Universidade do Minho
Escola de Economia e Gestão

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Tese de Doutoramento em Economia

Trabalho realizado sob a orientação da
Professora Doutora Anabela Botelho
e da
Professora Doutora Lígia M. Costa Pinto

agosto de 2015

DECLARAÇÃO DE INTEGRIDADE

Declaro ter atuado com integridade na elaboração da presente tese. Confirmo que em todo o trabalho conducente à sua elaboração não recorri à prática de plágio ou a qualquer forma de falsificação de resultados.

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Universidade do Minho, 6 de agosto de 2015

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Abstract

The main purpose of this dissertation is to contribute to the economic valuation of the environmental impacts associated with each of the renewable energy sources used in the generation of electricity in Portugal. The renewables covered in this research are: wind, solar photovoltaic, hydropower, and forest biomass. To achieve this goal, we use two stated preference methods: the contingent valuation and the discrete choice experiments. In these approaches, individuals do not actually have to make any behavioural change: they are only asked to state how they would behave in a certain scenario. This information is gathered though surveys conducted among the Portuguese population, including not only the general population but also the individuals living near twelve different facilities installed in distinct locations from north to south of continental Portugal. The use of questionnaires is a key research tool, allowing gathering crucial informations on respondents, including their opinion and perception regarding the renewables' environmental impacts and how their well-being is affected by the activity of the facilities installed in the proximity of their residences. One important motivation for this work is the evident lack of information about these crucial issues regarding the renewable energy sources in Portugal. This dissertation aims to be a valuable contribution to solve this lack of information by generating a consistent and integrated database containing the results of a systematic valuation of the renewables' environmental impacts in Portugal. This information will be of extreme importance, particularly for policy-makers in the energy planning area, whose decisions should be taken by considering all the stakeholders and including the economic valuation of all the externalities, not only the positive but also the negative ones, associated with each renewable energy source. In this context, the final aim of this dissertation is to contribute to more informed, consistent, sustainable and therefore more efficient decisions regarding the renewables' development in Portugal.

Valoração Económica dos Impactos Ambientais Gerados pela Produção de Electricidade através de Energias Renováveis em Portugal

Resumo

O objetivo principal desta dissertação é contribuir para uma valoração económica dos impactos ambientais associados a cada uma das fontes de energia renováveis utilizados na geração de electricidade em Portugal. As energias renováveis incluídas neste estudo são: energia eólica, energia solar fotovoltaica, energia hídrica e biomassa florestal. Para atingir este objetivo, usamos dois métodos de preferência declarada: a valoração contingente e a escolha discreta. Nessas abordagens, os indivíduos não têm de alterar o seu comportamento: apenas têm de indicar como se comportariam face a um determinado cenário. Esta informação é recolhida através de inquéritos realizados entre a população Portuguesa, incluindo não só a população em geral, mas também as pessoas que habitam nas proximidades de doze centrais eléctricas instaladas em locais distintos de norte a sul de Portugal continental. O uso de questionários é uma ferramenta-chave de pesquisa, permitindo reunir informações cruciais sobre os inquiridos, incluindo a sua opinião e percepção sobre os impactos ambientais das energias renováveis assim como o seu bem-estar é afectado pela actividade das centrais eléctricas instaladas na proximidade de suas residências. Uma das principais motivações desta tese é a evidente falta de informação sobre estas questões cruciais relativas às fontes de energia renováveis em Portugal. Esta dissertação tem como objetivo ser uma contribuição valiosa para combatar esta falta de informação, gerando um banco de dados consistente e integrado com os resultados de uma valoração sistemática dos impactos ambientais das energias renováveis em Portugal. Esta informação será de extrema importância, em particular para os decisores políticos na área de planeamento energético, cujas decisões devem ser tomadas considerando todas as partes interessadas e incluindo a valoração económica de todas as externalidades, não só as positivas mas também as negativas, associadas a cada fonte de energia renovável. Neste contexto, o objetivo final deste trabalho é contribuir para que as decisões relativas ao desenvolvimento das energias renováveis em Portugal sejam mais informadas, coerentes, sustentáveis e, portanto, mais eficientes.

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List of Abbreviations

AB: Averting Behaviour
CBA: Cost-Benefit Analysis
CE: Choice Experiments
CH_4: Methane
CO_2: Carbon Dioxide
DCE: Discrete Choice Experiments
CV: Contingent Valuation
CM: Choice Modelling
CT: Cheap Talk
CR: Contingent Ranking
EU: European Union
FB: Forest Biomass
FBPP: Forest Biomass Power Plant
GHG: Greenhouse Gas
GW: Gigawatts
GWh: Gigawatt-hours
HP: Hedonic Price
IIA: Independence from Irrelevant Alternatives
IID: Independently and Identically Distributed
MVA: Mega Volt Ampere
MW: Megawatts
MWh: Megawatt-hours
NOAA: National Oceanic and Atmospheric Administration
OECD: Organization for Economic Co-operation and Development
OLS: Ordinary Least Squares
PNBEPH: National Programme of Dams with High Hydroelectric Potential
PP: Power Plant
PV: Photovoltaic
PVF: Photovoltaic Farm
RES: Renewable Energy Sources
RP: Revealed Preference
SP: Stated Preference
TC: Travel Cost
TEV: Total Economic Value
TWh: Terawatt-hours
USA: United States of America
W: Watts
WF: Wind Farm
WTA: Willingness to Accept
WTP: Willingness to Pay

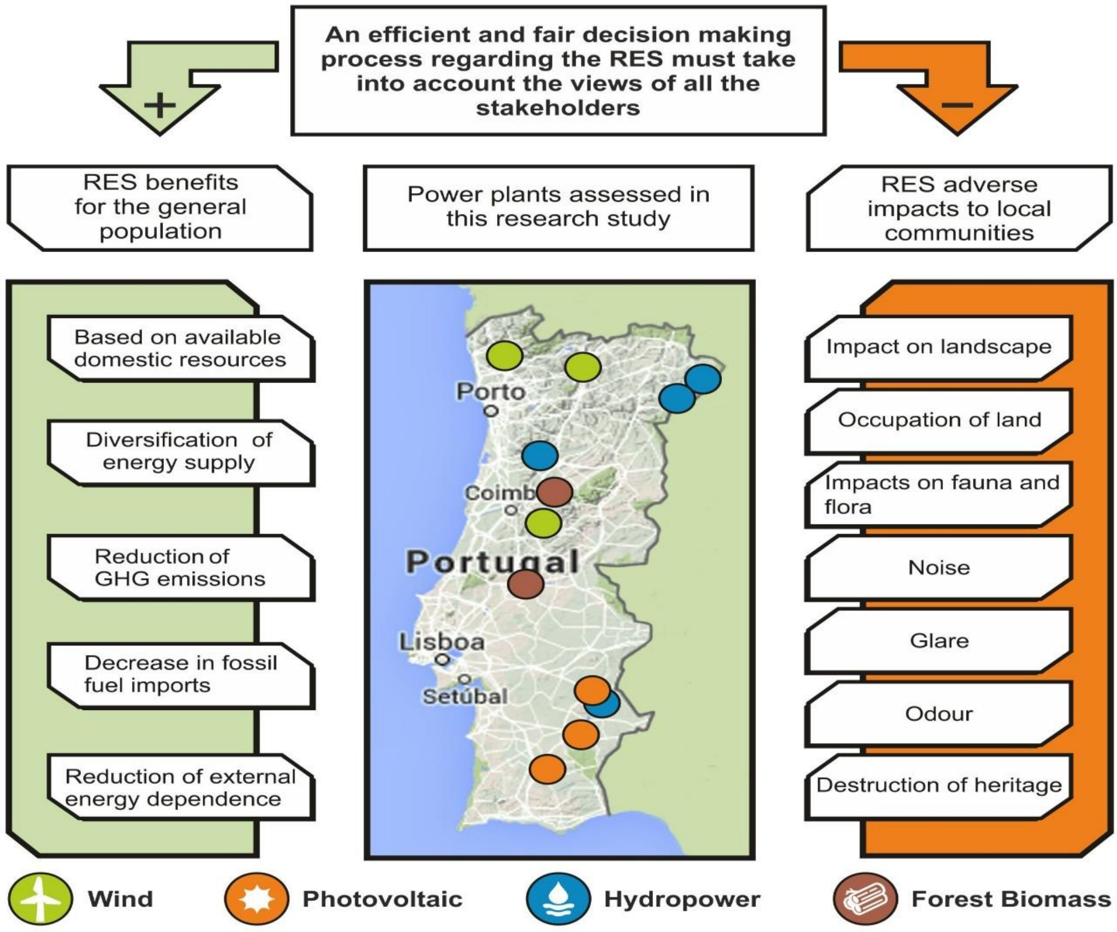
CHAPTER I: INTRODUCTION

I.1. Purpose of the Dissertation

Electricity plays a determinant role in our society. For instance, it comprises a large share of world energy demand and the relative importance of electricity to meet our energy needs has been growing. The increase in electricity demand, both in relative and absolute terms, creates new challenges for policy makers with respect to the future electricity production mix. One of the main concerns is to produce electricity without compromising the environmental protection and it is in this context that renewable energy sources (RES) represent a powerful driver of the countries' sustainability (Sundqvist, 2002).

In the case of Portugal, the energy strategy adopted in recent years has focused on three specific goals: the security of supply, the environmental protection and the promotion of competitive markets. Due to its strong ability to contribute to the achievement of these goals, the promotion of renewable energies is understood as a key policy in this context. The emphasis given to the renewable energies has been allowing us to diversify the sources of supply and to increase the supply of energy based on natural resources available in Portugal. It has been also an important contributor to a progressive reduction of our external energy dependency and to the accomplishment of the national targets reducing greenhouse gas (GHG) emissions (Deloitte, 2009, 2014). Nevertheless, despite these well-known benefits, the RES are also responsible for causing some adverse impacts on the environment and people`s lives: landscape intrusion, occupation of land, impacts on fauna and flora, noise, glare, odour, destruction of heritage, among others. These are particularly felt by the residents in the vicinity of the facilities (dams, wind farms, photovoltaic farms and forest biomass power plants) and should not be neglected in any decision-making process regarding the renewables that claims to be efficient and fair. In this research study we have inquired the residents of several local communities of continental Portugal in the surroundings of four dams, three wind farms (WFs), three photovoltaic farms (PVFs), and two forest biomass power plants (FBPPs). The following figure presents a schematic overview of the scope of this research study.

Figure I.1: Scope of the Dissertation



Source: Author`s elaboration

The prime aim of this dissertation is to attribute an economic value to the environmental impacts associated with each of the renewables (wind, solar photovoltaic, hydropower, and forest biomass) used in the electricity generation in Portugal, providing a reliable and consistent information that can be used as a valuable input to the improvement of energy policies in Portugal.

There are a number of different techniques available to value these impacts in economic terms. In this study, we use two stated preference (SP) methods: the contingent valuation (CV) and the discrete choice experiments (DCE). These techniques rely on the use of surveys, allowing researchers to gather information directly from the population. In this study, the questionnaires were distributed among two target audiences: on the one hand, the general population from different regions of the continental Portugal and, on the other hand, the population residing in the vicinity of different renewable energy facilities. The auscultation of these two types of individuals was determinant to the achievement of our main goal. The collected data was then treated and interpreted through the use of appropriate statistic and econometric models. With the CV method, the obtained data allows us to estimate the value of the environmental impacts of each RES. On the other hand, the data collected through the DCE method is used to elicit respondents' hierarchy of environmental impacts and to value each impact separately. These SP methodologies are key tools in the environmental economic valuation, presenting the advantage of enabling the estimation of both use and non-use values of the environmental goods and services, a task particularly complex since there are no markets, and consequently no prices, for these goods and services (they are non-market goods). Other methods, such as the revealed preference (RP) methods cannot be applied to ex-ante situations as the ones under study in the present work.

With the findings of this investigation, we expect to make an important contribution to the future establishment of an important database containing the results of the economic valuations of the environmental impacts of the RES in Portugal. We also expect to contribute to the definition of more efficient energy policies incorporating the findings of this research project.

I.2. A Guide to the Dissertation

In addition to the initial Introduction and a final Conclusion, this dissertation is composed of five more chapters.

In the Introduction, we cover some key points to a better understanding of what is developed in the following chapters of the dissertation. The objectives of the research, the methodology and the way the dissertation is organized are fundamental aspects that are presented in the introductory chapter of the thesis.

After this initial Introduction, the dissertation comprises five chapters. Each chapter includes an introduction, an extensive review of the relevant literature and concluding remarks. Despite the existence of five distinct chapters with a certain degree of independence, they are united by the common goal of answering the key questions of this research study.

As already mentioned, one of the main objectives of this thesis is to contribute to the economic valuation of environmental impacts associated with each of the RES in Portugal. Therefore, Chapter II is dedicated to the theoretical study of the two main approaches developed to place an economic value on nonmarket goods and services: revealed preference (RP) and stated preference (SP) methods. While RP methods infer preferences for nonmarket goods as implied by past behaviour in an associated market, SP methods include a range of survey-based methods that use constructed or hypothetical markets to elicit preferences for nonmarket goods or specific policy changes. A special attention is given to the two SP technique chosen to be used in this research study: the discrete choice experiments (DCE) and the contingent valuation (CV). With distinct purposes, these SP approaches are used in the questionnaires conducted among individuals living in different regions of continental Portugal.

