	2,6	3,0	2,4	1,9	3,9
Timing of adoption C12	1,9	2,4	1,9	1,8	3,7

Cluster centers consist of centering each dimension of innovation scales by averaging them within the cluster. This helps to understand the features of respondents belonging to each cluster.

The first cluster includes the highest value for Compatibility, Trialability, Knowledge and Communication; a high value of environmental friendliness; a medium/ high value of relative advantage and social risk; a low value of complexity, performance risk and timing of adoption. This cluster could be identified as the **'late majority'** of innovation.

The second cluster shows the highest value for relative advantages and environmental friendliness; a high value of compatibility and timing of adoption; a medium value of trialability and social risk; a medium-low value of complexity; a low value of performance risk, communication channels and knowledge. This cluster could be identified as the **‘early adopters’**.

The third cluster has a high value of communication channels; a medium value of knowledge; a low value of complexity and performance risk; the lowest value for compatibility, trialability, relative advantage, social risk, environmental friendliness and timing of adoption. This cluster could be defined as the **‘laggards’**.

The fourth cluster includes a high value of complexity, compatibility, trialability, relative advantage, performance risk, social risk, environamental friendliness; and a medium-low value of knowledge and timing of innovation. This cluster could be considered as **‘early majority’**.

Finally, the fifth cluster shows the highest value in terms of complexity, trialability, social risk and timing of adoption; a high value of compatibility, performance risk and knowledge; a medium value of relative advantage, environmental friendliness, and communication channels. This cluster could be representative of the **‘innovators’**.

Table 30 – Distances between cluster centres.

Cluster	Innovators	Early adopters	Early majority	Late majority	Laggards
Innovators		4,284	6,265	6,334	7,860
Early adopters	4,284		4,069	5,305	7,613
Early majority	6,265	4,069		3,853	5,532
Late majority	6,334	5,305	3,853		6,916
Laggards	7,860	7,613	5,532	6,916	

Table 30 illustrates the Euclidean distance between centroids of final clusters. The higher the distance, the higher will be the dissimilarity across clusters. The five clusters seem being distant from each other. As expected, the highest distance is observed between the ‘Laggards’ and ‘Innovators’, while ‘Late majority’ and ‘Early majority’ seem to be very close.

Finally, an ANOVA analysis in *Table 31* indicates which dimension of innovation contributes more for cluster identification.

Table 31 – ANOVA estimated with K-Means clustering.

	Cluster Mean Square	df	Error Mean Square	df	F	Sig.
Complexity A1	5.321	4	1.146	234	4.642	0.001
Complexity A2	4.341	4	0.926	234	4.687	0.001
Compatibility A3	10.188	4	1.190	234	8.561	0.000
Compatibility A4	7.597	4	1.215	234	6.254	0.000
Trialability A5	46.460	4	1.479	234	31.412	0.000
Trialability A6	18.229	4	1.517	234	12.015	0.000
Relative advantage A7	25.690	4	0.824	234	31.195	0.000
Relative advantage A8	21.743	4	1.019	234	21.338	0.000
Relative advantage A9	22.503	4	1.151	234	19.548	0.000
Performance risk A10	8.803	4	1.553	234	5.670	0.000
Social risk A11	1.766	4	1.568	234	1.127	0.345
Knowledge A12	33.740	4	1.087	234	31.032	0.000
Knowledge A13	30.511	4	1.054	234	28.960	0.000
Environmental friendliness A14	17.212	4	1.051	234	16.371	0.000
Environmental friendliness A15	33.114	4	0.782	234	42.335	0.000
Communication channels B1	16.433	4	0.665	234	24.722	0.000
Communication channels sources	0.972	4	0.175	234	5.546	0.000
Timing of adoption C1	41.983	4	0.994	234	42.246	0.000
Timing of adoption C2	55.187	4	0.967	234	57.064	0.000
Timing of adoption C3	57.890	4	0.761	234	76.111	0.000
Timing of adoption C4	11.200	4	1.326	234	8.444	0.000
Timing of adoption C5	9.407	4	1.074	234	8.756	0.000
Timing of adoption C6	9.236	4	1.083	234	8.528	0.000
Timing of adoption C7	40.767	4	0.954	234	42.729	0.000
Timing of adoption C8	40.245	4	0.739	234	54.471	0.000
Timing of adoption C9	14.082	4	1.183	234	11.904	0.000

Timing of adoption C10	27.429	4	0.853	234	32.143	0.000
Timing of adoption C11	30.249	4	1.163	234	26.015	0.000
Timing of adoption C12	33.812	4	0.970	234	34.864	0.000

The F tests should be used only for descriptive purposes because the clusters have been chosen to maximize the differences among cases in different clusters. The observed significance levels are not corrected for this and thus cannot be interpreted as tests of the hypothesis that the cluster means are equal.

From the analysis of ANOVA in *Table 31*, 'Timing of adoption' and 'Knowledge' represent the two variables which are significantly associated to clusters identification; These variables are followed by 'Relative advantage' and 'Trialability'. 'Social risks', instead, appears a less influent variable for cluster identification.

4.6. Chapter conclusions

The case study investigated for this Thesis 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 reduces significantly the error. This also implies a reduced sample size during survey analysis.

Second, the use of Honesty Priming Treatment is a valuable tool for minimizing hypothetical bias during CEs.

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).

However, social risks and issues related to wind energy are the main aspects emerging in the study of public opinion.

All aspects considered in CEs seem to affect a general perception of wind energy, with the exception of information and dismantling issues, which are factors emerged during FGs. A mismatch between hypothetical and real world applications of wind energy emerges. For this reason, a certain degree of underestimated information arises. Similarly, the obtained results also revealed 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.

Finally, given that wind energy is an increasingly dominant and innovative product in the energy market, wind energy technology can be considered an innovation compared to fossil fuel use.

For this reason, this chapter carried out an investigation about the innovativeness characteristics of the sample. The analysis included the identification of innovator types according to the definition of Rogers, as follows: innovators (21%), early adopters (17%), early majority (32%), late majority (24%) and laggards (7%).

CHAPTER 5
DISCUSSION AND POLICY INDICATIONS

The present Chapter turns to answer the research questions and provides useful insights for policy makers from the results previously presented.
Firstly, a description of current renewables energy market regulation at national and regional level is presented, according to the directives of the European Community. It follows a critical discussion and comparison of outcomes obtained from the preliminary pilot studies and the final case study.
In addition, the present chapter critically discusses the obtained results in light of the literature presented in the first chapter, and the research questions described in the introductory part of the present Thesis.
Finally, the Chapter describes main international, European and regional energy policies and suggests relevant insights to close the gap between bottom-up and top-down policy implications to drive wind energy markets and public acceptance.

5.1. Market regulation of renewables

In Italy, renewable energy regulation has been adopted with Legislative Decree (D.Lgs.) n.387/03, in reception of Directive 2001/77/EC. This legislative decree becomes an important opportunity for coordination and rationalization of rules and measures concerning the promotion of electricity produced from renewable sources.

D.Lgs. n.387/03 helped to create a clear and secure legal framework for investments in the renewable sector, despite several delays due to bureaucratic reasons. A key issue includes the adoption of guidelines and procedures relative to the localization of wind plants to limit potential damages to the landscape.

National guidelines – announced in the tenth paragraph of Art.12 – have been issued after almost seven years from the entry into force of the D.Lgs. During this period, regional provisional regulations have been adopted thus leaving stakeholders' needs difficult to coordinate. This un-harmonised system provided several side-effects among operators in the sector.

To limit the side effects, D.Lgs. n.387/03 provided a series of rules with the aim of promoting a greater contribution of renewable energy sources, among which the following are particularly important:

- Rationalization and simplification of authorization procedures (Art. 12). It provides a single authorization – issued by the region or by delegated provinces following a single procedure – issued within 180 days, in compliance with the principles of simplification and procedures established by Law n.241/90. This procedure is applied to construction and operation of electricity production plants powered by renewable sources (defined as being of public utility and urgent); modification works; upgrades, total or partial remaking and reactivation, as well as related works and the necessary infrastructures needed for construction and operation of plants.
- Prohibition of providing compensation measures for regions and provinces.
- Location of plants for electricity production from renewable sources, allowed also in agricultural areas.
- Specific disciplines for specific categories of renewable sources.
- Connection of plants to electricity grids. Art. 14 provides that the authority issues regulations defining technical and economic conditions for the supply of plants' connection service powered by renewable sources to power grids with a nominal voltage greater than 1 kW.

During the 2000s, further regulatory actions followed. In particular, Law n.239/2004 provides for the reorganization of the energy sector according to three main lines:

1. Definition of State and Regional responsibilities according to the new constitutional order outlined by Law n. 3/2001, amending Title V of the Constitution;
2. Completion of market liberalization;
3. Increase in market efficiency.

With reference to the principles of EU law and international obligations in the energy field, provisions for the energy sector are determined to ensure competition, benefits concerning civil and social rights, public safety, protection of the environment and the ecosystem. These provisions ensure legal and economic unity of the State and respect for regional and local autonomies, international treaties and community legislation.

The evolution of Apulian regulatory system appears dynamic, due to the importance of renewable sources in the region.

Resolution n.716 of May 31, 2005 titled 'Procedure for the issue of authorizations for plants construction and operation producing electricity from renewable sources', promotes electricity production from renewable sources in the internal market and proposes to support a greater contribution, while ensuring a harmonization of procedures for renewable energy production.

As for wind energy plants, Regional regulation n. 16 of April 4th, 2006 titled 'Regulations for the construction of propellers in the Region' introduces 'Regulatory Plans for the installation of wind power plants' (PRIE). PRIE establishes that each municipality should endow for >60 kW wind power plants – in the case of a plant with more than one wind turbine; and for >1 MW wind power plants in the case of a plant with a single wind turbine.

Art.4 of Regional regulation n. 16/2006 establishes that:

1. PRIE are aimed at identifying unsuitable areas or those areas in which it is not allowed to locate wind turbines, in addition to those reported in Art. 6 paragraph 3 of this Regulation;
2. For the purposes of simplifying the authorization procedures pursuant to Art.12 D.P.R. 387/2003, municipal administrations should adopt PRIE.