Chapter III begins by stressing the importance of the RES in promoting a sustainable development. This is followed by a detailed analysis regarding each of the four renewable energy sources covered in this dissertation: wind, hydropower, solar photovoltaic and forest biomass. It includes an analysis of the current situation and potential of each of the renewables and a comprehensive description of a representative number of power plants sited in different regions of continental Portugal, where we conducted an intensive auscultation of the local communities' perceptions regarding the renewables' impacts on their wellbeing. Furthermore, it contains a detailed description of the impacts of each renewable energy source. Finally, some key social issues in the debate on the renewables are also addressed, particularly the analysis of the public attitudes towards the renewables' deployment, an issue that is often neglected but that is crucial for an efficient renewables' development process.

In Chapter IV, the designing process of the DCE and CV questionnaires is described. This process is crucial for obtaining reliable, consistent and accurate data. Aware of this fact, in addition to an extensive literature review and expert consultation, we used qualitative research techniques, also described in this chapter. Furthermore, the discussion of the main issues regarding survey design and logistics is provided.

In Chapter V, the results of the application of the discrete choice experiments (DCE) and contingent valuation (CV) methods are presented, analyzed and thoroughly discussed.

Although based on different methodologies, the obtained results complement each other, allowing a more complete discussion of the issues covered in this thesis.

The dissertation ends with a final Conclusion, in which the main results and conclusions are described, explained and interpreted. Moreover, this chapter comprises the main contributions for the development of this area of research in Portugal along with some recommendations for future work.

CHAPTER II: ECONOMIC VALUATION OF THE ENVIRONMENT

II.1. Introduction

The need to undertake an economic valuation of the environmental goods and services results from the increasing recognition, particularly evident in the last decades, of the importance that the environment has in the individuals` welfare. Despite the fact that most of these goods and services do not have an associated price, since they are not usually tradable in the market, it does not necessarily mean they have no value. Accordingly, non-market valuation techniques must be used to assess their economic value, which, in turn, enables the incorporation of the environmental non-market goods and services in the cost-benefit analysis (CBA) procedures for achieving objective and realistic evaluations of all the consequences of different development options.

In the next sections an overview of the main concepts and issues associated with the economic valuation of environmental goods and services is provided. Section II.2 details the concept of total economic value (TEV) of environmental goods and services. Section II.3 describes the main revealed preference (RP) methods. In section II.4, are deepened the stated preference (SP) methods, with particular attention to the methods employed in the questionnaires used in this study: the contingent valuation (CV) and the discrete choice experiments (DCE). Then, section II.5 addresses the possibility of combining the two main non-market valuation used, the RP and the SP methods. The chapter closes with some concluding remarks.

II.2. Total Economic Value

The notion of total economic value (TEV) provides an all-encompassing measure of the economic value of any environmental asset. It is a central concept which has been determinant for a properly understanding of the changes in the individuals` well-being due to a project or policy that has environmental impacts (Pearce *et al*., 2006). TEV can be characterized differently according to the type of economic value arising and to the author`s adopted approach. According to Bateman *et al.* (2002, p.28), "The net sum of all relevant willingness to pay (WTP) and willingness to accept (WTA) defines the TEV of any change in wellbeing due to a policy or project". On the other hand, Torras (2000, p.286) defines the TEV of a natural resource as "the sum of its direct, indirect, option, and existence values". In other studies, the concept of TEV is simply defined as the sum of the non-marketable and marketable values (Torras, 2000, p.283). These definitions, while distinct, they nevertheless complement each other and constitute valuable contributions to a better understanding of such a comprehensive concept such as the total economic value (TEV).

The TEV of an environmental good or service results from its attributes and these can be associated with the use or non-use values of the good or service (Matos *et al.*, 2010). According to some studies (e.g., Bateman *et al.*, 2002; Pearce *et al.*, 2006), use values relate to actual use, planned use, or possible use of a good or service.

Regarding the actual use, this can be of two types: direct or indirect. The actual direct use value is related to the direct use of the environmental good or service. Such use may be extractive and thus the quantity of the good or service available for other users is reduced (e.g., the consumption of food or raw materials), or non-extractive, which entails that there is no reduction in available quantity of the good or service (e.g., enjoying recreational and cultural amenities such as wildlife and bird-watching) (Alcamo *et al.*, 2003; TEEB, 2010).

The actual indirect use value is associated with benefits that individuals experience indirectly or as a consequence of the primary function of a given resource (Torras, 2000, p. 286). It is usually associated with regulating services provided by ecosystem services which contribute indirectly to the enjoyment of other final consumption amenities, such as water and air purification, waste assimilation, erosion control, climate regulation, carbon storage, among others, leading to several benefits to individuals, namely reduced health risks (e.g., the forest`s ability to sequester carbon from the atmosphere yields positive externalities by helping to regulate the global climate (Torras, 2000; Alcamo *et al.*, 2003; TEEB, 2010).

The planned use refers to a clear intention to use on a specific date in the future the benefits of the good or service (e.g., a visit planned in the future to a national park) (Bateman *et al.*, 2002; Pearce *et al.*, 2006).

Actual and planned uses are fairly obvious concepts, but possible use, known as option value, could also be important since people may be willing to pay to maintain a good in existence in order to preserve the option of using it in the future (Bateman *et al*., 2002; Pearce *et al*., 2006). As stressed by Alcamo *et al*. (2003, p.133), despite the fact that people may not currently be deriving any utility from them, may environmental goods and services still hold value for preserving the option to use such goods and services in the future. It is worth noting, however, that this concept has been subject to different interpretations. If some authors (e.g., Torras, 2000) limit the option value concept to uncertain benefits, not considering the already-ascertained benefits postponed for future use (such as in the case of commercial timber), many others (e.g., Bateman *et al*., 2002; Pearce *et al.*, 2006) do not make any distinction between the two. On the other hand, in some studies (e.g., Alcamo *et al*., 2003; TEEB, 2010) both certain and uncertain future benefits are counted in TEV, designating the former option value, and the latter quasi-option value. According to Alcamo *et al*. (2003, p.133), "quasi-option value represents the value of avoiding irreversible decisions until new information reveals whether certain ecosystem services have values that are currently unknown". A good example is given by bioprospecting activities to discover potential medicine uses of plants (TEEB, 2010). Finally, it is important to note that some authors consider the option value (with or without making its distinction from the quasi-option value) a subset of non-use value rather than of use value, but they do not otherwise treat it differently.

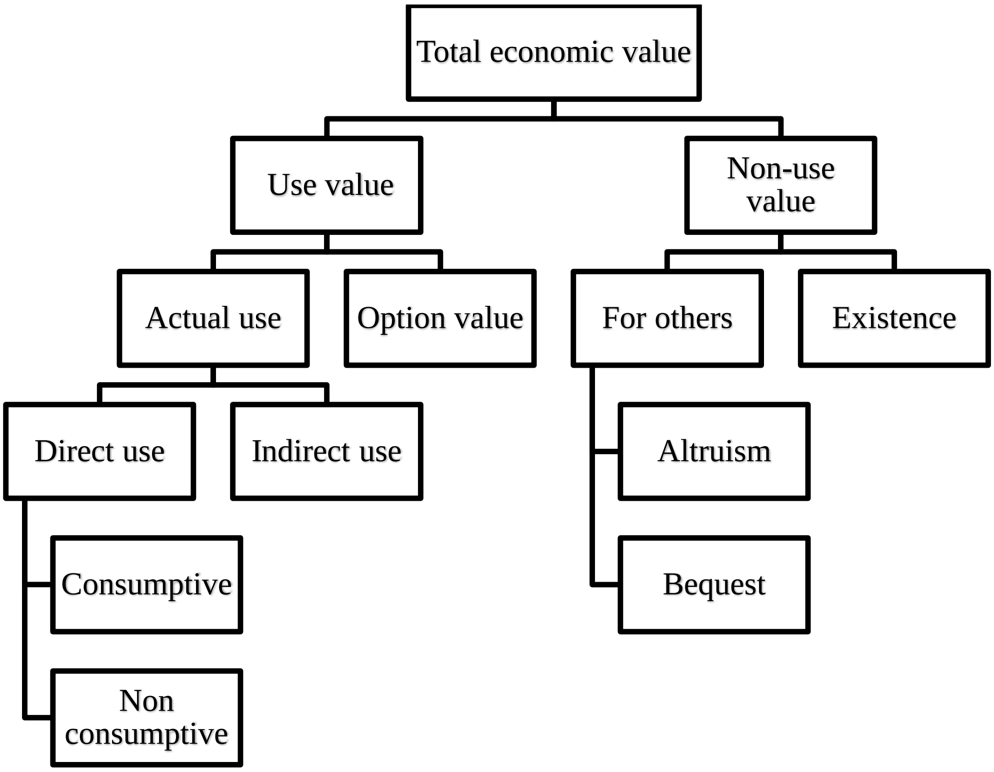
Non-use values, also known as passive use values, represent significant challenges for valuation since they are related to cultural, moral, religious or aesthetic properties which, in general, involve the production of experiences that occur in valuer` s mind (Chan *et al.*, 2011). We can find in the literature several definitions for this concept. For instance, Freeman (2003) argues that non-use value is better defined as any value not measurable by revealed preference (RP) techniques. The attraction of this view is that it avoids some eventual difficulties in defining what is mean by "use". According to Kolstad (2000), non-use values reflect the satisfaction that individuals derive from the knowledge that biodiversity and ecosystem services are maintained and that other people have or will have access to them. On the other hand, other authors, such as Bateman *et al*. (2002, p.28) and Pearce *et al*. (2006, p.86), state that "non-use value refers to willingness to pay to maintain some good in existence even though there is no actual, planned or possible use". We follow this latter approach, according to which non-use value can be classified in terms of (a) existence value, (b) altruistic value, and (c) bequest value.

Existence value refers to the willingness to pay (WTP) to keep a good in existence in a context where the individual expressing the value has no actual or planned use for himself or herself or for anyone else (Bateman *et al*., 2002; Pearce *et al.*, 2006). Motivations here could vary and might include having a feeling of concern for the asset itself (for example, a threatened species) or a "stewardship" motive whereby the valuer feels some responsibility for the asset. There is, however, other distinct perspectives regarding this concept. For example, some authors (e.g., Boyce *et al*., 1992; Plottu and Plottu, 2007) do not make any distinction between existence value and intrinsic value, but despite being closely related, they still are distinct concepts: while existence value depends on individual preferences, intrinsic value is independent of human needs and tastes. In other studies, namely in Madariaga and McConnell (1987), existence value is associated with any non-use value, or even some types of use value like "vicarious consumption" (e.g., viewing videos or TV programs about tropical wildlife). At the other extreme, Bergstrom and Reiling (1998) limit existence value merely to what the authors refer to as cognitive value, or the value in being able to "think about" the resource.

Altruistic value might arise when the individual is concerned that the good or service in question should be available to others in the current generation (Bateman *et al*., 2002; Pearce *et al*., 2006). As emphasized by TEEB (2010), this concept is deeply associated with intragenerational equity concerns.

The bequest value is similar to the previous concept, but the concern is that the next and future generations should have the option to make use of the good or service (Bateman *et al*., 2002; Pearce *et al*., 2006). In this case, the equity concerns are intergenerational. Figure II.1 shows the characterization of TEV by types of value accordingly to the approach adopted by several authors (e.g., Bateman *et al*., 2002; Pearce *et al*., 2006; TEEB, 2010).

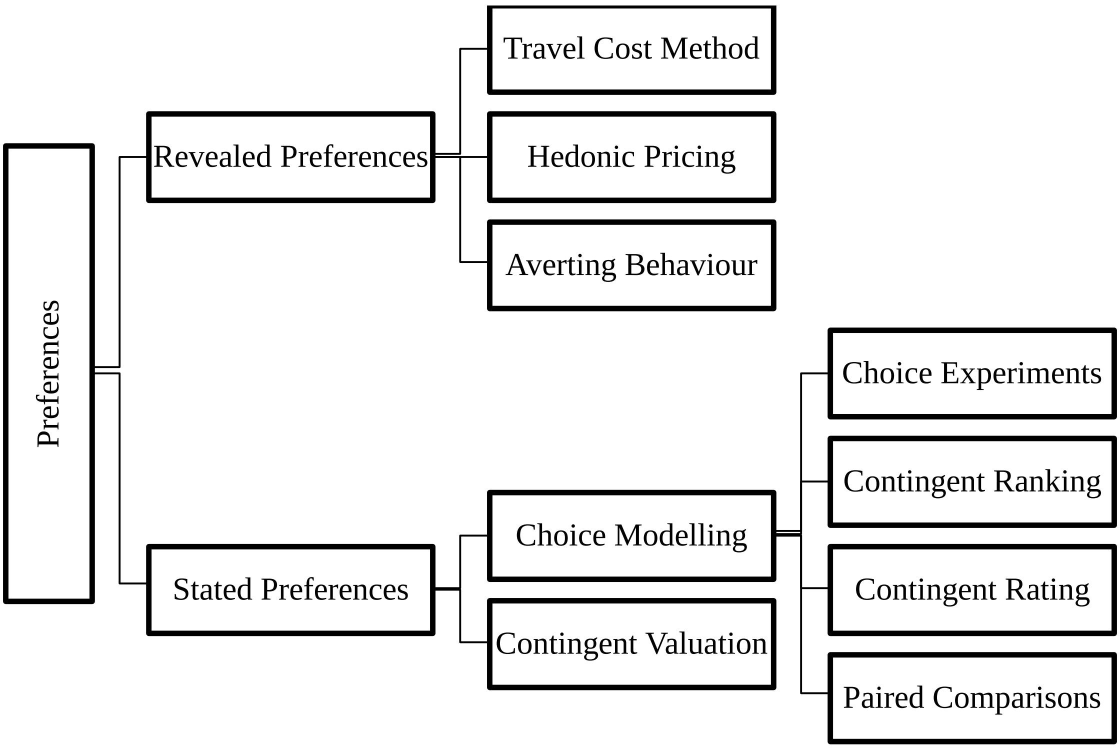
Figure II.1: Total Economic Value



Adapted from Bateman *et al*. (2002, p.29), Pearce *et al*. (2006, p.87) and TEEB (2010, chapter 5, p.14).

There are different techniques to estimate all these kinds of values for environmental goods in economic terms. These techniques (or methods) have traditionally been categorized as indirect – revealed preference (RP) methods, and direct –stated preference (SP) methods. The RP methods can only measure the use value of the goods and include three different main techniques: the travel cost (TC) method, the hedonic price (HP) method and the averting behaviour (AB) method. On the other hand, SP methods allow measuring both the use and the non-use values of the goods and have two main ramifications: the choice modelling (CM) and the contingent valuation (CV). In the choice modelling group, there are four different techniques: the choice experiments, the contingent ranking, the contingent rating and the paired comparisons. All these techniques are diagrammatically presented in Figure II.2 and will be analysed in the following sections.

Figure II.2: Economic Valuation Methods



Adapted from Garrod and Willis (1999, p.6), Bateman *et al.* (2002, p.30) and Pearce *et al*. (2006, p.88)

II.3. Revealed Preference Methods

Revealed preference (RP) methods use actual choices made by consumers to develop models of choice. These methods analyse or infer preferences for nonmarket goods as implied by past behaviour in an associated market, seeking to quantify the market footprint of nonmarket changes. RP methods have advantages and drawbacks. One major advantage of RP over SP techniques is the fact that they are based on actual behaviour, avoiding the criticism of being based on hypothetical behaviour, and hence typically enjoy higher credibility among policy makers. RP methods have also limitations. One drawback of these methods is their inability to estimate non-use values, as they are based on market footprints of some form of use-related behaviour. Another disadvantage is the RP methods` incapacity to estimate values for levels of quality that have not been experienced and revealed by the market (Atkinson and Mourato, 2008). Finally, RP methods may suffer from collinearity among attributes. Collinearity precludes the isolation of factors affecting choice. This isolation is often required in economic welfare analysis. For example, water quality attributes may be correlated but the economic valuation may only be interested in valuing an improvement in one of the attributes. The separation of these attributes is necessary for an accurate representation of the benefits and for policy analysis (Adamowicz *et al*., 1994). The main RP techniques are discussed in the following sections.

II.3.1. Travel-Cost Method

Although access to many environmental and resources amenities is free of charge (even if an entrance fee is charged, usually it is not a significant amount), individuals steel have the expense of travelling to these sites. Hoteling's famous letter (1947) represents a new stage in economic theory, presenting the empirical method known today as the travel-cost (TC) method. In response to an inquiry by the director of the United States National Park Service, Hotelling suggested the TC method of valuation that exploit the variation in travel cost to a site (an implicit price) that arises when people travel from different origins. By exploiting the empirical relationship between travel cost and visitation rates, it is possible to estimate a demand function for recreation (Font, 2000; Mendelsohn and Olmstead, 2009).

Since this pioneering contribution, the travel-cost (TC) method has often been used to value spatial nonmarket goods, particularly outdoor locations used for recreational purposes such as parks, woodland, beaches and lakes. Typically, the recreational area is an unpriced good. However, the basis of the TC approach is the recognition that individuals produce recreational experiences through the input of a number of factors, which may, in some way, command prices. Among these factors are the recreational area itself, travel to and from the area, and in some cases, staying overnight at a location. Such information is usually collected through surveys carried out at the recreational site and through secondary data, although complications abound, such as the treatment of multiple purpose trips and the estimation of the value of time. Recent treatments using this technique have looked at multiple-site TC and, in doing so, analyse visitors` choices between a number of substitute sites, which differ both in location (i.e., some have higher access costs) and site qualities, for any particular recreational trip. By observing how different visitors choose between sites with different qualities and different costs of access, it is possible to use econometric techniques to estimate how each of the quality variables and the cost variable contribute to the utility of a visit (Atkinson and Mourato, 2008).

Despite travel-cost (TC) models are among the most widely applied valuation methods, representing a very useful tool for estimating recreational demand for many resource amenities, its application still face some challenges. Being a statistical models, the TC method is vulnerable to the possibility that important factors are omitted, which may bias the results. Other challenges stem from the fact that actual travel cost, or some part of it, may be unobservable (Randall, 1994). The opportunity cost of travel time is a good example of an unobservable cost. In order to overcome this issue, for instance, some authors suggest assigning the wage rate to value time (Bockstael *et al.,* 1987), but, as shown by empirical evidence, people enjoy travelling (Cesario, 1976) and therefore the opportunity cost of travel time must be lower to the wage rate. Researchers must also consider how to value time spent at a recreational site (Smith *et al.,* 1983). Finally, another challenge concerns multipurpose trips. If some individuals travel with the specific purpose of visiting a single recreational sight, others are that travel with the aim of visiting several distinct sites. For these case of multi purposes trips, an individual recreation site represents only a part of the trip`s value. If the researcher drops multipurpose trips, it will bias downward the site`s value. Assigning proportional values to each destination or purpose is, unfortunately, arbitrary (Mendelsohn and Olmstead, 2009).

II.3.2. Hedonic Price Method

Derived from consumer`s theory (Lancaster, 1966), the hedonic price (HP) method relies on the proposition that an individual`s utility for a good or service is based on the attributes which it possesses. In certain circumstances, it may be possible to separate the effects of the various attributes of a good in a way which demonstrates how changes in the levels of each attribute affect the individual`s utility. In hedonic pricing, this is achieved by modelling individual`s willingness to pay (WTP) to consume a particular good as a function of the levels of the good`s characteristics or attributes (Garrod and Willis, 1999).

The hedonic price (HP) method is used to estimate the value of a non-market good by observing the behaviour of a related market-good. Specifically, the HP method uses a market good via which the non-market good is implicitly traded (Pearce *et al*., 2006). Two types of markets are of particular interest for the HP method in non-market valuation: (a) property markets; and b) labour markets.

Regarding the former case, the seminal work of Rosen (1974) stands out by providing the theoretical foundation of the property-hedonic model, by assuming that heterogeneous goods are valued for their utility-bearing characteristics. In the competitive housing market, the equilibrium hedonic price schedule P results from the market interaction between households` willingness to pay (WTP) for the housing characteristics and landlords` costs for providing them, and is given by the vector of house characteristics, z, so that $P = P(z)$ (Palmquist, 1999). The vector of characteristics z is often decomposed in a vector of structural (e.g., number and size of rooms), accessibility (e.g., proximity to an urban park), and environmental quality (e.g., green areas, quietness, and landscape) variables. Hence, even if there is a missing market for environmental quality, by unbundling the housing product it is possible to assess the implicit value that individuals are revealing for their explicit choice in the housing market (Schaerer *et al.,* 2007). For example, we might assume that, in general, people would prefer a quiet residential environment to a noisy one, but since no market exists for the amenity “peace and quiet”, we have no direct market evidence on how much this amenity is valued where people live. However “peace and quiet” can be traded implicitly in the property market. Individuals can express their preferences for a quiet environment by purchasing a house in a quiet area. A measure of the value of “peace and quiet” is then the premium that is paid for a quieter house compared with a noisier but otherwise identical one (Pearce *et al*., 2006).

Though valuable in many settings, hedonic property models have limitations. First, the researcher must assume that buyers and sellers have good information on the characteristics of all housing alternatives. Thus, the models are appropriate only for estimating the value of observable or known amenities and disamenities. Second, the models assume that people are mobile enough that current prices reflect their preferences (Mendelsohn and Olmstead, 2009). Finally, another problem with the hedonic property estimation procedure is that of multicollinearity. As an illustration, if local air quality and proximity to good schools are highly correlated, then it becomes all the more difficult to separate out the specific influence of each. This hedonic property process itself involves collecting large amounts of data on prices and characteristics of properties in an area, and applying statistical techniques to estimate a hedonic price function, relating each characteristic of interest to the house price (such as those relating to the property itself, local environmental quality, proximity to local amenities, and public services) (Atkinson and Mourato, 2008).

With regard to the labour market, the hedonic price (HP) method has been used to estimate the value of avoiding risk of death or injury by looking for price differentials between wages in jobs with different exposures to physical risk (Taylor, 2003; Krupnick, 2004). Different occupations involve different risks (for example, being a fire-fighter entails much higher risks of injury than does a desk-bound occupation) and thus employers must pay a premium to induce workers to undertake jobs entailing higher risks (Kolstad, 1999). It is based on this risk premium that the HP models estimate the value of avoiding physical risk. Similarly to what happens in the property market, the application of the HP model in the labor market also presents some limitations, namely the lack of perfect information (e.g., workers may not be fully aware of the accident risks they face in the workplace), and the problem of multicollinearity (e.g., there are several factors that determine both the choice of a profession and the wage differences).

II.3.3. Averting Behaviour

Averting behaviour (AB) is when actions are taken to reduce the impact of environmental damages. In their book, Garrod and Willis (1999) discuss the AB in simultaneous with other approaches that share some points of views: preventive, mitigation expenditure and averting behaviour approaches. These approaches assess the value of non-marketed commodities such as cleaner air and water, through the amounts that individuals are willing to pay for market goods and services to prevent a utility loss from environmental degradation, or to mitigate an environmental externality, or to change their behaviour to acquire greater environmental quality.

As stressed by Pearce *et al.* (2006), the averting behaviours (AB) might be more costly in terms of the time requirements they imply, or of the restrictions they impose on what the individual would otherwise wish to do. Alternatively, individuals might be able to avoid exposure to an environmental damage (a non-market bad) via the purchase of a market good. Garrod and Willis (1999) give some examples, namely the case of people that purchase bottled water to avoid drinking from public water supplies or install water filtration systems in their homes. Similarly, people may spend more time indoors to avoid exposure to air pollution, and install air purifiers in their homes to improve air quality. These purchases are effectively substitute goods for a cleaner environment. People may also install double glazing to reduce road traffic noise in their homes. In extreme cases people may move to another residential location to avoid an environmental externality.

In sum, if people incur private expenditures to avoid the damages from environmental disamenities, the sum of these incurred costs is at least a partial estimate of the value of these damages (Mendelsohn and Olmstead, 2009). This valuation method has inevitably some limitations, including the inability to capture the pain and suffering that cannot be avoided and, hence, averting behaviour measures are at best a lower bound on the value of the environmental disamenities (Harrington and Portney, 1987). Moreover, it is important to note that efficient policy initiatives have the ability to improve considerable the general environment and consequently allow individuals to spend less on substitute goods. Thus changes in expenditures on substitute goods is a good measure of people`s values for environmental improvements (Garrod and Willis, 1999).

II.4. Stated Preference Methods

Stated preference (SP) methods ask consumers what they would be willing to pay or accept for a change in an environmental amenity (Adamowicz *et al.*, 1994, p. 271). These direct methods do not require individuals to make any behavioural change, they only ask individuals to attach an economic value to non-marketed goods and services. Stated preference (SP) methods, like RP methods, have advantages and drawbacks. For instance, these methods are commonly criticized because of the hypothetical nature of the questions and the fact that actual behaviour is not observed. On the other hand, there are several reasons for using these methods. First, SP methods can be used to value any environmental good or service, even at levels of quality that are currently not in existence. Second, they currently provide the only viable alternative for measuring non-use values. Non-use values may be the most important social values in some policy contexts, such as endangered species and wilderness preservation. Furthermore, SP methods may be used to elicit values in cases in which the environmental quality change involves a large number of attribute changes (Adamowicz *et al.*, 1994; Bateman *et al.*, 2002; Mendelsohn and Olmstead, 2009).

II.4.1: Willingness to Pay and Willingness to Accept: Some Theoretical Considerations

A key issue often raised regarding the application of SP methods refers to the choice of the correct elicitation format. In principle, there are two possibilities: one can ask for people`s WTP for an improvement of an environmental quality or one can ask for their WTA compensation for renouncing this improvement or for the loss caused by the deterioration of an environmental amenity. The maximum WTP and the minimum WTA amounts provide crucial monetary measures of how much the respondent values a good or service, particularly in the case of non-market goods such as the environmental amenities. The background of this analysis relies in the theory of individual choice.

Individual Preferences

The theoretical framework established in the literature to reveal preferences and measure the value of goods traded in the market, although general, also provides the basic theoretical foundation of valuation of non-market goods or services. In this regard we present a brief description of the neoclassical theory of the consumer choice based on preferences.

Following Mas-Colell *et al*. (1995), the starting point for any individual decision problem is a set of alternatives (denoted by X) from which the individual must choose according to his preferences. These are assumed to be rational if two basic assumptions about the preference relation (denoted by $\succsim$, "at least as good as") are respected: completeness and transitivity. Thus, The assumption of completeness (for all $x, y \in X$, we have that $x \succsim y$ or $y \succsim x$ or both) says that the individual has a well-defined preference between any two possible alternatives. Also crucial for having rationality, the transitivity assumption (for all $x, y, z \in X$, if $x \succsim y$ and $y \succsim z$, then $x \succsim z$) implies that it is impossible to face the decision maker with a sequence of pairwise choices in which his preferences appear to cycle. Both assumptions represent a hard task to most individuals, particularly when evaluating alternatives that are far from the realm of common experience. Moreover, in these propositions are implicit the assumptions of the theory, according to which individuals are the best judges of their own welfare and the choices they make between alternative combinations reveal welfare judgments (if the individual prefers *x* to *y*, then *x* must provide him greater utility or an higher welfare).