As for the authorization process, the Deliberation of the Regional Council of 23 January 2007, n. 35 titled ‘Procedure for issuing the Single Authorization pursuant to Legislative Decree No. 387/2003 and for the adoption of the final authorization provision for plants powered by renewable sources and related works, as well as necessary infrastructures needed for construction and operation’ is adopted. Attachment A, point 1 of the Deliberation titled “Purpose and applicability, to letter a) and b)”, the regulation proposes to adopt national targets for the diffusion of the electricity production from renewable sources. This regulation supports, through the commitment undertaken by the Italian Government to the Kyoto Protocol, the reduction of GHG emissions; favours an adequate establishment of renewable energy plants in the territory of Apulia region; and promotes sustainable development. Furthermore, as for the single authorization, it also details inclusion criteria and applicants' requirements.

In 2008, the Resolution of the Regional Council n. 1462 titled ‘Procedure for issuing the authorization for the adoption of the final authorization provision for wind power plants. Directives of the regional procedures in the activities aimed at issuing the single authorizations for implementation of wind power plants’ includes the approval of regulations to improve the harmonization of regional procedures aimed at issuing authorizations for the construction of wind energy plants.

Following the above Resolution, the Management determination of January 3rd, 2011, n.1 titled ‘Single Authorization pursuant to Art.12 of D.Lgs.387/2003 – DGR n. 3029 of 30.12.2010’ – Approval of the ‘Technical Instructions for the computerization of the documentation supplied with the Single Authorization’ and the ‘Telematic Procedure Guidelines’’ aims at digitalizing the authorization procedure.

All wind plants overcoming the limit of 60kW – as set in Table A, Annex n.1 of the D.Lgs. n.387 / 2003 – can be installed and operate following the issue of the Single Authorization. This authorization indicates an Environmental Impact Assessment (EIA) for wind plants with more than 1 MW power.

In 2005, the Ministry of Economic Development, together with the Ministry of Environment, Territory and Sea Protection issued the Decree titled ‘Updating the directives for the incentive of energy produced from renewable sources pursuant to Art. 11, paragraph 5, of D.Lgs. 79/1999' that – in the abrogation of the Ministerial Decree 11/11/1999 and 18/03/2002 – decreed new provisions for the qualification of renewable source plants (IAFR qualification) and the issue of green certificates.

The IAFR qualification is ruled by the Ministerial Decree 18/12/2008. It is a prerequisite to obtain green certificates or access to the feed-in tariff.

Finally, the 2007 financial law postulated that, starting from 1/1/2007, public spending and incentives promoting renewable energy sources can only be granted for the production of electricity produced from renewable energy sources.

5.2. Discussion of results and policy indications

For several years, renewable energy sources (RES) have played a leading role in Italy. The GSE Statistical Report (GSE 2016) provides a complete and official statistical framework on the dissemination and use of these sources in Italy. Data are updated to 2015. Main data are also sent to the Statistical Office of the European Commission (Eurostat) and to the International Energy Agency (IEA), for statistical purposes and monitoring energy consumption targets from RES to 2020 set by Directive 2009/28 /EC and the National Action Plan for Renewable Energy (PAN).

According to the most recent reports of the IEA, future implementation of RES will continue to increase worldwide (IEA 2017) . However, this trend also depends by exogenous factors such as overall energy consumption, the international context, as well as policy strategies.

The integration of economic, environmental and social concerns into policy making is a hall-mark of the sustainability approach (Assefa and Frostell 2007), though this theoretical construct to date has been targeted, to some extent, to energy policy.

Considering the above, the obtained results of the present Thesis support the above dimensions into policy-making suggestions. The Sixth Environmental Action Programme titled 'Environment 2010: Our Future, Our Choice' – called for a deepening of environmental policy integration, which should fully assess all Commission policy initiatives with greater use of environmental indicators and best benchmarking practice. The Seventh Environmental Action Programme titled 'Living well, within the limits of our planet' – helps guiding EU action on environment and climate change up to and beyond 2020 as follows:

"In 2050, we live well, within the planet's ecological limits. Our prosperity and healthy environment stem from an innovative, circular economy where nothing is wasted and where natural resources are managed sustainably, and biodiversity is protected, valued and restored in ways that enhance our society's resilience. Our low-carbon growth has long been decoupled from resource use, setting the pace for a safe and sustainable global society".

In recent years, as discussed in the previous Section, concerns over climate change, diversification of energy sources and security of energy supply have led to policy reforms containing measures of environmental policy integration and liberalization. At the same time, these reforms concerned energy supply rather than energy demand, thus re-addressing supply rather than use; and dealt more with the economic rather than social side of the sustainable development definition.

Wind energy is the most advanced technology providing green electricity in several EU member states, including Italy (IEA 2017). To achieve renewable targets, governments need to get full information on social preferences in order implement adequate and efficient policy instruments.

The obtained results of the present Thesis reveal a certain degree of controversy about public acceptance of wind energy. In general, wind energy would be 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 in the context of Apulia region. However, differences in resident perception would result in terms of location of wind farms. This would support the emotional (i.e. the sentiment) attitude of residents to their territory (Jobert et al. 2007; Enevoldsen & Sovacool 2016).

Aesthetical impact of wind farms would be considered a minor factor compared to other issues proposed in the study. This trend is confirmed both in pilot studies results and the final case study. Therefore, it contrasts the majority of literature (Strazzera et al. 2012; Sunak & Madlener 2016).

Local communities would care most about economic aspects and technological efficiency of wind farms rather than other aspects; and starve to achieve more information about social benefits. This result is also supported by Szarka (2006).

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 people's perception of turbine colour and dimension, maintenance and implementation impacts as well as profit and disinformation, the higher the importance of location.

This result may suggest a major attention of 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 the territory and promote innovation and sustainable initiatives to local communities. Considering the high concentration of innovators and early adopters, wind energy would have the ground for success.

Of course, the main focus of wind energy policy should be targeted to investments in new capacity, despite this suggests a 'productivist' view of energy policy purpose. Yet, this aim drives the promotion of technological progress, reductions of costs and energy prices, and thus social acceptance.

Szarka (2006) defines two main alternatives to achieve increasing production capacity such as price-based (i.e. feed-in tariffs) and quota-based policies (i.e. renewable portfolio standards). The former (also named as REFIT) guarantees to all targeted suppliers a price per kilowatt. The latter (also named as RPS) requires that a specific amount of national energy, the 'quota', comes from renewable sources, thus providing market certification mechanisms reaching that quota.

Rickerson (2002) and Meyer (2003) argue that REFIT mechanisms would provide stronger capacity growth of wind power. In contrast, RPS would contribute less to reach the desired expansion of wind energy. Other studies (Haas et al.

2004; Lauber 2004; Sawin 2004) indicate different outcomes from different contexts and argue that a 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. Furthermore, preliminary valuation studies, including the use of non-market evaluation tools, as well as monitoring, market feasibility plans and detailed environmental impact assessment should be required.

An interesting aspect of case study results is public acceptance of wind energy in terms of willingness to accept social costs. In particular, the costs attributed to maintenance, implementation and dismantling are 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 preference on wind energy is due because this renewable source is perceived clean, and with acceptable costs such as bill savings. This aspect would suggest 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. 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 2001). These measures set tariffs at levels that are fair and efficient overcoming excessive prices and undue profits.

Risks and issues related to wind energy are the main aspects emerging from public perception. Following the positive attitude to innovation and wind energy of Apulian people to help energy market de-carbonization, the above policy indication could represent a starting point for a more efficient wind energy diffusion.

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. Nevertheless, participants to FGs have shown a positive and proactive general perception of wind developments provided that wind project management is transparent, contributes to the distribution of collective benefits and determines a careful environmental assessment. The obtained results are supported by the outcomes of the FG discussion and the international literature (Cohen, 2014; Caporale and De Lucia, 2015; Enevoldsen, 2016).

Mistrust for policy makers and stakeholders is an issue widely argued during FGs. This result also appears in accordance with global rankings in the case of AHP analysis. Users generally emphasise the lack of transparency of institutions. 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) and Enevoldsen and Sovacool (2016).

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) developed a multidimensional approach considering three stages: pre-commercial (including R&D and demonstration facilities); supported commercial (including the so-called near-market); and commercial (relative to the maturity stage). Also, Foxon’s approach helps to identify and fix system failure along the innovation chain.

Bergek and Jacobsson (2003) explain the success of the German wind energy policy by purposing a combination of its four-strand approach. Firstly, in the

R&D phase a policy encouraging the adoption of technological variety of wind turbines is necessary. Secondly, in later phases, policies should encourage market creation and development bringing the attention of inventors to the wind energy market. Thirdly, industrial policy strategies would also be relevant in this context. Finally, energy policies should favour and encourage social legitimacy of wind energy.

Based on the above, a third policy indication could be suggested from the obtained results.

> **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 phenomenon, local community would need to have adequate information on social costs and benefits of each wind energy project that the decision maker plans to implement on the territory. Furthermore, the generation of local economic benefits for the territory would create additional motivations to support sustainable development initiatives.

Institutional capacity is also relevant for policy ambition and success. Legitimacy and visions belong to a process of cumulative causation comprised by institutional change, market formation and strengthening of coalitions.

Generally, participants to FGs consider environmental attributes such as decarbonisation and/or green energy one of the main factors affecting wind energy developments. The case study revealed that CO_2 savings would be considered an important attribute compared to other aspects. Instead, avifaunal impact would not seem to influence negatively wind perception as expected. This aspect contrasts the current literature arguing on perceived risks in the ecosystem (Dai et al. 2015; Masden & Cook 2016). Dismantling impact appears among the top five factors against wind energy developments in the AHP valuations and participants to FGs were particularly active to discuss this aspect. It emerged that a lack of information and regulation on 'who has the right' to invoke the dismantling of turbines heavily affect public acceptance to wind energy.

However, dismantling issues became a secondary aspect in CE. A relevant difference would arise between what people declare and their choice behaviour. This difference is significant and mostly relating to environmental impacts as already argued by Caporale and De Lucia (2015).

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 of 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; and 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. In support of the above advices an emphasis should be placed on education activities through developing new undergraduate, graduate and postgraduate curricula throughout Apulia region. Furthermore, a support from the energy and industrial sector is also advised to guarantee the formation of adequate expertise between academia and industry.

5.3. Chapter conclusions

This Chapter has explained the main findings of the present Thesis. The obtained results have been investigated in the light of the research questions provided in the introductory section. These questions deepen wind energy perception considering potential wind energy risks, individual attitudes to innovate, and the overcome of hypothetical bias in SP.