If the rational relation $\succsim$ is continuous (for all sequence of pairs $\{(x^n, y^n)\}_{n=1}^{\infty}$ with $x^n \succsim y^n$ to all *n*, $x = \lim_{n\to\infty} x^n$ and $y = \lim_{n\to\infty} y^n$, we have $x \succsim y$), it may be represented by an ordinal preference function or utility function that assigns a number to each bundle as a function of the quantities of each element of the bundle.

When facing the task of making a decision, the consumer may act in two ways: given the prices and income, he decides in order to maximise the utility; or, given the prices and a certain level of utility, he decides in order to minimise the expenditure.

The first approach allows to obtain the combinations set of optimal consume combinations and the consumer` s maximum utility value. The Marshallian or ordinary demand functions relate the set of optimal consume combinations in each situation. By substituting these optimal solutions in the direct utility function, we obtain the indirect utility function. We now present in more detail this approach.

Following Freeman (2003), the utility function presents as follows:

$$u = u\ (X, Q, T) \qquad \text{(II.1)}$$

where *X* is a vector of the quantities of market goods, *Q* is a vector of public goods and environmental and resource services whose quantities or qualities are fixed for the individual, and *T* is a vector of the times spent in various activities that yield utility to the individual.

To simplify the exposition and notation, let us now consider an individual whose utility is only a function of private market goods. Assume that tastes and preferences are given and do not change. The individual faces a set of given prices for these goods and is assumed to choose the quantities of the goods so as to maximise his utility, given the constraints of prices and a fixed money income *M*. The maximisation problem can be expressed as:

Maximise $u = u\,(X)$ subject to $\sum_{i=1}^{n} p_i . x_i = M$ (II.2)

Where *X* is the vector of quantities ($X = x_1, \ldots, x_n$). The solution to this problem leads to a set of ordinary Marshallian demand functions:

$X_i = x_i\,(P, M)$ (II.3)

where *P* is the vector of prices ($P = p_1, \ldots, p_n$).

Substituting the expressions for x_i as functions of *P* and *M* into the direct utility function gives the indirect utility function, that is, utility as a function of prices and income, assuming optimal choices of goods:

$u = v\,(P, M)$ (II.4)

The indirect utility function represents the highest level of utility obtainable when facing prices *P* and income *M.*

According to Roy`s Identity, the demand functions can also be expressed in terms of derivatives of the indirect utility function:

$x_i\,(P, M) = -\,\frac{(\partial v/\partial pi)}{(\partial v/\partial M)}$ (II.5)

The alternative approach to the individual choice problem uses the expenditure function to compute the minimum level of required wealth to reach the utility level *u*. It is derived by formulating the dual of the utility maximisation problem. According to Freeman (2003), the individual is assumed to minimise total expenditure,

Minimise $e = \sum_{i=1}^{n} p_i . x_i$ subject to $u\,(X) = u^0$ (II.6) where u^0 is the maximum utility attained with the solution to the primal problem. Just as the solution to the utility maximisation problem yields a set of ordinary demand curves conditional on prices and income, the solution of the expenditure minimization problem yields a set of functions giving optimal quantities for given prices and utility. These are Hicks-compensated demand functions that show the quantities consumed at various prices assuming that income is adjusted (compensated), so that utility is held constant at u^0. Substituting these demand functions into the expression for total expenditure yields the expenditure function. This expression gives the minimum expenditure necessary to achieve a specific utility level, given market prices:

$$e = e\ (P, u^0) \qquad \text{(II.7)}$$

where e is the expenditure and u^0 is the specified utility level. The compensated demand function can also be found by differentiating the expenditure function with respect to each of the prices:

$$\frac{\partial e}{\partial p_i} = h_i = h_i\ (P, u^0) \qquad \text{(II.8)}$$

where h_i is the compensated demand for x_i.

As stressed by Haab and McConnell (2003), since there is no area under demand curves, only the indirect utility function and the expenditure function are relevant in the application of SP methodologies to value pure public goods, such as those providing an existence value not valued by the market. These functions provide the theoretical structure to welfare estimation, allowing to transit from a positive perspective of the consumer`s theory based in the preferences to a normative one focused in the welfare analysis.

Hicksian Welfare Measures

To introduce the alternative welfare measures, we consider the simplest case of only two goods and the welfare gain associated with a decrease in the prices of one of these goods. The literature presents different alternative measures of this welfare change (see Freeman, 2003), but we limit our analysis to two Hicksian welfare measures: the compensating variation (CV) and the equivalent variation (EV), which are theoretical refinements of the Marshallian consumer surplus.

If we consider, for instance, a price fall, the compensating measure is defined as the amount of compensation paid or received that keeps the consumer at the initial welfare level (u^0) after the price change ($p_1^1 < p_1^0$) had taken place. On the other hand, the equivalent measure is defined as the amount of compensation paid or received that brings the consumer to his subsequent welfare level (u^1) if the price change ($p_1^1 < p_1^0$) did not take place. In the compensating and equivalent variations, individuals may adjust the quantities of the good whose price changed (we excluded from this analysis other possible welfare measures, namely the compensating and the equivalent surplus which do not allow this flexibility) (Seller *et al*., 1985; Bockstael and McConnell, 1980).

Analytically, following the presentation of Freeman (2003) for a price decrease, the welfare variation measures may be defined based on the indirect utility function or on the expenditure function. Thus, in terms of the indirect utility function, CV is the solution to:

$$v\ (P^0, M) = v\ (P^1, M - CV) = u^0 \qquad \text{(II.9)}$$

The CV can also be defined in terms of the expenditure function. It is the difference between the expenditures required to sustain utility level u_0, at the two price sets:

$$\begin{aligned} CV &= e\ (p_1^0, p_2, u^0) - e\ (p_1^1, p_2, u^0) > 0 \\ &= M - e\ (p_1^1, p_2, u^0) \qquad \text{(II.10)} \end{aligned}$$

It can also be written as the integral of the marginal welfare measure (see equation II.8) over the relevant range:

$$CV = \int_{P_1^1}^{P_1^0} h_1(P, u^0) d\, p_1 \qquad \text{(II.11)}$$

Because spending *M* at the new price set yields a higher level of utility, we can also write

$$M = e\ (p_1^1, p_2, u^1) \qquad \text{(II.12)}$$

And by substitution

$$CV = e\,(p_1^1, p_2, u^1) - e\,(p_1^1, p_2, u^0) > 0 \qquad \text{(II.13)}$$

In other words, although the CV is defined in terms of u^0, it also measures the amount of money required to raise utility from u^0 to u^1 at the new set of prices.

Regarding the EV, its analytical expressions are similar to those used for the CV. In terms of the indirect utility function, EV is the solution to:

$$v\,(P^0, M + EV) = v\,(P^1, M) = u^1 \qquad \text{(II.14)}$$

And in terms of the expenditure function, EV is the difference between the two expenditure levels:

$$\begin{aligned} EV &= e\,(p_1^0, p_2, u^1) - e\,(p_1^0, p_2, u^0) > 0 \\ &= e\,(p_1^0, p_2, u^1) - M \end{aligned} \qquad \text{(II.15)}$$

Considering equal expenditure levels, that is: $e\,(p_1^0, p_2, u^0) = e\,(p_1^1, p_2, u^1)$, EV can also be written as

$$EV = e\,(p_1^0, p_2, u^1) - e\,(p_1^1, p_2, u^1) \qquad \text{(II.16)}$$

In other words, although the EV is defined in terms of monetary equivalent of a change from u^0 to u^1, it can also be measured by the change in expenditure associated with price changes given utility level u^1.

The EV can also be written as the integral of the marginal welfare measure (see equation II.8) over the relevant range:

$$EV = \int_{P_1^1}^{P_1^0} h_1(P, u^1)\,d\,p_1 \qquad \text{(II.17)}$$

All of this discussion was made in terms of welfare gain due to a price decrease, but it is also possible to estimate the welfare loss due to a price increase by developing the same reasoning but in a symmetrical fashion.

According to Haab and McConnell (2003), compensating and equivalent variation measures are closely related to the welfare measures of willingness to pay (WTP) and willingness to accept (WTA). They measure the same phenomenon: the increment in income that makes a person indifferent to an exogenous change, namely in price or in quality. WTP is the maximum amount of income a person will pay in exchange for an improvement in circumstances, or the maximum amount a person will pay to avoid a decline in circumstances. On the other hand, WTA is the minimum amount of income a person will accept for a decline in circumstances, or the minimum amount a person will accept to forego an improvement in circumstances. CV is the amount of income paid or received that leaves the person at the initial level of well-being, and EV is the amount of income paid or received that leaves the person at the final level of well-being. WTP and WTA relate to the right to a utility level, as implied by their nomenclature. On the other hand, EV and CV rely on the initial versus final well-being for the distinction. CV decomposes in the following way: when the final well-being is worse than the initial well-being, it is WTA but when the final well-being is better than the initial well-being, it is WTP. EV is just the opposite: WTA for situations where the well-being is improved and WTP when well-being declines. These correspondence between the Hicksian measures for price change and the WTP and WTA concepts are summarized in the following table.

Table II.1: Relation between CV, EV, WTP and WTA

	EV	**CV**
Utility Increase (e.g. price decrease)	WTA	WTP
Utility Decrease (e.g. price increase)	WTP	WTA

Source: Freeman (2003); Haab and McConnell (2003)

Despite the presented theory was developed based on a price change, it may also be applied using other variables. This is particularly important, since most public programmes regarding non non-market environmental goods or services relate to changes in the quality or quantity rather than changes in the prices of market goods or services. Thus, welfare measures also have to be studied in this context.

Following Haab and McConnell (2003), we now consider the individual preference function: $u(x, q)$, where $x = (x_1, \dots, x_m)$ is the vector of private goods available at prices $p = (p_1, \dots, p_m)$, and $q = (q_1, \dots, q_n)$ is the vector of public goods. In this framework, individuals choose their x, but their q is exogenous. The individual maximises utility subject to income y. The indirect utility function is given by:

$$v(p, q, y) = max\,\{u(x, q) | p.x \leq y\} \qquad \text{(II.18)}$$

The minimum expenditure function is dual to the indirect utility function and is given by:

$$\text{e (p, q, u)} = min\,\{p.x | u\,(x, q) \geq u\} \qquad \text{(II.19)}$$

As already detailed, these functions are associated with two consistent ways of describing monetary welfare measures: CV versus EV; and WTP versus WTA.

If we consider a positive change in q such that: $q^* \geq q$ and that increases in q are desirable $(\partial v / \partial q_i \geq 0)$, it is possible to define WTP as:

$$v(p, q, y) = v(p, q^*, y - WTP) \qquad \text{(II.20)}$$

We can also define WTP with the expenditure function:

$$WTP = e(p, q, u) - e(p, q^*, u) \quad \text{when} \quad u = v(p, q, y) \qquad \text{(II.21)}$$

Developing the same reasoning for WTA, it is also possible to define it through the indirect utility function and the expenditure function as:

$$v(p, q^*, y) = v(p, q, y + WTA) \qquad \text{(II.22)}$$

and

$$WTA = e(p, q, u^*) - e(p, q^*, u^*) \quad \text{when} \quad u^* = v(p, q^*, y) \qquad \text{(II.23)}$$

Disparity between WTA and WTP

Experimental and survey measures of willingness to pay (WTP) for a good or service and willingness to accept (WTA) compensation to forgo it often find that WTA is much larger than WTP. Understanding the reasons behind this disparity is crucial for choosing between the two measures (Tunçel and Hammitt, 2014).

Several reasons for the disparity between WTA and WTP have been suggested. We follow present some of them.

i) Income and substitution effects

One of the most obvious and referred explanation for the observed disparity between WTA and WTP is the income effect. When the good is sufficiently desirable (when the income elasticity of demand is large enough) it is observed that income significantly constrains individuals` ability to pay and consequently WTA may exceed WTP. The magnitude of an income effect depends on the availability and price of substitutes, because an owner`s WTA will not exceed the price at which a perfect substitute can be purchased. Thus, to the extent that perfect substitutes are lacking, the opportunities for a disparity are enhanced. However, it is important to note that a lack of substitutes would tend to increase both WTA and WTP and so it is not responsible for the disparity. For relatively inexpensive market goods with ample substitutes, the income effect is unlikely to play a large role in the disparity between WTA and WTP (except individuals with little disposable income). On the other hand, for more unique and valuable goods, the income effect is a likely contributor to the disparity observed between WTA and WTP (Brown and Gregory, 1999; Hanemann, 1991).

ii) Transaction costs

Transaction costs are those incurred to make a purchase or sale possible, such as locating the good or travelling to where it will be exchanged. For instance, an individual might increase a selling price in order to cover the transaction cost of purchasing a substitute. To the extent that transaction costs affect buyers and sellers differently, a disparity between WTA and WTP may result. However, most experiments showing a disparity have been designed so as to minimise or eliminate any effect of transaction costs on the magnitude of the observed disparity (Brown and Gregory, 1999; Brown, 2005).

iii) Commitment costs

The individuals` feelings of uncertainty and irreversibility combined with the perception of the opportunity loss to gather more information about the good`s value before acting is, according to Zhao and Kling (2001, 2004), one of the explanations for the disparity between WTA and WTP. Unlike experiments and surveys, a key feature of a market transaction is that a consumer is not forced to make a decision in any time period. Rather, one can gather information up to the point where the benefit of further waiting does not compensate for the cost anymore. If a consumer has to make a decision immediately without extra information, there are commitment costs and individuals demand some compensation for it. The existence of commitment costs lead individuals to require higher values for WTA and consequently this behaviour generates a disparity between WTA and WTP.

iv) Endowment effect

The endowment effect describes the notion that desirable things are considered more valuable when they are part of a person`s endowment than when they are not, all else equal (Thaler, 1980). This explanation for the disparity between WTA and WTP is based on the asymmetric valuation of losses and gains suggested by the Prospect Theory (Kahneman and Tversky, 1979) and the claim that selling a good creates a loss, whereas buying the same good generates a gain. As stressed by Tversky and Kahneman (1991), the endowment effect is conceptually the same as loss aversion and captures the intrinsic human traits that pain matters more than pleasure and that individuals habituate to steady states. These human inherent conditions result in a general reluctance to sell, so that a good which is owned is considered to be worth more simply because it is in his hand. The endowment effect is likely to create an especially strong aversion to losses in cases where the probability sale is involuntary, as in many of the usual contingent valuation settings (Brown and Gregory, 1999).

Alternatively to these reasons deeply related to the human behaviour, some authors (e.g. Plott and Zeiler, 2005, 2007) claim that the disparity between WTA and WTP is mainly due to experimental-design features and elicitation techniques. However, this reason is far from being consensual. With a distinct view regarding this issue, we stress the work developed by Horowitz and McConnell (2002). These authors reviewed and conducted a meta-analysis of 45 studies that estimated both WTA and WTP values with the aim of examining the effects of the experimental conditions and type of good valued. With regard to experimental conditions, they examined whether "weak experimental features" may contribute to the disparity. Their results do not support this hypothesis. In particular, they have found no systematic difference in the disparity between studies using hypothetical and real transactions. This suggests that the disparity between WTA and WTP is not peculiar to the hypothetical contexts that characterize stated preference studies, one of the explanations sometimes advanced for the disparity. They also found that studies using incentive compatibility elicitation mechanisms do not produce lower disparities. However, it is important to note that the authors did find that some determinant issues regarding elicitation methods, particularly the type of WTA/WTP question, may affect the disparity. Finally, with regard to type of good, Horowitz and McConnell (2002) found a smaller disparity between WTA and WTP for ordinary private goods than for public goods or other goods that are not usually available in the markets.

Since differences between WTA and WTP are acknowledged, and to some extent explained, it is clear that the individuals` choice is a key issue in empirical SP studies and the measure chosen is determinant in achieving accurate results. In the next section, we present and discuss the different SP techniques which seek to discover individuals` preferences for specified policy changes.

II.4.2. Contingent Valuation Method

The CV method is a direct survey approach to estimating consumer preferences. Using an appropriately designed questionnaire, a hypothetical (or contingent) market is described where the good in question (e.g., an improvement in water quality, reduction in a risk to human health, or protection of an ecosystem) can be traded. This contingent market defines the good itself, the institutional context in which it would be provided, and the way it would be financed. Respondents are then asked to express their maximum willingness to pay (WTP) or minimum willingness to accept (WTA) compensation for a hypothetical change in the level of provision of the good (Mitchell and Carson, 1989; Hanley *et al.*, 2001; Atkinson and Mourato, 2008). One of its major advantages is to allow the estimation of non-use values (e.g. Walsh *et al*., 1984; Brookshire *et al*., 1983), non-market use values (e.g., Choe *et al.*, 1996; Loomis and duVair, 1993) or both (e.g., Niklitschec and Leon, 1996; Desvousges *et al*., 1993) of environmental resources. Theoretically, CV is well rooted in welfare economics, namely in the neo-classical concept of economic value based on individual utility maximisation. This assumes that stated WTP amounts are related to respondents` underlying preferences in a consistent manner (Hanley *et al*., 2001; Atkinson and Mourato, 2008).

Contingent valuation (CV) method is, by far, the most widely applied SP technique and over the last decades, particularly from the 1990s onwards, this method has been extensively applied in both developed and developing countries. The CV method was originally proposed by Ciriacy-Wantrup (1947) who was of the opinion that the prevention of soil erosion generates some “extra market benefits” that are public goods in nature, and therefore, one possible way of estimating these benefits is to elicit the individuals` willingness to pay (WTP) for these benefits through a survey method (Portney, 1994; Hanemann, 1994). However, Davis (1963) was the first to use CV method empirically when he estimated the benefits of goose hunting through a survey among the goose-hunters. This method also gained popularity after the two major non-use values, namely, option and existence values, have been recognized as important components of the total economic value (TEV) in environmental economics literature, especially during the 1960s (Venkatachalam, 2004). Another major boost to the recognition of the importance of the CV method were the conclusions of the special panel appointed by the US National Oceanic and Atmospheric Administration (NOAA) in 1993 (Arrow *et al*., 1993) following the Exxon Valdez oil spill in Alaska in 1989. The panel concluded that, subject to a number of recommendations, CV studies could produce estimates reliable enough to be used in a (US) judicial process of natural resource damage assessment. It is now over two decades since the NOAA deliberations and the number of CV studies has not stopped growing, addressing a very wide range of environmental issues (Pearce *et al.*, 2006; Atkinson and Mourato, 2008). In the preface of his book, Carson (2011, p.vi) stresses that among the entries of the bibliography “There are now over 7.500 CV studies and papers from over 130 countries”.

Despite numerous methodological improvements and a widespread application particularly in the field of environmental economics, the contingent valuation (CV) method still raises substantial controversy. One of the main areas of concern regards the ability of the method to produce valid and reliable estimates of WTP or WTA. A number of factors may systematically bias respondents` answers. These factors are not specific to CV studies but are common to most survey based techniques and are most attributable to survey design and implementation problems (Pearce et al., 2006). As stressed by Mitchell and Carson (1989, p.3), "If the study is well designed and carefully pretested, the respondents` answers to the valuation questions should represent valid WTP responses". We underline that, despite this issue regards both WTP and WTA, there is a considerably lower number of studies on the validity of the stated WTA answers in comparison to the WTP ones (List and Gallet, 2001).

Several biases may affect the validity and reliability of the CV method. Possible types of bias include:

i) Hypothetical bias

The nature of the market created in a CV survey is mainly hypothetical, and therefore, it may attract a "hypothetical bias" (Neill *et al*., 1994). This bias is defined as the difference between hypothetical and actual statements of value, where actual statements of value are obtained from experiments with real economic commitments (List and Gallet, 2001). The research on this subject appears to have commenced with Bohm`s (1972) seminal experimental lab study which compared bids in hypothetical and actual experimental markets that elicited subjects` stated value to sneak preview a Swedish television show. The results of this study suggest that people moderately overstate their actual values when asked a hypothetical question. Subsequent lab research has generally supported Bohm`s findings (e.g. Bishop and Heberlein, 1979; Neill *et al*., 1994; Cummings *et al*., 1995; Brown *et al.*, 1996; Fox *et al.*, 1998; List and Shogren, 1998). There are exceptions to the conclusion about the existence of a hypothetical bias (e.g., Sinden, 1988; Johannesson *et al.*, 1998; Smith and Mansfield, 1998), but this studies appear to be in the minority. In a recent survey of the literature, Harrison and Rutström (2008) found that 34 of 39 CV estimates reviewed contained hypothetical bias with an average bias of about 338%.

These results are consistent with those in the meta-analyses developed by List and Gallet (2001) in which the authors also concluded that WTP studies yield smaller hypothetical-to-actual ratios than WTA studies; and that certain elicitation methods induce disparities between hypothetical and actual statements.

ii) Strategic bias

There is a strategic bias if survey respondents intentionally mislead the researcher (Bishop and Heberlein, 1987). Respondents may understate or overstate preferences depending on whether or not they think their answers will influence policy and depending on how much they expect to have to pay in reality. The concern with strategic bias stems from the free rider problem associated with public goods (Samuelson, 1954). The problem here is to persuade individuals to reveal their true preferences “in contexts where, by not telling the truth, they will still secure a benefit in excess of the costs they have to pay” (Pearce and Markandya, 1989, p.36). The debate on strategic bias was initiated by Samuelson (1954) when he criticised the survey methods alleging that individuals would always tend to “free ride” on survey questions. Following Samuelson’s (1954) work many laboratory experiments have been conducted and, despite not focusing exclusively the issue of strategic bias, they provided mixed results about the occurrence of strategic bias in CV results: some empirical studies report the existence of a strategic bias in their results (Milon, 1989; Throsby and Withers, 1986), while other explicitly reject the existence of a strategic bias (Bohm, 1972; Rowe *et al*., 1980). Nevertheless, many of the CV studies take a stand that the incentives for strategic behaviour in most CV studies are weak and that if any such behaviour does occur it is likely to have little effect on mean values and thus it is not a major problem in CV experiments (Hoehn and Randall, 1987; Mitchell and Carson, 1989; Griffin *et al.*, 1995; Schulze *et al*., 1981).

iii) Embedding bias

Also variously labeled as a part-whole bias, symbolic bias, disaggregation bias, sub-additivity effect, or scope effect (Cummings *et al*., 1986, Mitchell and Carson, 1989; Hanemann, 1994; Bateman *et al*., 1997), the embedding bias occurs if “the same good is assigned a lower value if WTP for it is inferred from WTP for a more inclusive good rather than if the particular good is evaluated on its own” (Kahneman and Knetsch, 1992, p.58). An example of the embedding effect is reported in Kahneman (1986)'s CV study in which the expressed willingness of Toronto residents to pay increased taxes to prevent the drop in fish populations in all province lakes was only slightly higher than the WTP to preserve the fish stocks in only a small area of the province. The similar WTP values observed for a small part of the region and for the whole region appears not making sense. Another example confirming the existence of embedding bias in CV is reported by Desvouges *et al*. (1993)'s study on migratory bird. In this CV experiment, three independent samples at two Malls in Atlanta, Georgia, were assigned three different scenarios that differ only in terms of number of bird death prevented from oil spills: 2,000, 20,000 or 200,000. Despite the considerable difference in the number of birds, the obtained WTP values for all the three treatments showed that there was no significant difference between the WTP values for these treatments indicating the presence of embedding effect. Despite the existence of some studies reporting a null embedding effect (e.g. Choe *et al*., 1996), most CV studies identify the existence of this bias. According to Bateman *et al*. (1997), the embedding bias concerns both public goods and private goods, and may not be attributable simply to problems with the CV method: instead, it may be a symptom of some fundamental property of individuals` preferences which conventional consumer theory does not allow for.

iv) Anchoring bias

The anchoring bias is considered a major cause of departure from the simple model of choice when uncertainty exists in policy outcomes (Kato and Hidano, 2007). This effect occurs when people`s answers to a question are influenced by thinking about an arbitrary value as possible answer to the question (Tversky and Kahneman, 1974). Kahneman *et al.* (1999) reviewed the psychological literature and noted that anchoring effects are commonly observed when people are asked to process uncertain numbers. In a classic study by Tversky and Kahneman (1974), people estimated whether a number that resulted from the spin of a "wheel of fortune" was more or less than the percentage of African countries in the United Nations and then guessed the correct percentage. People`s guesses were substantially lower if they began with a low anchor than if they began with a high anchor. This pioneer study on the anchoring effects was followed by others, of which we highlight the Wilson *et al*. (1996)`s work in which the authors found that: completely arbitrary numbers can anchor people`s judgements, even when there is no logical reason to consider these numbers as answers to target questions; the amount of knowledge people have about the target question moderated these effects, presumably because they could retrieve from memory the answer they believed to be correct; people must pay sufficient attention to an arbitrary number for basic anchoring effects to occur; and anchoring processes appear to occur unintentionally and nonconsciously, in that most people reported that they were not influenced by the anchor, and neither the offer of an incentive to be accurate nor forewarning people about anchoring effects eliminated these effects. We also stress the study by Herriges and Shogren (1996) in which they highlight the importance of the first bid amount in a CV experiment and conclude that if the individual does anchor his prior WTP to the initial bid, all the answers to the following questions are affected and consequently the results can be significantly biased. Based on the presented arguments, we fully subscribe the words of Wilson *et al*. (1996, p.401), "Researchers should be wary of asking their participants to attend to a numerical value and then give a numerical estimate on an unrelated question".

v) Information bias

The information in a CV experiment plays a crucial role. The validity of the CV results depends mainly on the information provided to the respondents (Venkatachalam, 2004). A number of empirical studies have detected statistically significant changes in commodity valuations, namely in the environmental context, induced by changes in the information presented to consumers (Cummings *et al*., 1986; Bergstrom *et al*., 1990). Such effects are usually labeled *information biases.* In the Whitehead and Blomquist (1991)' s study, the authors concluded that the explicit introduction of information about related environmental goods (substitutes and complements) may minimise misstatements of WTP from different prior information across respondents. Neill (1995) and Ajzen *et al.* (1996) also found that reminding of budget constraint and availability of substitutes influence the WTP values in laboratory experiments. On the other hand, some CV studies on the information effect provide contradictory results. For instance, Loomis *et al*. (1994) studied the impact of reminding budget constraint and substitutes on WTP values and concluded that the information provided had no impact on the stated WTP values. One possible explanation for this unexpected result was that the respondents might have already taken into account the budget constraints and substitutes while providing their WTP values. This result underlines the fact that some respondents may be well informed about the related complements and substitutes of the good being valued, but others may not. Therefore, if there exists asymmetric information among respondents, the additional information provided in the CV studies contributes to the achievement of more accurate WTP results (Bergstrom *et al*., 1990; Venkatachalam, 2004).