The implementation of Honesty Treatment helps to overcome hypothetical bias in stated preferences.

Potential risks linked to the perception of wind energy affect social acceptance but seem less relevant to the risks attributed to fossil fuels.

Economic aspects, mostly defined in terms of benefits, significantly affect wind choice behaviour, rather than environmental and aesthetical impacts.

Wind power plants are considered an innovative technology, in relation to fossil fuels power plants, and present several potentials in terms of the 'innovation attitude' of the sample. In particular, people would be risk takers and this could favour the adoption of efficient wind energy developments overcoming current risks.

To conclude, a bottom-up policy insight would consider enhancing community acceptance and pro-active participation:

1. Participation through decision making (i.e. community actions for planning wind farm projects);
2. Local community benefits (i.e. profit and investment sharing on local projects);
3. Information and incentives to local energy consumption (i.e. wind energy promptly available at reduced costs to locals);
4. Environmental regeneration (i.e. improving ecological quality of nearby lands using profits from wind farms).

CONCLUSIONS

In order to reach the aim of understanding preferences of public acceptance for on shore wind energy attributes and their incidence on public well-being, the objectives of this Thesis, as outlined in the Introduction, are:

1. To use Choice Experiments to understand public perception of wind energy attributes;
2. To investigate the efficiency of Honesty Priming Tasks to mitigate hypothetical bias in Choice Experiments;
3. To understand consumers' attitude to innovate.

Chapter 1 reviewed the literature background on wind energy. The review was performed by looking at the different facets of perception and psycho-social characteristics affecting social acceptance of wind energy, and examining general impacts and issues discussed in the literature.

Social perception is based on evaluation of public or social acceptance according to three dimensions: socio-political acceptance; community acceptance and market acceptance.

Furthermore, specific determinants affect social acceptance, such as personal, psychological, and contextual factors. An effect of these determinants is the NIMBY phenomenon, which is one of the main causes of social conflicts and economic losses in terms of wind energy.

The chapter also provided a detailed understanding on the following individual attributes which are generally used to calibrate case studies: aesthetic impact, environmental sustainability, economic sustainability, functional efficiency, noisiness, and inadequacy of institutions.

In Chapter 2, the use of stated choice methods under a theoretical and applied point of view was widely discussed.

In particular, the Theory of Value explained the foundations of non-market good valuation. Also, stated preference models were described as useful tools to analyse changes in individuals' well-being from public good consumption. Random utility models and utility maximization represented the conceptual framework to investigate choice and ranking in SCM applications. Stated preferences models generally assess the value of non-market goods by using individuals' stated behaviuor in a hypothetical setting.

The hypothetical task was built through the use of a Choice Experiments (CEs) approach. Preference analysis and price estimation of attributes, as defined in a multi-value space through CEs, could present more complexity. The complex model of valuation through a choice modelling approach has the potential for success in situations in which practical issues limit CV. People are asked to choose their preferred alternative within a set of two or more alternatives and among different choice sets. Alternatives are different in relation to a combination of attribute levels and across attributes. The model helps to investigate how people change their preferences in relation to the change occurred in attribute levels and determine variations of people's well-being. Furthermore, some supporting techniques to CEs were introduced, such as Focus Groups, survey distortion reductions, and innovativeness scales.

Chapter 3 illustrated pilot studies to retrieve useful preliminary results in terms of wind energy attributes. Results from a desk analysis of wind energy market at national and regional level justified the choice of Apulia region as the area under study.

The first pilot survey conducted a general examination of attributes perception. NIMBY phenomenon was supported by survey analysis results, whereas economic aspects and technological efficiency, rather than environmental aspects, were considered.

With the objective of identifying latent issue affecting wind energy perception, two Focus Groups were implemented. The text-mining analysis and AHP results suggested the inclusion of positive effects of wind energy production on air pollution and the importance of faunal and dismantling impacts. Moreover, FGs supported the importance of other attributes included in the final survey such as: visual impact, amount of energy production, CO_2 savings, faunal impact (i.e. number of birds killed), costs, savings in the energy bill, dismantling and information.

Chapter 4 described the final survey submitted to a random sample of the population of Apulia region.

The objectives of the case study addressed the understanding of public attitudes towards fossil fuels and wind energy, as well as existing trade-offs between all factors (pros and cons) of a wind energy installation.

Survey results provided a series of interesting insights in terms of correlation among knowledge, risks and wind perception. The study filled the literature gap in terms of estimated attitudes between perceived risks and territorial impact of wind energy.

The construction of CEs for the case under study followed the following steps: (i) Construction of an orthogonal design with attributes and attribute levels according to current literature and previous studies; (ii) Pilot CEs; iii. Use of MNL logit regressions from pilot CEs; (iv) Use of priors to estimate utility functions and D-efficient design; (v) A final survey with CEs.

Results suggested that the use of a D-error in the experimental design significantly reduces the error and minimizes the sample size.

Furthermore, hypothetical bias was checked through the Honesty Priming Treatment. Results suggested a positive effect of HHP treatment before CEs.

The main drivers of public acceptance for wind energy were CO_2 savings and costs (i.e. maintenance and operational). Considering the positive signs of the estimated coefficients for the above attributes, respondents should be considered risk taker. This result would contrast the assumptions behind the Prospect Theory.

Social risks and issues related to wind energy were the main aspects emerging from the case study. All aspects considered in CEs seemed to affect a general perception of wind energy, with the exception of information and dismantling issues, which were factors emerged during Focus Groups. Similarly, the dismantling issue and avifaunal impact were considered minor aspects. This may be explained by the relatively low bird mortality in the area under study, compared to coal power plants.

Wind energy was considered an innovative technology compared to fossil fuels technology. The diffusion of innovation was investigated according to Rogers theory. Results suggested a risk taker attitude of respondents, once again in contrast with the Kahneman's theory.

Chapter 5 provided a critical assessment of the main findings. The obtained results were explored in the light of the research questions advocated in this Thesis' work. Relevant policy indications were suggested to overcome the literature gap concerning public acceptance of wind energy.

6.1. Limitations and future perspectives

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 Thesis should be considered during the design and development phases of a wind farm.

A positive perception of local residents may be encouraged promoting community participation and information initiatives. In particular, Dai et al. (2015) suggest working together to seek solutions to impact issues.

Advance of technology and adoption of more recent wind turbines will also improve functional efficiency and environmental sustainability, if supported by adequate governmental strategies and local plans.

The assumptions suggested by current literature find support through an investigation of Stated Preference of people living in Apulia region, which is representative of national wind energy production. Nonetheless, a comparison with other Italian regions which are less representative of wind energy production at national level could be further addressed in future studies.

The use of Choice Experiments was the core of the present Thesis. However, preference analysis and price estimation of attributes, as defined in a multi-value space through CEs, 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-error method; stimulus control subject to respondents; evaluation of marginal variations in hypothetical multi-dimensional scenarios; 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, limitations also appear for the implementation of CEs. Firstly, the complexity of a well-defined market limits the alternatives offered in the choice sets. Secondly, the investigation to set a well-defined market could be expensive and time-consuming, particularly for the survey design, survey management, and data collection (Jacquement et al. 2011; de-Magistris et al. 2013; Jacquement et al. 2013).

Due to these difficulties, an ex-ante calibration method, such as the Honesty Priming Treatment, was performed in the hypothetical CE to mitigate the hypothetical bias. Therefore, the obtained results indicate the inadequacy of methods for hypothetical bias mitigation. However, a further improvement that may be made on this work is to consider different types of treatments, such as the neutral treatment (NT) (de-Magistris et al. 2013) in order to proceed with a comparison of results between HPT and NT methods. By doing so, the effect of each treatment on hypothetical bias can be defined, and the use of an adequate treatment can be determined according to the hypothetical context under study. Thus, an interesting contribution to further developments of priming treatment use with CEs in the field of social acceptance of wind energy as well as other fields arises in the next future.

Also, a further extension of the present Thesis is to consider, as alternative to the Probability Theory, the theoretical insight of the Possibility Theory proposed by Zadeh (1978). This theory is part of the mathematical fuzzy measure theory introduced by Choquet in 1953 and suggests to use measures such as plausibility and belief measures, as well as fuzzy set membership functions to risk assessment and uncertainty studies. The main peculiarity of the Possibility Theory is that it handles incomplete information and quantifies the meaning of an event. Based on this view, and considering Klir and Parviz's (1992) argument that neither of theories 'is weaker or stronger than the other", future perspectives of the present Thesis can be investigated through the use of fuzzy measures by providing an adequate setting of the case study.

Finally, the use of innovativeness scales helped the present Thesis to investigate heterogeneity within the sample. In addition, to reduce the error term due to missing information on potential other attributes, the use of Focus Groups and preliminary pilot surveys was taken into account for a deeper investigation of public acceptance.

Future works should consider an investigation of wind energy perception in areas with low diffusion of wind power plants. A cross-country comparative analysis can be further suggested between low and high-diffusion areas of wind power plants to address the NIMBY phenomenon on public acceptance.

Finally, an extension to current work should also examine public acceptance to other renewable sources and investigate latent issues, which arise in perception studies and help policy makers with setting efficient energy mix policies.

NOTES

[1.] WTP is the maximum sum of money that an individual is willing to pay rather than do without an increase in some good (i.e. the environmental amenity).
[2.] WAC is the minimum sum of money that an individual is required to voluntarily forgo an improvement that otherwise would be experienced.
[3.] The error is independent and identically distributed if each random variable has the same probability distribution as the others and all are mutually independent.
[4.] Contingent valuation methods belong to Conjoint/Choice Models (including contingent ranking, contingent rating and paired comparisons). These methods valuate a non-market good with given attributes and the partial utilities deriving from each attribute (Mazzanti & Montini 2001; Scarpa et al. 2005).

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REFERENCES

Adamowicz, W. & Louviere, J., 1998. Introduction to Attribute-Based Stated Choice Methods Introduction to Attribute-Based Stated Choice Methods. , (January).

Agterbosch, S., Glasbergen, P. & Vermeulen, W.J.V., 2007. Social barriers in wind power implementation in The Netherlands: Perceptions of wind power entrepreneurs and local civil servants of institutional and social conditions in realizing wind power projects. *Renewable and Sustainable Energy Reviews*, 11(6), pp.1025–1055.

Agterbosch, S., Meertens, R.M. & Vermeulen, W.J. V, 2009. The relative importance of social and institutional conditions in the planning of wind power projects. *Renewable and Sustainable Energy Reviews*, 13(2), pp.393–405.

Aitken, M., 2010. Why we still don ' t understand the social aspects of wind power : A critique of key assumptions within the literature. *Energy Policy*, 38, pp.1834–1841. Available at: http://dx.doi.org/10.1016/j.enpol.2009.11.060.

Álvarez-Farizo, B. & Hanley, N., 2002. Using conjoint analysis to quantify public preferences over the environmental impacts of wind farms. *Enargy Policy*, 30, pp.107–116.

de Araùjo, M.S.M. & de Freitas, M.A.V., 2008. Acceptance of renewable energy innovation in Brazil — case study of wind energy. *Renewable and Sustainable Energy Reviews*, 12, pp.584–591.

Ardente, F. et al., 2008. Energy performances and life cycle assessment of an Italian wind farm. *Renewable and Sustainable Energy Reviews*, 12, pp.200–217.

Arnett, E.B. et al., 2011. Altering turbine speed reduces bat mortality at wind-energy facilities. *Frontiers in Ecology and the Environment*, 9(4), pp.209–214.

Assefa, G. & Frostell, B., 2007. Social sustainability and social acceptance in technology assessment: A case study of energy technologies. *Technology in Society*, 29(1), pp.63–78. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0160791X0600042X [Accessed

March 21, 2017].
Assefa, G.Ã. & Frostell, B., 2007. Social sustainability and social acceptance in technology assessment : A case study of energy technologies. *Technology in Society*, 29, pp.63–78.
Baerwald, E.F. et al., 2009. A Large-Scale Mitigation Experiment to Reduce Bat Fatalities at Wind Energy Facilities. *Journal of Wildlife Management*, 73(7), pp.1077–1081. Available at: http://www.bioone.org/doi/abs/10.2193/2008-233.
Bell, D. et al., 2013. Re-visiting the ‘ social gap ’ : public opinion and relations of power in the local politics of wind energy. , 22(1), pp.115–135.
Bell, D., Gray, T. & Haggett, C., 2005. The Social Gap in Wind Farm Siting Decisions:Explanations and Policy Responses. , (March 2013), pp.37–41.
Bell, D., Gray, T.I.M. & Haggett, C., 2005. The ‘ Social Gap ’ in Wind Farm Siting Decisions : Explanations and Policy Responses. , 14(4), pp.460–477.
Ben-Akiva, M. & Lerman, S., 1985. Discrete choice analysis: theory and application to travel demand. *MIT Press, Cambridge, MA*.
Van Den Berg, G.P., 2004. Effects of the wind profile at night on wind turbine sound. *Journal of Sound and Vibration*, 277(4–5), pp.955–970.
Bergmann, A., Colombo, S. & Hanley, N., 2008. Rural versus urban preferences for renewable energy developments ☆. *Ecological Economics*, 65, pp.616–625.
Bergmann, A., Hanley, N. & Wright, R., 2006. Valuing the attributes of renewable energy investments. *Energy Policy*, 34(9), pp.1004–1014.
Berry, R. et al., 2011. Web-based GIS Approaches to Enhance Public Participation in Wind Farm Planning. *Transactions in GIS*, 15(2), pp.147–172.
Bezirtzoglou, C., Dekas, K. & Charvalos, E., 2011. Climate changes, environment and infection: Facts, scenarios and growing awareness from the public health community within Europe. *Anaerobe*, 17, pp.337–340.
Bidwell, D., 2013. The role of values in public beliefs and attitudes towards commercial wind energy. *Energy Policy*, 58, pp.189–199. Available at: http://dx.doi.org/10.1016/j.enpol.2013.03.010.
Bishop, I.D., 2002. Determination of thresholds of visual impact: The case of wind turbines. *Environment and Planning B: Planning and Design*, 29(5), pp.707–718.
Bishop, I.D. & Miller, D.R., 2007. Visual assessment of off-shore wind turbines: The influence of distance, contrast, movement and social variables. *Renewable Energy*, 32(5), pp.814–831.
Bliemer, M.C.J. & Rose, J.M., 2005. Efficient Designs for Alternative Specific Choice Experiments.

Bonar, P.A.J., Bryden, I.G. & Borthwick, A.G.L., 2015. Social and ecological impacts of marine energy development. *Renewable and Sustainable Energy Reviews*, 47, pp.486–495. Available at: http://dx.doi.org/10.1016/j.rser.2015.03.068.

Bujdosó, Z. et al., 2012. The Social Aspects and Public Acceptance of Biomass Giving the Example of a Hungarian Region. , 1(2), pp.39–43.

Burguillo, M. & del Rio, P., 2008. Assessing the impact of renewable energy deployment on local sustainability : Towards a theoretical framework. *Renewable and Sustainable Energy Reviews*, 12, pp.1325–1344.

Busch, M. et al., 2013. Consequences of a cumulative perspective on marine environmental impacts: Offshore wind farming and seabirds at North Sea scale in context of the EU Marine Strategy Framework Directive. *Ocean and Coastal Management*, 71, pp.213–224. Available at: http://dx.doi.org/10.1016/j.ocecoaman.2012.10.016.

Caporale, D. & De Lucia, C., 2015. Social acceptance of on-shore wind energy in Apulia Region. *Renewable and Sustainable Energy Reviews*, 52(March 2010), pp.1378–1390. Available at: http://dx.doi.org/10.1016/j.rser.2015.07.183.

Caporale, D. & De Lucia, C., 2015. Social acceptance of on-shore wind energy in Apulia Region (Southern Italy). *Renewable and Sustainable Energy Reviews*, 52.

Carlman, I., 1985. The views of politicians and decision-makers on planning for the use of wind power in Sweden. In *Commission of the European Communities, (Report) EUR*.

Carson, R.T. et al., 1994. Experimental analysis of choice. *Marketing Letters*.

Carter, N. et al., 2014. Methods & Meanings. , 41(5), pp.545–547.

Casale, C.A., 2009. Guida per l'utilizzo dell'Atlante eolico dell'Italia. Studi sui potenziali sviluppi delle energie rinnovabili. , pp.1–84.

Celik, A.N., Muneer, T. & Clarke, P., 2007. An investigation into micro wind energy systems for their utilization in urban areas and their life cycle assessment. *Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy*, 221(8), pp.1107–1117.

Chapman, S., 2014. Factoid forensics : Have " more than 40 " Australian families abandoned their homes because of wind farm noise ? , 16(August), pp.208–212.

Chartrand, T.L. et al., 2008. Nonconscious Goals and Consumer Choice. *Journal of Consumer Research*.

Claudy, M.C. et al., 2010. Consumer awareness in the adoption of microgeneration technologies An empirical investigation in the Republic of Ireland. *Renewable and Sustainable Energy Reviews*, 14, pp.2154–2160.

Claudy, M.C., Michelsen, C. & Driscoll, A.O., 2011. The diffusion of microgeneration technologies – assessing the influence of perceived product characteristics on home owners ' willingness to pay. *Energy Policy*, 39(3), pp.1459–1469. Available at: http://dx.doi.org/10.1016/j.enpol.2010.12.018.

Cohen, J.J., Reichl, J. & Schmidthaler, M., 2014. Re-focussing research efforts on the public acceptance of energy infrastructure : A critical review. *Energy*. Available at: http://dx.doi.org/10.1016/j.energy.2013.12.056.

Cummings, R.G. & Taylor, L.O., 1999. Unbiased value estimates for environmental goods: A cheap talk design for the contingent valuation method. *American Economic Review*.

Cyr, J., 2015. The Pitfalls and Promise of Focus Groups as a Data Collection Method.

Dai, K. et al., 2015. Environmental issues associated with wind energy - A review. *Renewable Energy*, 75, pp.911–921. Available at: http://dx.doi.org/10.1016/j.renene.2014.10.074.

Daniel, T.C. & Meitner, M.M., 2001. Representational validity of landscape visualizations: The effects of graphical realism on perceived scenic beauty of forest vistas. *Journal of Environmental Psychology*, 21(1), pp.61–72.

De-Magistris, T., Gracia, A. & Nayga, R.M., 2013. On the use of honesty priming tasks to mitigate hypothetical bias in choice experiments. *American Journal of Agricultural Economics*, 95(5), pp.1136–1154.

Dell'Olio, L., Ibeas, A. & Cecin, P., 2011. The quality of service desired by public transport users. *Transport Policy*, 18, pp.217–227. Available at: http://dx.doi.org/10.1016/j.tranpol.2010.08.005.

Devine-Wright, P., 2005. Beyond NIMBYism: towards an Integrated Framework for Understanding Public Perceptions of Wind Energy. *Wind Energy*, 8, pp.125–139.

Devine-Wright, P., 2007. Reconsidering public attitudes and public acceptance of renewable energy technologies : a critical review. , (February).

Eichhorn, M. et al., 2012. Model-Based Estimation of Collision Risks of Predatory Birds with Wind Turbines. *Ecology and Society*, 17(2).

Ejdemo, T. & Söderholm, P., 2015. Wind power , regional development and bene fi t-sharing : The case of Northern Sweden $. , 47, pp.476–485.

Ek, K., 2005. Public and private attitudes towards "" green "" electricity : the case of Swedish wind power. , 33, pp.1677–1689.

Ek, K., 2002. Valuing the Environmental Impacts of Wind Power. *Environmental Valuation in Develped Countries: Case Studies*, pp.181–212.

Ek, K. & Persson, L., 2014. Wind farms - Where and how to place them? A choice experiment approach to measure consumer preferences for characteristics of wind farm establishments in Sweden. *Ecological Economics*.