Concern with these biases, particularly the hypothetical bias, has motivated a growing number of researchers to explore techniques to minimise or even eliminate such biases, thereby developing methods to obtain unbiased estimates for WTP with the CV method. According to Cummings and Taylor (1999), one method used in efforts to derive unbiased value estimates relies on calibration techniques. One of those techniques consists in subjects responding to hypothetical and then real valuation questions. Hereafter, a calibration function is estimated, relating differences in responses obtained in the two treatments to subject characteristics. With this method, hypothetical WTP is "calibrated" by subjects' self-reports of embedding. Although calibration is considered a useful tool for *ex post* adjustments of stated preference (SP) values, its practicality appears to be limited, because it is commodity-specific, that is, there isn`t a general calibration function valid for all different goods. A second and very different approach, an *ex-ante* approach, to deal with the specific hypothetical bias problem focuses on the design of the CV questionnaire. The main underlying idea is, rather than attempting to remove the hypothetical bias, to include an explicit discussion of the hypothetical bias problem - what hypothetical bias is and why it might occur. This is referred to as the "cheap talk" design following the use of this term in the information, bargaining, and game-theory literature, and it makes the issue of hypothetical bias an integral part of the CV questionnaire. With the ”cheap-talk”, participants are informed of the tendency to misstate their true values as a result of the hypothetical setting and then are asked to complete the valuation task as if they were in a real-life setting.

After Cummings and Taylor (1999) having presented the first published study to test ”cheap-talk”, other authors, such as List (2001), Poe *et al*. (2002), Lusk (2003), and Murphy *et al*. (2005), have begun to explore the use of "cheap talk" to address this specific problem. These studies show a number of patterns emerging: despite mixed evidence, “cheap-talk” appears to be effective at lowering stated values; shorter scripts tend to be less effective; inexperienced consumers are more receptive to “cheap-talk” scripts than experienced or knowledgeable respondents; “cheap-talk” appears to be more effective at higher payment levels where hypothetical bias may be more pronounced; and, finally, it is important to note that not all studies confirm the effectiveness of ”cheap-talk”.

Partly as a response to this problem of biased results, valuation practitioners are increasingly developing an interest in alternative stated preference (SP) formats such as choice modelling (CM).

II.4.3. Choice Modelling

Choice modelling (CM) “is a family of survey-based methodologies for modelling preferences for goods, where goods are described in terms of their attributes and of the levels that these take” (Hanley *et al.,* 2001, p.436). Respondents are presented with various alternative descriptions of a good, differentiated by their attributes and levels, and are asked to rank the various alternatives, to rate them or to choose their most preferred. By including price/cost as one of the attributes of the good, willingness to pay (WTP) can be indirectly recovered from people`s rankings, ratings or choices. As with contingent valuation (CV), choice modelling (CM) can also measure all forms of value including non-use values. The conceptual microeconomic framework for these analyses lies in Lancaster (1966)`s work, which assumes that the well-being consumers derive from goods can be decomposed into its composing characteristics. Empirically, CM has been widely used in the market research and transport literatures (e.g. Green and Srinivasan, 1978; Henscher, 1994), but recently it has been increasingly applied in other areas such as the environment (e.g., Hanley *et al*., 2001; Bennett and Blamey, 2001; Bateman *et al.*, 2002).

A typical choice modelling (CM) exercise is characterized by a number of key stages (Hanley *et al*., 2001; Bateman *et al.*, 2002; Pearce *et al*., 2006):

i) Selection of attributes: Identification of relevant attributes of the good to be valued. This is done through literature reviews, focus groups and expert consultations. A monetary cost is typically one of the attributes to allow the estimation of WTP;

ii) Assignment of levels: The attribute levels should be feasible, realistic, non-linearly spaced, and span the range of respondents` preference maps. This is done through literature reviews, focus groups, pilot surveys and expert consultations. A baseline "*status quo*" level is usually included;

iii) Choice of experimental design: Statistical design theory is used to combine the levels of the attributes into a number of alternative scenarios or profiles to present to respondents. *Complete factorial designs* estimate the full effects of the attributes upon choices: it includes the effects of each of the individual attributes presented (main effects) and the extent to which behaviour is connected with variations in the combination of different attributes offered (interactions). These designs often originate an impractically large number of combinations to be evaluated. *Fractional factorial designs* can reduce the number of scenario combinations presented with a concomitant loss in estimating power (some/all interactions will not be detected). These designs are available through specialized software;

iv) Construction of choice sets: The profiles identified by the experimental design are then grouped into choice sets to be presented to respondents. Profiles can be presented individually, in pairs or in groups;

v) Measurement of preferences: Choice of a survey procedure to measure individual preferences: ratings, rankings or choices;

vi) Estimation procedure: OLS regression or maximum likelihood estimation procedures (logit, probit, ordered logit, conditional logit, nested logit, panel data models, etc.). Variables that do not vary across alternatives have to be interacted with choice-specific attributes.

As already mentioned, individual preferences can be uncovered in choice modelling (CM) surveys by asking respondents to rank the options presented to them, to score them or to choose their most preferred. These different ways of measuring preferences correspond to different variants of the CM approach. There are four main variants in which respondents face a specific task (Hanley *et al.*, 2001; Bateman *et al.*, 2002; Pearce *et al.*, 2006):

i) Choice experiments: Respondents are presented with a series of alternatives and asked to choose their most preferred. It is included the *status quo*, essentially for welfare-consistent estimates;

ii) Contingent ranking: Respondents are asked to rank a set of alternative options. Each one is characterized by a number of attributes offered at different levels across options. To obtain welfare-consistent estimates, one of the options must always be currently feasible (like a "do nothing" option);

iii) Contingent rating: Respondents are presented with a number of scenarios one at a time and are asked to rate each one individually on a scale (for instance, from 1 to 10). The consistent of welfare-estimates is, in this case, doubtful;

iv) Paired comparisons: Respondents are asked to choose their preferred alternative out of a set of two choices and to indicate the strength of their preference in a scale. The consistent of welfare-estimates is, in this case, doubtful.

All these CM techniques differ in the quality of information they generate, in their degree of complexity and also in their ability to produce WTP estimates that can be shown to be consistent with the usual measures of welfare change. In the following sections, each of the CM techniques is analysed in detail.

II.4.3.1. Choice Experiments

In a choice experiment (CE) respondents are presented with a series of alternatives, differing in terms of attributes and levels, and asked to choose their most preferred. Initially developed by authors such as Louviere and Hensher (1982) and Louviere and Woodworth (1983), CE resulted from the advances and contributions of different disciplines, namely psychology, economics and statistics (Lancsar and Louviere, 2008). CE has a theoretical grounding in Lancaster's characteristics theory of value and in random utility theory. According to Lancaster (1966), any good can be defined as a set of attributes and, by examining the relative importance people place on these attributes, it is possible to determine its value. However, as stressed by Bateman *et al*. (2002), although it may seem a simple task, it is not easy to completely describe anything in terms of its attributes. In the case of an environmental good, such as a river, the utility received from it depends on all sorts of intangible and “hard-to-measure” things, and not just observables such as pollution levels. Moreover, it is possible to make errors in measuring attributes and people`s subjective perspectives. This is all true and it is in this context that the other link with economic theory comes in via *random utility theory*. This theory derives from Luce (1959) and McFadden (1974), and is based around an alternative theory of choice to that used to derive conventional demand curves. According to this framework, the indirect utility function for each respondent *i* (*U*) can be decomposed in two parts: a deterministic element (*V*), which is typically specified as a linear index of the attributes (*X*) of the *j* different alternatives in the choice set, and a stochastic element (*e*), which represents unobservable influences on individual choice. This is shown in the following equation:

$$U_{ij} = V_{ij}\,(X_{ij}) + e_{ij} = bX_{ij} + e_{ij} \qquad \text{(II.24)}$$

Thus, the probability that a respondent *i* prefers option *g* in the choice set to any alternative option *h* can be expressed as the probability that the utility associated with option *g* exceeds that associated with all other options, as stated in the next equation:

$$P[(U_{ig} > U_{ih})\ \forall h \neq g] = P[(V_{ig} + e_{ig}) > (V_{ih} + e_{ih})] = P[(V_{ig} - V_{ih}) > (e_{ih} - e_{ig})] \qquad \text{(II.25)}$$

To derive an explicit expression for this probability, it is necessary to know the distribution of the error terms (e_{ij}). A common assumption is that they are independently and identically distributed (IID) with an extreme-value (Weibull) distribution:

$$P(e_{ij} \leq t) = F(t) = exp(-\,exp(-\,t)) \qquad \text{(II.26)}$$

The above distribution of the error term implies that the probability of any particular alternative *g* being chosen as the most preferred can be expressed in terms of the logistic distribution (McFadden, 1974) stated in the following equation:

$$P(U_{ig} > U_{ih}\ \ \forall h \neq g) = \frac{exp(\mu V_{ig})}{\sum_j exp(\mu V_{ij})} \qquad \text{(II.27)}$$

This specification is known as the conditional logit model, where μ is a scale parameter, inversely proportional to the standard deviation of the error distribution. This parameter cannot be separately identified and consequently is assumed to be one. This specification implies that selections from the choice set must obey the Independence from Irrelevant Alternatives (IIA) property or Luce's Choice Axiom (Luce, 1959) which states that the relative probabilities of two options being selected are unaffected by the introduction or removal of other alternatives. This property follows from the independence of the Weibull error terms across the different options contained in the choice set.

This model can be estimated by conventional maximum likelihood procedures, with the respective log-likelihood functions stated in the next equation, where y_{ij} is a variable which takes a value of one if respondent *i* chose option *j* and zero otherwise.

$$log\ L = \sum_{i=1}^{N} \sum_{j=1}^{J} y_{ij}\ log \left[\frac{exp(V_{ij})}{\sum_{j=1}^{J} exp(V_{ij})} \right] \qquad \text{(II.28)}$$

Socio-economic variables can be included along with choice set attributes in the *X* terms in equation (II.24), but since they are constant across choice occasions for any given individual (e.g. income is the same when the first choice is made as the second), they can only be entered as interaction terms. Some software packages have automatic routines for creating these interactions.

Once the parameter estimates have been obtained, a willingness to pay (WTP) compensating variation welfare measure that conforms to demand theory can be derived for each attribute using the formula given by (II.29) (Hanemann, 1984; Parsons and Kealy, 1992) where V^0 represents the utility of the initial state (for example, pre-project) and V^1 represents the utility of the alternative (for example, post-project) state. The coefficient b_y gives the marginal utility of income and is the coefficient of the cost attribute.

$$WTP = b_y^{-1}\ ln \left\{ \frac{\sum_i exp(V_i^1)}{\sum_i exp(V_i^0)} \right\} \qquad \text{(II.29)}$$

It is straightforward to show that, for the linear utility index specified in (II.24), the above formulae can be simplified to the next ratio of coefficients (II.30), where b_C is the coefficient on any of the attributes. These ratios are often known as implicit prices and show WTP for a change in any of the attributes.

$$WTP = \frac{-b_C}{b_y} \qquad \text{(II.30)}$$

Choice experiments (CE) are therefore consistent with utility maximisation and demand theory (e.g. Hanley *et al.*, 2001; Bateman *et al*., 2002; Pearce *et al*., 2006). It should also be noted that the inclusion of a *status quo* option in the choice set is essential to achieve welfare measures consistent with the demand theory. Otherwise, if a *status quo* alternative is not included in the choice set, respondents are effectively being “forced” to choose one of the presented alternatives, which they may not desire at all, yielding inaccurate estimates of consumer welfare.

In the environment context, the use of this approach is extremely valuable, by allowing to calculate the WTP amounts for specific environmental attributes of a certain good or service. Moreover, it reveals, in monetary terms, how important certain environmental improvements are relative to others. These monetary measures constitute important inputs into decision making processes (Sundqvist, 2002). One of the first applications of the CE approach in environmental resources was reported by Adamowicz *et al.* (1994) who applied this method to the evaluation of recreationalists` preferences for alternative flow scenarios for Highwood and Little Bow Rivers in Alberta, Canada, concluding that attributes such as water quality and fish catch were significant determinants of trip destination. This first CE study in the environmental context was followed by others, of which we highlight: Bergland (1997) who used the CE method to value changes in agricultural landscapes in Norway; Hanley *et al.* (1998) report results from a CE study of landscape and wildlife protection in Scotland; and Adamowicz *et al*. (1998) present a CE application focusing on the protection of old-growth forests in west central Alberta, from the perspective of safeguarding caribou populations (a threatened species in Alberta). After these first contributions, the number of studies adopting the CE approach to assess WTP for environmental improvements has significantly increased, being currently one of the SP methods most widely used for environmental valuation.

II.4.3.2. Contingent Ranking

In a contingent ranking (CR) experiment respondents are required to rank a discrete set of alternatives from their most to their least preferred. Each alternative in the choice set differs from the others in the levels of its component attributes, and the cost which the respondent would incur as a result of the choice. The attribute levels of each alternative are used along with the observed rankings to estimate a discrete-choice, utility-maximizing model for the sample data. The estimated parameters of this model are then used to estimate the trade-off which respondents make between disposable income and an improvement in the provision of the commodity (e.g., environmental quality) described in the choice sets. As with CE, a *status quo* option is normally included in the choice set to ensure welfare consistent results (Garrod and Willis, 1997; 1999).