Ekins, P., 2004. Step changes for decarbonising the energy system : research needs for renewables , energy efficiency and nuclear power. *Energy Policy*, 32, pp.1891–1904.
Enevoldsen, P. & Sovacool, B.K., 2016. Examining the social acceptance of wind energy: Practical guidelines for onshore wind project development in France. *Renewable and Sustainable Energy Reviews*, 53, pp.178–184. Available at: http://dx.doi.org/10.1016/j.rser.2015.08.041.
Evans, A., Strezov, V. & Evans, T.J., 2009. Assessment of sustainability indicators for renewable energy technologies. *Renewable and Sustainable Energy Reviews*, 13, pp.1082–1088.
Everaert, J. & Kuijken, E., 2010. Wind turbines and birds in Flanders (Belgium): Preliminary summary of the mortality research results. *Research Institute for Nature and Forest*, (2002), pp.1–10.
Feder, K. et al., 2015. An assessment of quality of life using the WHOQOL-BREF among participants living in the vicinity of wind turbines. *Environmental Research*, 142, pp.227–238. Available at: http://dx.doi.org/10.1016/j.envres.2015.06.043.
Ferrini, S. & Scarpa, R., 2007. Designs with a priori information for nonmarket valuation with choice experiments: A Monte Carlo study. *Journal of Environmental Economics and Management*, 53(3), pp.342–363.
Fokaides, P.A. & Miltiadous, Irene-Chrysovalanto Neophytou, Marina K.-A. Spyridou, L.-P., 2013. Promotion of wind energy in isolated energy systems : the case of the Orites wind farm. *Clean Technology Environmental Policy*.
Follestad, A., Reitan, O. & Schulze, J., 2006. *Vindkraft og fugl på Smøla 2003–2006*,
Foote, R., 2010. The wind is blowing the right way for birds. *Renewable Energy Focus*, 11(2), pp.40–42. Available at: http://dx.doi.org/10.1016/S1755-0084(10)70052-1.
Franceschinis, C., Thiene, M., et al., 2017. Adoption of renewable heating systems: An empirical test of the diffusion of innovation theory. *Energy*, 125, pp.313–326. Available at: http://dx.doi.org/10.1016/j.energy.2017.02.060.
Franceschinis, C., Scarpa, R. & Thiene, M., 2017. A Monte Carlo Evaluation of the Logit-Mixed Logit under Asymmetry and Multimodality. *Working Paper*. Available at: ftp://wms-webprod1.mngt.waikato.ac.nz/RePEc/wai/econwp/1723.pdf.
Freeman, M.A., Herriges, J.A. & Kling, C.L., 2014. *The Measurement of Environmental Resource Values: Theory and Methods*,
Greenwood, M. et al., 2017. Hearing voices : Comparing two methods for analysis of focus group data. *Applied Nursing Research*, 35, pp.90–93. Available at: http://dx.doi.org/10.1016/j.apnr.2017.02.024.

Gross, C., 2007. Community perspectives of wind energy in Australia : The application of a justice and community fairness framework to increase social acceptance. *Energy Policy*, 35, pp.2727–2736.
GSE, 2016. Rapporto statistico. Energia da fonti rinnovabili in Italia.
Guo, Y. et al., 2015. Not in my backyard , but not far away from me : Local acceptance of wind power in China. *Energy*, 82, pp.722–733. Available at: http://dx.doi.org/10.1016/j.energy.2015.01.082.
Hahn, J., Ham, J.C. & Moon, H.R., 2011. The Hausman test and weak instruments. *Journal of Econometrics*.
Hammond, K.R., 1955. Probabilistic functioning and the clinical method. *Psychological Review*.
Harrison, G.W., 2006. Experimental evidence on alternative environmental valuation methods. *Environmental and Resource Economics*.
Hausman, J.A. & Wise, D.A., 1978. A Conditional Probit Model for Qualitative Choice: Discrete Decisions Recognizing Interdependence and Heterogeneous Preferences. *Econometrica*.
Herbert, G.M.J., Iniyan, S. & Goic, R., 2010. Performance , reliability and failure analysis of wind farm in a developing Country. *Renewable Energy*, 35(12), pp.2739–2751. Available at: http://dx.doi.org/10.1016/j.renene.2010.04.023.
IEA, I.E.A., 2017. CO2 Emissions from Fuel Combustion 2017 - Highlights. *International Energy Agency*, 1, pp.1–162. Available at: www.iea.org/t&c/%0Ahttps://www.iea.org/publications/freepublications/publication/CO2EmissionsfromFuelCombustionHighlights2017.pdf.
Jacquemet, N. et al., 2013. Preference elicitation under oath. *Journal of Environmental Economics and Management*, 65(1), pp.110–132.
Jami, A.A.N. & Walsh, P.R., 2014. The role of public participation in identifying stakeholder synergies in wind power project development : The case study of Ontario , Canada. *Renewable Energy*, 68, pp.194–202. Available at: http://dx.doi.org/10.1016/j.renene.2014.02.004.
Janhunen, S., Hujala, M. & Pätäri, S., 2014. Owners of second homes , locals and their attitudes towards future rural wind farm. *Energy Policy*, 73, pp.450–460. Available at: http://dx.doi.org/10.1016/j.enpol.2014.05.050.
Jobert, A., Laborgne, P. & Mimler, S., 2007. Local acceptance of wind energy : Factors of success identified in French and German case studies. , 35, pp.2751–2760.
Johansson, M. & Laike, T., 2007. Intention to respond to local wind turbines: The role of attitudes and visual perception. *Wind Energy*, 10(5), pp.435–451.
Johnson, M.K. et al., 2009. CG2Real: Improving the Realism of Computer Generated Images using a Large Collection …. *Dspace.Mit.Edu*, 17(9), pp.1273–1285. Available at:

http://dspace.mit.edu/handle/1721.1/46335?show=full%0Apapers2://publication/uuid/499B25AD-4E40-4E9B-9A0F-D03CA55B15C5.

Johnston, R.J. et al., 2017. Contemporary Guidance for Stated Preference Studies. *Journal of the Association of Environmental and Resource Economists*, 4(2), pp.319–405. Available at: https://www.journals.uchicago.edu/doi/10.1086/691697.

Jones, C.R. & Richard Eiser, J., 2010. Understanding "local" opposition to wind development in the UK: How big is a backyard? *Energy Policy*.

Jung, N. et al., 2016. Social acceptance of renewable energy technologies for buildings in the Helsinki Metropolitan Area of Finland. *Renewable Energy*, 99(December 2002), pp.813–824. Available at: http://dx.doi.org/10.1016/j.renene.2016.07.006.

Kampa, M. & Castanas, E., 2008. Human health effects of air pollution. *Environmental Pollution*, 151, pp.362–367.

Kamperman, G.W. & James, R.R., 2008. The "how to" guide to siting wind turbines to prevent health risks from sound. , p.47.

Katsaprakakis, D. Al, 2012. A review of the environmental and human impacts from wind parks. A case study for the Prefecture of Lasithi, Crete. *Renewable and Sustainable Energy Reviews*, 16(5), pp.2850–2863. Available at: http://dx.doi.org/10.1016/j.rser.2012.02.041.

Kay, A.C. & Ross, L., 2003. The perceptual push: The interplay of implicit cues and explicit situational construals on behavioral intentions in the prisoner's dilemma. *Journal of Experimental Social Psychology*.

Klein, E.E., Tellefsen, T. & Herskovitz, P.J., 2007. The use of group support systems in focus groups : Information technology meets qualitative research. *Computers in Human Behavior Computers*, 23, pp.2113–2132.

Klug, H., 2002. Noise from Wind Turbines Standards and Noise Reduction Procedures. *The Forum Acousticum*, (September), pp.16–20.

Kontogianni, A. et al., 2014. Planning globally , protesting locally : Patterns in community perceptions towards the installation of wind farms. *Renewable Energy*, 66, pp.170–177. Available at: http://dx.doi.org/10.1016/j.renene.2013.11.074.

Krohn, S. & Damborg, S., 1999. On Public Attitudes Towards Wind Power. *Renewable Energy 16*, 16, pp.954–960.

Krueger, R.A. & Casey, M.A., 2000. *Focus groups* Third., Thousand Oaks, CA: Sage Publications, Inc.

KUNZ, T.H. et al., 2007. Assessing Impacts of Wind-Energy Development on Nocturnally Active Birds and Bats: A Guidance Document. *Journal of Wildlife Management*, 71(8), pp.2449–2486. Available at: http://www.bioone.org/doi/abs/10.2193/2007-270.

Kuvlesky, William P., J. et al., 2007. Wind Energy Development and Wildlife Conservation: Challenges and Opportunities. *Wildlife Research*.

Ladenburg, J., 2015. Does more wind energy influence the choice of location for wind power development ? Assessing the cumulative effects of daily wind turbine encounters in Denmark. *Energy Research & Social Science*, 10, pp.26–30. Available at: http://dx.doi.org/10.1016/j.erss.2015.06.005.

Ladenburg, J., Termansen, M. & Hasler, B., 2013. Assessing acceptability of two onshore wind power development schemes : A test of viewshed effects and the cumulative effects of wind turbines. *Energy*, 54, pp.45–54. Available at: http://dx.doi.org/10.1016/j.energy.2013.02.021.

Lancaster, K.J., 1966. A New Approach to Consumer Theory. *Journal of Political Economy*.

Larsen, J.K. & Guillemette, M., 2007. Effects of wind turbines on flight behaviour of wintering common eiders : implications for habitat use and collision risk. *Journal of Applied Ecology*, 44, pp.516–522. Available at: https://doi.org/10.1111/j.1365-2664.2007.01303.x.

Leung, D.Y.C. & Yang, Y., 2012. Wind energy development and its environmental impact: A review. *Renewable and Sustainable Energy Reviews*, 16(1), pp.1031–1039. Available at: http://dx.doi.org/10.1016/j.rser.2011.09.024.

Liechti, F., Guélat, J.Ô. & Komenda-Zehnder, S., 2013. Modelling the spatial concentrations of bird migration to assess conflicts with wind turbines. *Biological Conservation*, 162, pp.24–32. Available at: http://dx.doi.org/10.1016/j.biocon.2013.03.018.

List, J.A. & Gallet, C.A., 2001. What experimental protocol influence disparities between actual and hypothetical stated values? *Environmental and Resource Economics*.

Liu, Y., Fan, Z.-P. & Zhang, Y., 2012. Risk decision analysis in emergency response: A method based on cumulative prospect theory. *Computers & Operations Research*, 42, pp.75–82. Available at: http://dx.doi.org/10.1016/j.cor.2012.08.008.

Longo, A., Markandya, A. & Petrucci, M., 2008. The internalization of externalities in the production of electricity : Willingness to pay for the attributes of a policy for renewable energy ☆. *Ecological Economics*, 67, pp.140–152.

Lorenzoni, I., Nicholson-cole, S. & Whitmarsh, L., 2007. Barriers perceived to engaging with climate change among the UK public and their policy implications. *Global Environmental Change*, 17, pp.445–459.