The data on the complete ranking of all the alternatives is analysed using a random utility function framework. The estimation is often done with the econometric technique of Beggs *et al.* (1981) who, considering the assumption of an independently and identically distributed (IID) random error with a Weibull distribution, developed a rank-order logit model capable of using all the information contained in a survey where alternatives are fully ranked by respondents. Their specification is based on the repeated application of the probability expression given in equation (II.31) until a full ranking of all the alternatives has been obtained. The probability of any particular ranking of alternatives being made by individual *i* can be expressed as:

$$P_i\,(U_{i1} > U_{i2} > \ldots > U_{ij}) = \prod_{J=1}^{J} \left[\frac{exp(V_{ij})}{\sum_{k=j}^{J} exp(V_{ik})} \right] \qquad \text{(II.31)}$$

Clearly, this rank ordered model is more restrictive than the standard conditional logit model in as much as the extreme value (Weibull) distribution governs not only the first choice but all successive choices as well. As before, the models relies critically on the IIA assumption, which in this case is what permits the multiplication of successive conditional logit probabilities to obtain the probability expression for the full ranking.

The parameters of the utility function can be estimated by maximizing the log likelihood function given in the next equation:

$$log\ L = \sum_{i=1}^{N} \sum_{j=1}^{j} log \left[\frac{exp(V_{ij})}{\sum_{k=j}^{J} exp(V_{ik})}\right] \quad (II.32)$$

A number of other studies subsequently used this methodology, including Desvouges *et al*. (1983) in their study of alternative approaches for estimating benefits of water quality improvements; Rae and Reddy (1986) for estimating the value to visitors of improving visibility in US National Parks; Lareau and Rae (1989) in their investigation of preferences for reductions in diesel odors; Garrod and Willis (1997) for valuing the non-use benefits of enhancing forest biodiversity; and Foster and Mourato (1997) for valuing the environmental impacts of pesticide use in the UK.

The contingent ranking (CR) approach shares many conceptual characteristics with the choice experiments (CE) approach, but they still are distinct. The major difference between the two approaches is that the former provides information about how alternatives are fully ranked by respondents. Chapman and Staelin (1982) focus in their study that CR can be seen as a series of choices in which respondents face a sequential choice process: respondents are presented with a finite set of alternatives and asked to choose the most preferred choice, which is assigned rank one and then removed from the choice set; then, respondents are asked to select the best alternative from among the remaining ones, which is assigned rank two. This process continues until the choice set is completely ranked from top to bottom. So, with this perspective, one can decompose a contingent ranking exercise into a set of choice experiments. WTP values can therefore be estimated as in CE example. Ranking data provides more statistical information than CE, which leads to smaller confidence intervals around the parameter estimates and so might result in more precise implicit prices or measures of WTP (Pearce *et al*., 2006).

However, contingent ranking (CR) approach also present significant limitations. For instance, Ben-Akiva *et al*. (1992) investigate in their study the reliability of ranking data and found that response data from different ranking levels were not equally reliable and in some cases produced statistically significantly different estimates of welfare measures. The authors suggest that respondents may use different criteria in making ranking decisions at different levels, i.e., the criteria for ranking the first and the last choices may be different. This may be a consequence of the respondent fatigue or of the difficulty in discrimination between lower ranked alternatives. Additionally, it is argued that the ranking task represents a significant cognitive burden on respondents and that the ranking may not be consistent with the axioms of consumer theory. This question is analysed in several studies, namely by Foster and Mourato (1997) who propose a series of tests to evaluate the consistency of their ranking data, finding 90% of their respondents failing one of these tests at least once but less than 30% failing one test on each occasion.

II.4.3.3. Contingent Rating

In a contingent rating exercise respondents are presented with a number of scenarios one at a time and are asked to rate each one individually on a semantic or numeric scale. This approach does not, therefore, involve a direct comparison of alternative choices and consequently there is no formal theoretical link between the expressed ratings and economic choices (Hanley *et al*., 2001).

Although the contingent rating does not produce welfare consistent estimates, there are some procedures that can be used to strengthen the link between this method and economic theory (Bateman *et al*., 2002). First, it is usually possible to analyse contingent rating data by dropping the scale (which people tend to use differently) and only using information on what choice was preferred. This at least provides a test of whether the “extra” information in the rating is consistent with the choice data.

Alternatively, rating data can be analysed within the framework of the random utility model with ratings being first transformed into a utility scale. In this context, the indirect utility function is assumed to be related to the individual`s ratings via a transformation function:

$$R_{ij}(X_{ij}) = \phi\,[V_{ij}(X_{ij})] \qquad \text{(II.33)}$$

where R represents the rating of individual i for choice j and ϕ is the transformation function. For instance, in marketing applications, these data are typically analysed using ordinary least squares (OLS) regression techniques which imply a strong assumption about the cardinality of the ratings scale.

Another approach that allows the contingent rating data to be analysed in a random utility framework is to use ordered probit and logit models that only imply an ordinal significance of the ratings. However, there remains the implicit assumption that ratings are comparable across individuals (Hanley *et al.*, 2001).

Roe *et al*. (1996) have shown how to estimate compensating variation measures from ratings data based on rating differences. This approach consists in subtracting a monetary cost from income until the ratings difference is made equal to zero:

$$R^1_{ij}\,(X^1_{ij}, M - WTP) - R^0_{ij}\,(X^0_{ij}, M) = 0 \qquad \text{(II.34)}$$

Where R^0 is the rating of the baseline choice, R^1 the rating attributed to the alternative choice, and M is income. Other procedures to derive welfare estimates from rating exercises are reviewed by Morrison *et al.* (1999).

Despite its popularity amongst some research areas, namely in marketing, the contingent rating method presents a number of drawbacks, which limits its applicability in economic benefit assessments. For instance, in marketing applications, the analysis of ratings has typically implied a strong assumption about the cardinality of the ratings scale (e.g. a rating of 8 implies say twice as much utility is enjoyed than if a rating of 4 was chosen). An alternative and less demanding approach is to assume that the ratings only have an ordinal significance. In either case, there remains the implicit assumption that ratings are comparable across individuals, which may not be valid. In general, there is concern that contingent rating exercises do not produce welfare consistent value estimates, which clearly is a drawback in an economic assessment (Pearce *et al*., 2006). For all these reasons, there are few studies applying the contingent rating method in environmental economics (e.g. Mackenzie, 1993; Roe *et al*., 1996; Alvarez-Farizo and Hanley, 2002).

II.4.3.4. Paired Comparisons

In a paired comparison exercise respondents are asked to choose their preferred alternative out of a set of two choices and to indicate the strength of their preference in a numeric or semantic scale. This format is also known as graded or rated pairs. This approach combines elements of choice experiments (CE) (choosing the most preferred alternative) and rating exercises (rating the strength of preference). If the ratings are re-interpreted as providing an indication about choices only, then this approach collapses into a CE. If instead it is assumed that a change in rating is related to a change in utilities, then the resulting data can be analysed using ordered probit or logit techniques, similarly to the contingent rating procedure. Hence the comments and procedures described above for CE and contingent rating also apply in this case. Note that a *status quo* option must always be present in the pairs for the resulting estimates to be welfare consistent (Hanley *et al*., 2001; Bateman *et al*., 2002; Pearce *et al.*, 2006).

Paired comparisons are extremely popular amongst marketing practitioners, especially after the introduction of computerized interviewing techniques and the development of specialized computer software such as Adaptive Conjoint Analysis (Green *et al*., 1991; Sawtooth Software, 1993) which determines attributes, levels and pairwise comparisons, tailor-made for each respondent. It should however be noted that these computer generated designs do not necessarily conform with standard optimally criteria.

II.5. Combining Revealed and Stated Preference Techniques

There is a growing realization that revealed preference (RP) and stated preference (SP) information is highly complementary and can be used in joint estimation of preferences. This interest in combining RP and SP data has risen in transportation (e.g., Ben- Akiva and Morikawa, 1990) and in marketing (e.g., Swait and Louviere, 1993; Swait *et al.*, 1994). In environmental economics we can also find some important studies that combine these data sources to examine effects of environmental quality change: Cameron (1992) made one of the first efforts in environmental economics to combine RP and SP data, with the conception of a model in which jointly estimates contingent valuation and travel cost parameters; some years later, Adamowicz *et al.* (1994 and 1997) built upon the pioneering approach employed by Cameron by designing the stated and revealed preference questions to conform to a common random utility formation; other important studies have afterwards appeared, such as Louviere (1994), Huang *et al.* (1997), Kling (1997) and Henscher *et al.* (1999).

The reasons for wanting to combine RP and SP data can be summarized as providing a check on convergent validity, a means of more efficient sampling and combining the best features of the two approaches. There are different methods to combine RP and SP techniques as explained in the following sections.

II.5.1. Random Utility Models Combining SP and RP Data

Joint estimation of choice models using stated and revealed preference data is widely used in transport applications, although there remain technical difficulties. The basis for the approach is that while people make hypothetical responses to choice tasks in an SP interview, and their answers may not correspond to what they would actually do, RP data are based on real choices actually made and may therefore be more reliable. Knowing that it is assumed that the "utility" of each alternative offered comprises a deterministic component, based on the weightings attached to each alternative`s attributes, and a random component, reflecting influences that are unknown to the researcher, the key assumption made in joint estimation is that the difference between hypothetical responses to the SP tasks and the observed real choices in the RP data can be explained entirely by differences in this random term (Bateman *et al.*, 2002).

Adamowicz *et al*. (1994; 1997) present us a pioneer study in this area, in which the authors examine a set of RP, SP, and combined models of recreational site choice in a random utility framework. According to Bateman *et al*. (2002), the main advantages we can take from this approach are: attribute levels can be specified outside of the range of observed values (for example, higher water quality, better fish catches); stated and revealed preference answers can be compared; stated preference responses can be calibrated on revealed preference behaviour; and econometrically, we can estimate the ratio of scale parameters in the two logit models.

II.5.2. Contingent Behaviour Panel Data Models of Price Changes

This method has been applied to the study of the demand for recreation by Englin and Cameron (1996). Their insight was to recognize that some of the weakness of traditional travel cost models could be addressed by using a panel data approach. Panel data are data where each individual in the sample provides a number of observations. It is widely employed in labour economics, where data on hours worked by *n* workers over *m* months may exist giving a (*n* x *m*) data set, with each worker generating *m* observations.

In travel cost models, data are collected by interviewing recreationalists on site or by mailshot. However, it would be very expensive to repeat the survey for the same group of individuals many times to collect panel data similar to the workers` example. In a travel cost study, each person gives two vital pieces of information: how many trips they made to a site or group of sites and the cost to them of visiting the site. If each respondent was asked how they would change their behaviour if these costs rose or fell by some precise amount, then this would generate extra observations for each individual (for example, we could ask "how many fewer trips would you make next year if your costs were 30 per cent higher than they are at present?"). This process thus provides a data set where for each person there is one observation on existing trips as a function of actual costs (RP data) and a series of observations on predicted trips for a range of hypothetical prices (SP data). This is a type of panel data (Bateman *et al*., 2002).

According to Bateman *et al.* (2002), the main advantages in having a panel data set in this context are: there are more observations from each person in the sample; the range over which welfare change estimates can be produced can be extended beyond the range of existing environmental or cost variables by including higher or lower than observed levels in the contingent behaviour parts of the exercise; differences in observed and hypothetical behaviour can be tested; individual heterogeneity can be controlled for; and, finally, the panel data approach solves partly the omitted variable bias problem in the travel cost parameter estimates, by having exogenously-determined variations in the cost to plot against changes in the number of visits for each person.

II.5.3. Contingent Behaviour Models of Environmental Quality Changes

This approach is very similar to the one described above, except that instead of asking respondents how their demand for environmental good would change if its price changed, the interest is in how their demand would change if environmental quality alters. Both pooled and panel data models can be used, and the advantages are similar to those set out in the preceding section. In particular, scenarios that lie outside of the range of currently (or historically) observed levels for environmental quality can be used, and the differences in revealed and stated behaviour tested for (Bateman *et al*., 2002).

In conclusion, we may affirm that combining RP and SP data enhances the unique strengths of these respective data while minimizing their limitations. We have already referred the main advantages and, although minimised, there still exist limitations to consider, such as: it is harder to implement; the models can get very complex statistically; contingent behaviour may be inconsistent with real behaviour; it does not work in all contexts; there is still limited experience of using combined approaches for environmental issues; and a longer questionnaire must be used, which could mean lower item response rates, more protesting and lower quality responses (Bateman *et al*., 2002).

II.6. Concluding Remarks

In this Chapter, we discussed fundamental concepts and issues on environmental economic valuation. We started by deepening the concept of total economic value (TEV), a fundamental concept in the context of economic valuation of environmental goods, whose value is not limited to the use value – it must also be considered the non-use value of the environmental goods.

There are different techniques available to estimate all these kind of values for environmental goods in economic terms. In this chapter, we deepened the revealed preferences (RP) and the stated preferences (SP) methods, referring the main advantages and disadvantages associated with each one. We also considered the combination of both methods. Nevertheless, it is clearly given greater emphasis to SP methods, since they enable the valuation of both use and non-use values of the environmental goods.

With this Chapter we hope to have achieved our main purpose, which was to clarify and increase knowledge of the theoretical framework associated with economic valuation of the environment.