Louviere, J. & Hensher, D., 1982. On the Design and Analysis of Simulated

Choice or Allocation Experiments in Travel Choice Modelling. *Transportation Research Record*.

Louviere, J., Hensher, D. & Swait, J., 2000. *Stated Choice Methods Analysis and Applications* 2000th ed., New York: Cambridge University Press. Available at: http://www.cambridge.org/uk/catalogue/catalogue.asp?isbn=9780521788304.

Louviere, J.J. & Woodworth, G., 1983. Design and Analysis of Simulated Consumer Choice or Allocation Experiments: An Approach Based on Aggregate Data. *Journal of Marketing Research*.

De Lucia, C. & Caporale, D., 2013. Greener cities and territories : Brief notes on socio- economic acceptance to renewable energy sources. *Plurimondi*, 6(12), pp.183–200.

Marsh, G., 2007. WTS: the avian dilemma. *Renewable Energy Focus*, 8(4), pp.42–45.

Masden, E.A. et al., 2009. Cumulative impact assessments and bird/wind farm interactions: Developing a conceptual framework. *Environmental Impact Assessment Review*. Available at: http://dx.doi.org/10.1016/j.eiar.2009.05.002.

Masden, E.A. & Cook, A.S.C.P., 2016. Avian collision risk models for wind energy impact assessments. *Environmental Impact Assessment Review*, 56, pp.43–49. Available at: http://dx.doi.org/10.1016/j.eiar.2015.09.001.

Mazzanti, M. & Montini, A., 2001. Valutazione economica multi-attributo mediante esperimenti di scelta. Aspetti metodologici e strumenti di analisi econometrica. In *Società italiana di economia pubblica*. Pavia, pp. 5–6.

McFadden, D., 1974. Conditional logit analysis of qualitative choice behavior. *Frontiers in Econometrics*.

McFadden, D. & Train, K., 2000. Mixed MNL models for discrete response. *Journal of Applied Econometrics*, 15(5), pp.447–470. Available at: http://dx.doi.org/10.1002/1099-1255(200009/10)15:5%3C447::AID-JAE570%3E3.0.CO;2-1 http://onlinelibrary.wiley.com/store/10.1002/1099-1255(200009/10)15:5%3C447::AID-JAE570%3E3.0.CO;2-1/asset/570_ftp.pdf?v=1&t=hq4h9p2b&s=85b27895c18fcbdac79f85651d2f9933dc8532c4.

Meyerhoff, J., Ohl, C. & Hartje, V., 2010. Landscape externalities from onshore wind power. *Energy Policy*, 38, pp.82–92. Available at: http://dx.doi.org/10.1016/j.enpol.2009.08.055.

Møller, H. & Pedersen, C.S., 2011. Low-frequency noise from large wind turbines. *The Journal of the Acoustical Society of America*, 129(6), pp.3727–3744. Available at: http://asa.scitation.org/doi/10.1121/1.3543957.

Molnarova, K. et al., 2012. Visual preferences for wind turbines : Location , numbers and respondent characteristics. *Applied Energy*, 92, pp.269–278.
Morgan, D.L., 1997. *Focus Groups as Qualitative Research* Second., Thousand Oaks, CA: Sage Publications, Inc.
Mroczek, B. et al., 2015. Evaluation of quality of life of those living near a wind farm. *International Journal of Environmental Research and Public Health*, 12(6), pp.6066–6083.
Nardone, A. et al., 2010. Effects of climate changes on animal production and sustainability of livestock systems. *Livestock Science*, 130, pp.57–69.
Nomura, N. et al., 2001. Life-cycle emission of oxidic gases from power-generation systems. *Applied energy*, 68(2), pp.215–227.
Nunneri, C. et al., 2008. Ecological risk as a tool for evaluating the effects of offshore wind farm construction in the North Sea. *Regional Environmental Change*, 8, pp.31–43.
van Os, H.W.A., Herber, R. & Scholtens, B., 2014. Not Under Our Back Yards ? A case study of social acceptance of the Northern Netherlands CCS initiative. *Renewable and Sustainable Energy Reviews*, 30, pp.923–942. Available at: http://dx.doi.org/10.1016/j.rser.2013.11.037.
Panwar, N.L., Kaushik, S.C. & Kothari, S., 2011. Role of renewable energy sources in environmental protection : A review. *Renewable and Sustainable Energy Reviews*, 15, pp.1513–1524. Available at: http://dx.doi.org/10.1016/j.rser.2010.11.037.
Patton, M., 1990. Qualitative Evaluation and Research Methods. *Qualitative Evaluation and Research Methods*.
Pedersen, E., 2011. Health aspects associated with wind turbine noise — Results from three field studies. *Noise Control Engineering Journalneering Journal*, 59, pp.47–53. Available at: https://doi.org/10.3397/1.3533898.
Petrova, M.A., 2013. NIMBYism revisited : public acceptance of wind energy in the United States. , 4(December).
Polzin, F. et al., 2015. Public policy in fl uence on renewable energy investments — A panel data study across OECD countries. *Energy Policy*, 80, pp.98–111. Available at: http://dx.doi.org/10.1016/j.enpol.2015.01.026.
Proops, J.L.R. et al., 1996. The lifetime pollution implications of various types of electricity generation: An input-output analysis. *Energy Policy*, 24(3), pp.229–237.
Raadal, H.L. et al., 2011. Life cycle greenhouse gas (GHG) emissions from the generation of wind and hydro power. *Renewable and Sustainable Energy Reviews*, 15, pp.3417–3422. Available at: http://dx.doi.org/10.1016/j.rser.2011.05.001.
Robinson, N., 1999. The use of focus group methodology Ð with selected

examples from sexual health research. *Journal of Advanced Nursing*, 29(4), pp.905–913.

Rogers, E.M. et al., 2005. Complex adaptative systems and the diffusion of innovations. *The Innovation Journal*, 10(3), pp.1–26.

Rogers, E.M., 2003. Diffusion of Innovations Theory. *New York: Free Press*.

Ronchi, E., Colonna, P. & Berloco, N., 2013. Reviewing Italian Fire Safety Codes for the analysis of road tunnel evacuations: Advantages and limitations of using evacuation models. *Safety Science*.

Saidur, R. et al., 2011. Environmental impact of wind energy. *Renewable and Sustainable Energy Reviews*, 15(5), pp.2423–2430. Available at: http://dx.doi.org/10.1016/j.rser.2011.02.024.

Sangiorgio, V., Uva, G. & Fatiguso, F., 2018. Optimized AHP to Overcome Limits in Weight Calculation: Building Performance Application. *Journal of Construction Engineering and Management*, 144(2), p.04017101. Available at: http://ascelibrary.org/doi/10.1061/%28ASCE%29CO.1943-7862.0001418.

Scarpa, R., Ferrini, S. & Willis, K.G., 2005. Performance of error component models for status-quo effects in choice experiments. *Applications of simulation methods in environmental and resource economics*, 6, pp.247–273. Available at: http://dx.doi.org/10.1007/1-4020-3684-1_13.

Scarpa, R. & Rose, J.M., 2008. Design efficiency for non-market valuation with choice modelling: How to measure it, what to report and why. *Australian Journal of Agricultural and Resource Economics*, 52(3), pp.253–282.

Scarpa, R. & Willis, K., 2010. Willingness-to-pay for renewable energy: Primary and discretionary choice of British households' for micro-generation technologies. *Energy Economics*, 32(1), pp.129–136. Available at: http://dx.doi.org/10.1016/j.eneco.2009.06.004.

Schleisner, L., 2000. Life cycle assessment of a wind farm and related externalities. *Renewable Energy*, 20(3), pp.279–288.

Signorello, G. & De Salvo, M., 2010. Razionalità e stabilità delle preferenze espresse negli esperimenti di scelta . Una verifica mediante le alternative decoy. *AESTIMUM*, 56, pp.31–58.

Smallwood, K.S. & Karas, B., 2009. Avian and Bat Fatality Rates at Old-Generation and Repowered Wind Turbines in California. *Journal of Wildlife Management*, 73(7), pp.1062–1071. Available at: http://www.bioone.org/doi/abs/10.2193/2008-464.

Solomon, S. et al., 2009. Irreversible climate change due to carbon dioxide emissions. *PNAS*, 106(6), pp.1704–1709.

Solomon, S. et al., 2010. Persistence of climate changes due to a range of greenhouse gases. *Proceedings of the National Academy of Sciences of the*

United States of America, 107(43), pp.18354–9. Available at: http://www.pnas.org/cgi/content/long/107/43/18354.

Sovacool, B.K., 2009. Contextualizing avian mortality: A preliminary appraisal of bird and bat fatalities from wind, fossil-fuel, and nuclear electricity. *Energy Policy*, 37(6), pp.2241–2248.

Sovacool, B.K., 2013. The avian benefits of wind energy: A 2009 update. *Renewable Energy*, 49(January 2013), pp.19–24. Available at: http://dx.doi.org/10.1016/j.renene.2012.01.074.

Stigka, E.K., Paravantis, J.A. & Mihalakakou, G.K., 2014. Social acceptance of renewable energy sources : A review of contingent valuation applications. *Renewable and Sustainable Energy Reviews*, 32, pp.100–106. Available at: http://dx.doi.org/10.1016/j.rser.2013.12.026.

Stoll-Kleemann, S., Riordan, T.O. & Jaeger, C.C., 2001. The psychology of denial concerning climate mitigation measures : evidence from Swiss focus groups. *Global Environmental Change*, 11, pp.107–117.

Strazzera, E., Mura, M. & Contu, D., 2012. Combining choice experiments with psychometric scales to assess the social acceptability of wind energy projects : A latent class approach. *Energy Policy*, 48, pp.334–347. Available at: http://dx.doi.org/10.1016/j.enpol.2012.05.037.

Sunak, Y. & Madlener, R., 2016. The impact of wind farm visibility on property values: A spatial difference-in-differences analysis. *Energy Economics*, 55, pp.79–91. Available at: http://dx.doi.org/10.1016/j.eneco.2015.12.025.

Tahvanainen, L. et al., 2001. Forest management and public perceptions - Visual versus verbal information. *Landscape and Urban Planning*, 53(1–4), pp.53–70.

Thayer, R.L. & Freeman, C.M., 1987. Altamont: Public perceptions of a wind energy landscape. *Landscape and Urban Planning*.

Thompson, D.F., 2008. Deliberative Democratic Theory and Empirical Political Science. *Annual Review of Political Science*, 11(1), pp.497–520. Available at: http://www.annualreviews.org/doi/10.1146/annurev.polisci.11.081306.070555.

Thurstone, L.L., 1927. Three psychophysical laws. *Psychological Review*.

Varun, Prakash, R. & Bhat, I.K., 2009. Energy, economics and environmental impacts of renewable energy systems. *Renewable and Sustainable Energy Reviews*, 13(9), pp.2716–2721.

Walker, B.J.A., Wiersma, B. & Bailey, E., 2014. Energy Research & Social Science Community benefits , framing and the social acceptance of offshore wind farms : An experimental study in England. *Energy Research & Social Science*, 3, pp.46–54. Available at:

http://dx.doi.org/10.1016/j.erss.2014.07.003.
Walter, G., 2014. Determining the local acceptance of wind energy projects in Switzerland : The importance of general attitudes and project characteristics. *Energy Research & Social Science*, 4, pp.78–88. Available at: http://dx.doi.org/10.1016/j.erss.2014.09.003.
Warren, C.R. et al., 2005. "Green on green": Public perceptions of wind power in Scotland and Ireland. *Journal of Environmental Planning and Management*, 48(6), pp.853–875.
Williams, R., 2016. Understanding and interpreting generalized ordered logit models. *Journal of Mathematical Sociology*, 40(1), pp.7–20.
Wolsink, M., 2012. The research agenda on social acceptance of distributed generation in smart grids : Renewable as common pool resources. *Renewable and Sustainable Energy Reviews*, 16, pp.822–835. Available at: http://dx.doi.org/10.1016/j.rser.2011.09.006.
Wolsink, M., 2007. Wind power implementation: The nature of public attitudes: Equity and fairness instead of "backyard motives." *Renewable and Sustainable Energy Reviews*, 11(6), pp.1188–1207.
Wüstenhagen, R., Wolsink, M. & Bürer, M.J., 2007. Social acceptance of renewable energy innovation : An introduction to the concept. *Energy Policy*, 35, pp.2683–2691.
Yamani Douzi Sorkhabi, S. et al., 2016. The impact of land use constraints in multi-objective energy-noise wind farm layout optimization. *Renewable Energy*, 85, pp.359–370. Available at: http://dx.doi.org/10.1016/j.renene.2015.06.026.
Zoellner, J., Schweizer-Ries, P. & Wemheuer, C., 2008. Public acceptance of renewable energies : Results from case studies in Germany. *Energy Policy journal*, 36, pp.4136–4141.

Regulatory References

Constitutional law n. 3, 18/10/2001.
Decreto Legislativo n.387, 29/12/2003, 'Attuazione della direttiva 2001/77/CE relative alla promozione dell'energia elettrica prodotta da fonti energetiche rinnovabili nel mercato interno dell'elettricità' (G.U. n.25, 31/01/2004 - suppl.ord. n.17) [in italian].
Deliberation of the Regional Council n. 35, 23/01/2007, 'Procedure for issuing the Single Authorization pursuant to Legislative Decree No. 387/2003 and for the adoption of the final authorization provision for plants powered by renewable sources and related works, as well as infrastructures indispensable

for construction and operation'.
Directive 2001/77/EC of the european parliament and of the council, 27/09/2001, 'Promotion of electricity produced from renewable energy sources in the internal electricity market' (OJ L 283, 27.10.2001, p. 33).
Law n. 241, 7/08/1990, 'New Rules Regarding Administrative Procedure and the Right of Access to Administrative Documents'.
Law n. 239, 28/08/2004, 'Reorganisation of the energetic sector, as well as delegation to the Government to rearrange the provisions in force concerning energy' (Official Gazette n.215, 13/09/2004).
Legge n. 296, 27/12/2006, 'Disposizioni per la formazione del bilancio annuale e pluriennale dello Stato (legge finanziaria 2007)' (G.U. n.299, 27/12/2006 – supp.ord. n. 244) [in italian]
Regional regulation n. 16, 4/04/2006, 'Regulations for the construction of propellers in the Region'.
Resolution of the Regional Council n. 716, 31/05/2005, 'Procedure for the issue of authorizations for plants construction and operation producing electricity from renewable sources'.
Resolution of the Regional Council n. 1462 , 1/08/ 2008, 'Procedure for issuing the authorization for the adoption of the final authorization provision for wind power plants. Directives of the regional procedures in the activities aimed at issuing the single authorizations for implementation of wind power plants'.
Management determination n.1, 3/01/2011, 'Single Authorization pursuant to Art.12 of D.Lgs.387/2003 – DGR n. 3029 of 30.12.2010 – Approval of the 'Technical Instructions for the computerization of the documentation supplied with the Single Authorization' and the 'Telematic Procedure Guidelines''.
Ministerial decree, 24/10/2005, 'Updating the directives for the incentive of energy produced from renewable sources pursuant to Art. 11, paragraph 5, of D.Lgs.79/1999'.
Ministerial decree, 18/12/2008, 'Incentivazione della produzione di energuia elettrica da fonti rinnovabili, ai sensi dell'articolo 2, comma 150, della legge 24/12/2007 n.244, Gazzetta Ufficiale del 02/01/2009' [in italian].

APPENDIX

Table A1
Correlation matrix of attributes affecting wind farm social acceptance.

Environmental	Economic impact				Functional efficiency			Noisiness			Inadequacy of the institutions		
Agriculture production alteration	Maintenance costs	Implementation costs	Dismantling costs	Profit	Useful life	Amount of energy production	Average daily operation	Turbine distance	Turbine dimension	Number of turbines	Misinformation	No transparency of public procurement	Lack of benefit knowledge
1.00													
0.51*	1.00												
0.55*	**0.74****	1.00											
0.51*	**0.63****	**0.68****	1.00										
0.36*	0.50*	0.52*	0.47*	1.00									
0.39*	0.50*	0.50*	0.50*	0.42*	1.00								
0.51*	0.56*	0.59*	0.47*	0.54*	**0.72****	1.00							
0.46*	0.58*	0.56*	0.50*	0.45*	**0.76****	**0.81****	1.00						
0.39*	0.50*	0.52*	0.48*	0.46*	0.51*	0.54*	0.52*	1.00					
0.45*	0.43*	0.53*	0.53*	0.34*	**0.60****	0.54*	0.58*	**0.65****	1.00				
0.47*	0.50*	0.51*	0.46*	0.48*	0.59*	**0.65****	0.59*	**0.76****	**0.70****	1.00			
0.55*	0.62**	0.59*	**0.61****	0.43*	0.57*	**0.61****	0.61**	0.57*	0.55*	0.57*	1.00		
0.33*	0.32*	0.42*	0.42*	0.41*	0.45*	0.49*	0.41*	0.41*	0.34*	0.39*	**0.61****	1.00	
0.50*	**0.60****	0.52*	0.48*	0.50*	**0.63****	**0.71****	**0.63****	0.52*	0.47*	0.57*	**0.70****	0.55*	1.00

		Aesthetic impact								
		Number of turbines	Turbines distance	Turbines dimension	Turbines colour	Location	Management impact	Implementation impact	Dismantling impact	Faunal alteration
	Number of turbines	1.00								
	Turbines distance	**0.69****	1.00							
Aesthetic impact	Turbines dimension	**0.68****	**0.64****	1.00						
	Turbines colour	0.36*	0.40*	0.41*	1.00					
	Location	**0.60****	0.57*	**0.68****	0.45*	1.00				
	Management impact	0.42*	0.42*	0.38*	0.11	0.39*	1.00			
	Implementation impact	0.53*	0.47*	0.50*	0.16	0.49*	**0.80****	1.00		
Environmental impact	Dismantling impact	0.49*	0.51*	0.48*	0.15	0.54*	**0.71****	**0.80****	1.00	
	Faunal alteration	0.40*	0.40*	0.49*	0.27	0.52*	0.53*	**0.66****	**0.63****	1.00
	Agriculture production alteration	0.31*	0.33*	0.42*	0.25	0.40*	0.58*	**0.65****	**0.61****	**0.83****
	Maintenance costs	0.28	0.39*	0.39*	0.14	0.40*	0.57*	0.56*	0.46*	0.50*
Economic impact	Implementation costs	0.28	0.41*	0.49*	0.17	0.38*	0.53*	0.53*	0.49*	**0.60****
	Dismantling costs	0.29	0.43*	0.42*	0.24	0.47*	0.46*	0.53*	**0.65****	0.53*
	Profit	0.25	0.29	0.21	0.12	0.27	0.31*	0.45*	0.46*	0.42*
	Useful life	0.45*	0.44*	0.37*	0.19	0.44*	0.44*	0.52*	0.49*	0.50*
Functional efficiency	Amount of energy production	0.40*	0.40*	0.42*	0.25	0.47*	0.42*	0.56*	0.47*	**0.62****
	Average daily operation	0.33*	0.43*	0.41*	0.18	0.47*	0.40*	0.50*	0.47*	0.57*
	Turbine distance	0.46*	0.47*	0.36*	0.27	0.40*	0.43*	0.50*	0.52*	0.47*
Noisiness	Turbine dimension	0.54*	0.55*	0.55*	0.26	0.45*	0.43*	0.57*	0.58*	0.49*
	Number of turbines	0.49*	0.45*	0.49*	0.22	0.47*	0.40*	0.55*	0.52*	0.53*
	Misinformation	0.35*	0.36*	0.38*	0.12	0.46*	0.46*	0.57*	0.55*	0.58*
Inadequacy of the institutions	No transparency of public procurement	0.37*	0.32*	0.21	0.10	0.27	0.42*	0.44*	0.44*	0.40*
	Lack of benefit knowledge	0.31*	0.35*	0.28	0.12	0.36*	0.46*	0.53*	0.50*	0.54*

Table A2
Correlation matrix of attributes resulting from text-mining analysis of FGs.

Information	Integration	Interest	Nature	Landscape	Perception	Planning	Issues	Prduction	Renewable	Dismantling	Ground	Visual	Location
1													
0,3	1												
0,52**	-0,2	1											
0,43*	**0,58****	-0,1	1										
0,2	**0,77****	0,12	0,35	1									
0,46*	0,48*	0,13	**0,71****	**0,54****	1								
0,3	-0,1	0,16	-0,2	-0	-0,2	1							
0,66**	-0,2	0,33	-0,2	-0,1	0,05	**0,66****	1						
0,46*	-0,2	**0,62****	-0,2	-0,2	-0,2	**0,65****	0,45*	1					
0,2	-0,2	**0,50****	-0,1	-0	0,01	0,47*	0,1	**0,78****	1				
0,2	0,02	0,18	-0,1	0,06	-0,3	**0,90****	0,4	**0,75****	**0,54****	1			
0,73**	0,16	0,34	0,48*	0,18	**0,61****	0,4	0,4	**0,55****	**0,60****	0,34	1		
0,69**	0,18	0,43*	0,34	0,41*	**0,79****	0	0,41*	0,2	0,28	-0,1	**0,76****	1	
0,65**	-0,1	0,06	0,1	-0,2	0,34	0,3	**0,79****	0,1	-0,1	-0,1	0,48*	**0,58***	1

Attribute	Environment	Beautiful	Benefits	Knowledge	Costs	Nuisance	Favourable	Big	Impact	Environmental impact	Aesthetical impact
Environment	1										
Beautiful	-0	1									
Benefits	**0,74****	**0,53****	1								
Knowledge	0,43*	-0,3	0,1	1							
Costs	**0,62****	0,2	**0,71****	-0	1						
Nuisance	-0,4	**0,74****	0,1	-0,3	-0,2	1					
Favourable	0,48*	**0,53****	**0,59****	0,21	**0,57****	0,26	1				
Big	0,06	**0,61****	0,40*	0,06	-0,1	0,40*	0,08	1			
Impact	**0,69****	0,26	0,49*	**0,68****	0,28	0,11	**0,61****	0,3	1		
Environmental impact	**0,81****	0	**0,54****	**0,53****	0,46*	-0,1	**0,67****	-0,1	**0,79****	1	
Aesthetical impact	0,32	**0,53****	0,4	**0,54****	0,09	0,27	**0,52****	**0,61****	**0,83****	0,38	1
Information	**0,58****	**0,66****	**0,84****	0,14	**0,50****	0,3	**0,73****	**0,57****	**0,60****	0,48*	**0,59****
Integration	0,18	-0,2	0,2	0,19	0,22	-0,42*	-0,1	0,2	-0,1	-0,19	-0,03
Interest	**0,50****	0,2	0,3	**0,54****	0,09	0,33	**0,56****	0,15	**0,88****	**0,75****	**0,64****
Nature	0,35	-0	0,40*	-0,1	0,13	-0,2	-0,2	0,39	-0,1	-0,1	-0,13
Landscape	0,14	-0,1	0,1	0,45*	0,13	-0,3	-0,1	0,33	0,22	-0,12	0,36
Perception	0,23	0,28	0,4	0,18	-0,1	0,06	-0,2	**0,79****	0,26	-0,16	0,41*
Planning	0,35	0,38	0,43*	-0,1	**0,75****	0,11	**0,54****	-0,1	0,31	0,27	0,22
Issues	0,16	**0,91****	**0,63****	-0,2	0,49*	**0,63****	**0,69****	0,38	0,40*	0,24	**0,54****
Prduction	**0,80****	0,15	**0,59****	0,39	**0,66****	-0,1	**0,73****	-0,2	**0,76****	**0,90****	0,42*
Renewable	**0,66****	-0,1	0,2	**0,53****	0,33	-0,3	0,46*	-0,1	**0,70****	**0,65****	0,43*
Dismantling	**0,56****	0,01	0,44*	0,06	**0,84****	-0,2	0,44*	-0,4	0,33	0,46*	0,06
Ground	**0,75****	0,40*	**0,74****	0,29	0,46*	-0,1	0,45*	**0,52****	**0,63****	0,44*	**0,58****
Visual	0,37	**0,54****	**0,50****	0,37	0,04	0,24	0,29	**0,89****	**0,65****	0,2	**0,84****
Location	0,01	**0,95****	**0,54****	-0,3	0,14	**0,61****	0,45*	**0,65****	0,18	-0,05	0,49*

SHORT CURRICULUM VITAE

Personal Information

First name / Surname: Diana Caporale
E-mails: diana.caporale@poliba.it ; diana.caporale.90@gmail.com
Nationality: Italian
Gender: female
Driving licence: category B

Working Experience and Education

Dec/2012-Jul/2014
Master in Marketing Management (Strategic and Operative) at Università di Foggia (Italy)
Mark: 110/110 cum laude

Sep/2009-Dec/2012
Bachelor in Economics and Management of Tourist Services at Università di Foggia (Italy)
Mark: 110/110

Research periods abroad

Feb/2017-Apr/2017
Visiting period at E.T.S.I. Caminos, canals y Puertos, Departamento de Transpostes y T.P.P., Grupo GIST, Universidad de Cantabria. Supervisors: Prof. Luigi dell'Olio, Prof. Angel Ibeas Portilla

Mar/2018-May/2018
Visiting period at Business School of Durham University. Supervisor: Prof. Riccardo Scarpa

Classes and Seminars attended

Jan/2018

Empirical Methods in Energy and Environmental Economics, ETH Zürich. Instructors: Prof. Massimo Filippini, Prof. William Greene, Prof. Adán L. MartÍnez-Cruz

Feb/2017

Random Utility Models, Universidad de Cantabria. Instructor: Prof. Luigi dell’Olio

May/2016-June/2016

An Introduction to multivariate Methods: Classification and Function Approximation, Politecnico di Bari. Instructor: Prof. Harrison B. Prosper

May/2016

Probability, Statistics, and All That: The Basic Minimum, Politecnico di Bari. Instructor: Prof. Harrison B. Prosper

May/2016

Application of MATLAB, Politecnico di bari. Instructor: Prof. Marigrazia Dotoli

Technical skills and competences

Data Analysis and Statistics (SPSS, STATA, MATLAB, NGENE, NLOGIT, RAPIDMINER)

Programming languages: MATLAB, SQL

Operating systems: Windows

Language skills

Italian: Mother Tongue | *English*: Intermediate (Eurpean Level:B2) | *French*: Intermediate (Eurpean Level:B1) | *German*: Elementary (Eurpean Level:A2)

Research interest

Econometrics, behavioural analysis, quantitative and qualitative interviews, Focus Groups, Choice Experiments, environmental economics, sustainability, renewable energy, wind energy, macroeconomics, microeconomics.

List of publications

<u>Journal papers:</u>

Caporale, D., De Lucia, C., dell'Olio, L., Ibeas Portilla, A. (under preparation) Focus Group application to evaluate citizen perception of wind energy sustainability.

Caporale, D., De Lucia, C. (forthcoming). Landscape and environment: the social acceptance of wind energy in Apulia and Basilicata Regions. *Plurimondi. An International Forum For Research and Debate on Human Settlements*

Caporale, D., Sangiorgio, V., Amodio, A., De Lucia, C. (2019) Agent perception of wind farm sustainability: an Optimized Analytical Hierarchy Process and Focus Group analysis. In submission to: Journal of Cleaner Production.

Caporale, D., De Lucia C. (2015) Social acceptance of on-shore wind energy in Apulia Region (Southern Italy). Renewable & Sustainable Energy review, 52, 1378-1390. DOI: 10.1016/j.rser.2015.07.183.

De Lucia, C., **Caporale, D.** (2013). Greener cities and territories: Brief notes on socio-economic acceptance to renewable energy sources. Guest Editors: Copeta C. Special Issue: *Plurimondi. An International Forum For Research and Debate on Human Settlements,* 6(12), 183-200. ISSN: 1129-4469.

<u>Conference papers:</u>

De Lucia, C., Pazienza, P., Balena, **Caporale, D.**, P., Spinelli, S. (2018). ICT and tourism as drivers of sustainable local development: The case of Apulia

Region in southern Italy. Accepted to be presented at: *V International Tourism Conference – 2030 Agenda. Meeting the. Escola Universitària Formatic Barcelona*, 2nd-3rd July, Barcelona, Spain.

De Lucia, C., Pazienza, P., Balena, P., Vecchione V., **Caporale, D.** (2018). Tourism and identity. Is local knowledge a driver of touristic attractiveness and local development? Accepted to be presented at: *XXXIX Conferenza scientifica annuale Le Regioni d'Europa tra identità locali, nuove comunità e disparità territoriali*, 17th-19th September, Bolzano, Italy.

De Lucia, C., Bartlett, M., Balena, P., Pazienza, P., **Caporale, D.** (2017). Modelling the gap between tourist preferences and local knowledge as drivers of touristic attractiveness. *European Colloquium on Theoretical and Quantitative Geography (ECTQG)*, 7th-11th September, York, UK.

Caporale, D. (2017). Consumer's perception of on-shore wind energy: the case of Apulia Region in Southern Italy. *"Smart technologies4Smart energies" EXPO 2017 ASTANA "FUTURE ENERGY" Italian Pavilion*, 6th-11th July, Astana, Kazakistan.

Caporale, D., De Lucia, C., Pazienza, P. (2017) Consumer perception of biomass energy: The case of Apulia Region in Southern Italy. *25th European Biomass Conference & Exhibition*, 12th-15th June, Stockholm, Sweden.

Caporale, D., De Lucia C., Borri D. (2017) Consumer perception of the trade-offs between micro wind generation, risks and landscape: an Italian case study. *1st International Conference on Energy Research & Social Science – ENERGY FOR SOCIETY*, 2nd-5th April, Melia Sitges, Spain.

Caporale, D., De Lucia, C. (2014) Consumer's perception of on-shore wind energy: The case of Apulia Region in Southern Italy. 2nd Symposium of Energy Challenges & Mechanics, 19th-21st August, Aberdeen, Scotland.

Caporale, D., De Lucia, C. (2014) Between landscape and CO2 savings. Consumers' perception of on-shore wind energy in the Daunian Sub- Appenine in Southern Italy. Urban Environmental Pollution 2014. Climate Change and Urban Environment, 12nd-15th June, Toronto, Canada. Conference organized by Elsevier Ltd.

Conference proceedings:

Caporale, D., De Lucia, C. (forthcoming) Landscape and environment: the social acceptance of wind energy in the Daunian Sub-Apennine. IV CONVEGNO INTERNAZIONALE CRIAT, I paesaggi aperti agro-pastorali del Mediterraneo: genesi, economie, governo del territorio, 11th-12th October 2017, Foggia, Italy.