CHAPTER III: ELECTRICITY PRODUCTION THROUGH RENEWABLE ENERGY SOURCES

III.1. Introduction

Energy, and particularly electricity generation, is a key subject in the current societies, playing a determinant role in improving individuals` living standards. Nevertheless, the increased use of fossil fuel sources is the major culprit for man-made global climate changes, through emission of GHG and global warming of the planet. Moreover, in the particular case of Portugal, the scarcity in fossil resources leads to a considerable external energy dependency which, besides being a heavy burden on the national budget, makes the country extremely vulnerable to external market fluctuations. These factors along with the political commitment to comply with the Kyoto protocol, and subsequent international agreements, have encouraged the increased use of RES. Despite the well-known benefits associated with the renewables, they are not completely benign to the environment, being responsible for causing some adverse environmental impacts. These impacts differ between the different renewables and affect people's wellbeing, particularly those living in the surroundings of the installations.

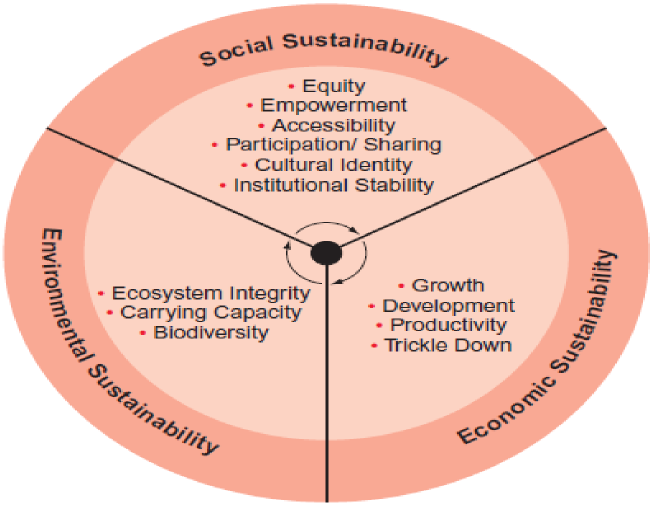
This Chapter analyses the main impacts caused by the activity of the different renewables installations, addressing also their social implications. In Section III.2, we underline the importance of the RES for a sustainable development. Section III.3 focuses on the potential of Portugal to use different RES. Moreover, as a result of a detailed analysis of the current electricity generation based on renewable energy sources and taking into account their size, installed power capacity and location, we have selected a group of 12 power plants in continental Portugal to make a deep local research focusing on their technical characteristics and the surrounding social environment in which they operate. A detailed description of these facilities is presented in this section. Based on a comprehensive literature review, the main impacts associated with electricity generation activity of the different RES power plants are described in Section III.4. Then, in Section III.5, we address the social acceptance (or the lack of it) of the renewable energies, a major issue in any debate on the RES impacts since its use in electricity generation has serious implications on individuals` well-being and, as a consequence, should not be neglected. The Chapter closes with some concluding remarks.

III.2. Renewable Energy and Sustainable Development

From supplying power and heat to production systems to satisfying heating, cooling, lighting, and mobility needs, energy is pervasive in everyday life, being one of the most distinctive features of modern developed societies. Energy resources are essential in creating wealth and improving living standards for individuals and societies. Therefore, we may say that energy is a key consideration in any discussion on sustainable development.

Sustainable development has been defined in many ways, including “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”, definition adopted by the Brundtland Report (WCED, 1987, p.43). Although this is the most common definition of sustainability, it is necessary to put this concept into practice considering the cross-fertilization between distinct disciplines (Hui, 1997). According to general scientific literature sustainable development must be focused on three main pillars: economic, environmental and social concerns. Hopwood *et al.* (2005, p.39) states that “The concept of sustainable development is the result of the growing awareness of the global links between mounting environmental problems, socio-economic issues to do with poverty and inequality and concerns about a healthy future for humanity. It strongly links environmental and socio-economic issues”. The following figure shows a conceptual diagram of the three main segments of sustainability: social, economic and environmental sustainability. Important factors included in the social segment are: equity, empowerment, accessibility, participation, sharing, cultural identity and institutional stability. The environmental segment includes ecosystem integrity, carrying capacity and biodiversity. Finally, in the economic segment, we have factors such as growth, development, productivity and the trickle-down theory. Each domain has distinct goals and perspectives, but they are strongly linked.

Figure III.1: The Three Segments of Sustainability



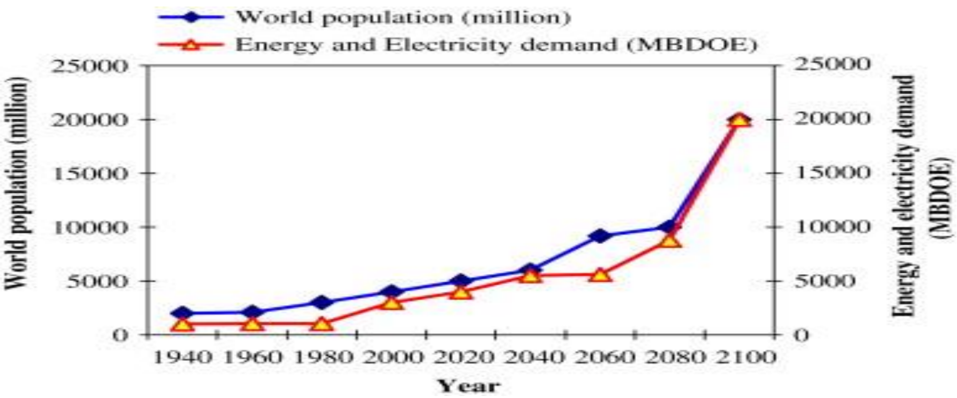
Source: Khan (1995)

The energy sector, which supports our economies and contributes directly to our quality of life, is a critical area for achieving sustainability (Hui, 1997). According to Dincer and Rosen (2005), a secure supply of energy resources is generally necessary but not sufficient for societal development. Sustainable societal development, however, requires a sustainable supply of energy resources, i.e. a secure supply that is readily and sustainably available in the long term at a reasonable cost and that can be utilized for all required tasks without causing negative societal impacts. Effective and efficient utilization of energy resources can also contribute to sustainable development.

The major problems and challenges concerning energy that the world is currently facing are:

i) Growing energy demand: as world populations grow (the annual population growth rate is currently around 2% worldwide and higher in many countries), the need for more and more energy is exacerbated (Dincer and Rosen, 2005; Omer, 2008). The figure below shows clearly this situation.

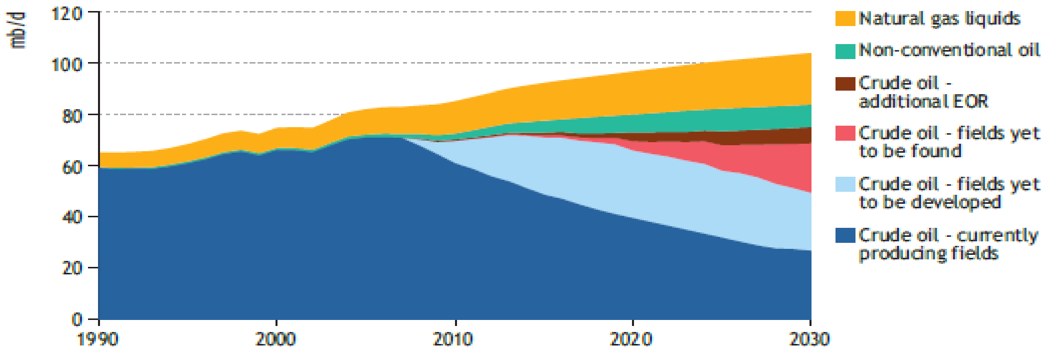
Figure III.2: World Population, Energy and Electricity Demand



Source: Omer (2008)

ii) Depletion of non-renewable energy sources: at the current rate of usage, taking into consideration population increases and higher consumption of energy by developing countries, oil resources, natural gas and uranium will be depleted within a few decades. As for coal, it may take two centuries or so (Omer, 2008). The following figure shows oil production in the past, the present and the future years until 2030.

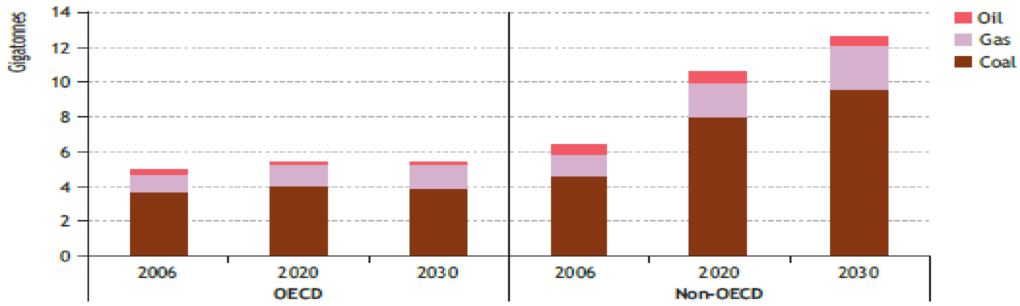
Figure III.3: World Oil Production by Source



Source: IEA (2008)

iii) Energy environmental impacts: energy processes, namely the burning of fossil fuels, lead to many environmental problems, including global climate change, acid precipitation, stratospheric ozone depletion and emissions of a wide range of pollutants, including radioactive and toxic substances (Dincer and Rosen, 2005). Next figure illustrates the CO_2 emissions problem associated with energy depletion highlighting an evident disparity between OECD and non-OECD countries.

Figure III.4: Energy-related CO_2 Emissions from Power Plants by Fuel and Region



Source: IEA (2008)

iv) Energy pricing that does not reflect real costs: many energy-resource prices have increased over the last couple of decades, in part to account for environmental costs, yet many suggest that energy prices still do not reflect actual societal costs (Dincer and Rosen, 2005).

v) Global disparity in energy consumption: the wealthy industrialized economies, with 25% of the world`s population are responsible for the consumption of 75% of the world`s energy supply (Dincer and Rosen, 2005; Omer, 2008). Energy poverty is stark in some countries and, without new policy initiatives, the number of people living without electricity (people exposed to health risks associated with the burning of fuelwood and charcoal for cooking) will actually rise in the outlook period. This problem is shown in the next figure, where 65% of the population without electricity is concentrated in only ten countries.

Figure III.5: Number of People without Access to Electricity

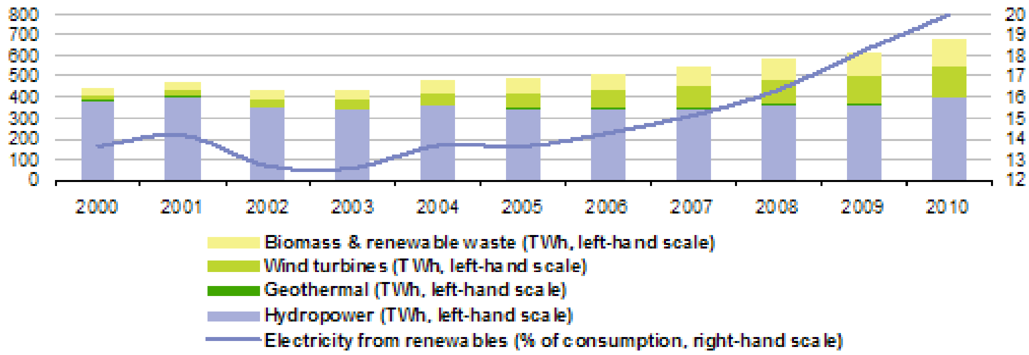
	Total population, 2006 (million)	Number of people without electricity access* (million)	(%)
Angola	16.6	14.6	88
Cameroon	18.2	14.2	78
Chad	10.5	10.1	97
Congo	3.7	2.9	78
Côte d'Ivoire	18.9	11.6	61
Equatorial Guinea	0.5	0.4	73
Gabon	1.3	0.9	70
Mozambique	21	18.6	89
Nigeria	144.7	76.6	53
Sudan	37.7	26.9	71
Total	273.1	176.9	65

* Most recent estimates.

Source: IEA (2008)

vi) Limited use of renewable energy resources and technologies: there is a clear dominance of non-sustainable and non-renewable energy resources and, despite being acknowledged that renewables provide a potential solution to the energy-resource scarcity, the statistics for the year of 2009 show that: the world relied on renewable sources for only 13.1% of its primary energy supply; renewables only accounted for 19.5% of global electricity generation; and only 3% of global energy consumption for road transport (IEA, 2013). In the specific case of the EU, the reality is very similar as the following figure shows: despite the increasing in the recent years, the contribution of renewables to the production of electricity is still very limited.

Figure III.6: Electricity Generated from RES, EU-27, 2000-2010



Source: Eurostat (2012).

These and other energy-related issues need urgently to be solved if humanity and society are to develop sustainably in the future. Renewable energy sources (RES) appear to provide a strong component of an effective sustainable solution and have the ability to contribute over the long term to achieve sustainable solutions to today`s energy problems.

According to Dincer and Rosen (2005), renewable energy sources and technologies are a key component of sustainable development for the following main reasons:

i) They generally cause less environmental impact than other energy sources. The variety of RES provides a flexible array of options for their use;

ii) They cannot be depleted. If used carefully in appropriate applications, RES can provide a reliable and sustainable supply of energy almost indefinitely. Also, they can help reduce the depletion of the world`s non-renewable energy sources;

iii) They favor system decentralization and local solutions that are somewhat independent of the national network, thus enhancing the flexibility of the system and providing economic benefits to small isolated populations;

iv) The small scale of the equipment involved often reduces the time required from initial design to operation, providing greater adaptability in responding to unpredictable growth and/or changes in energy demand;

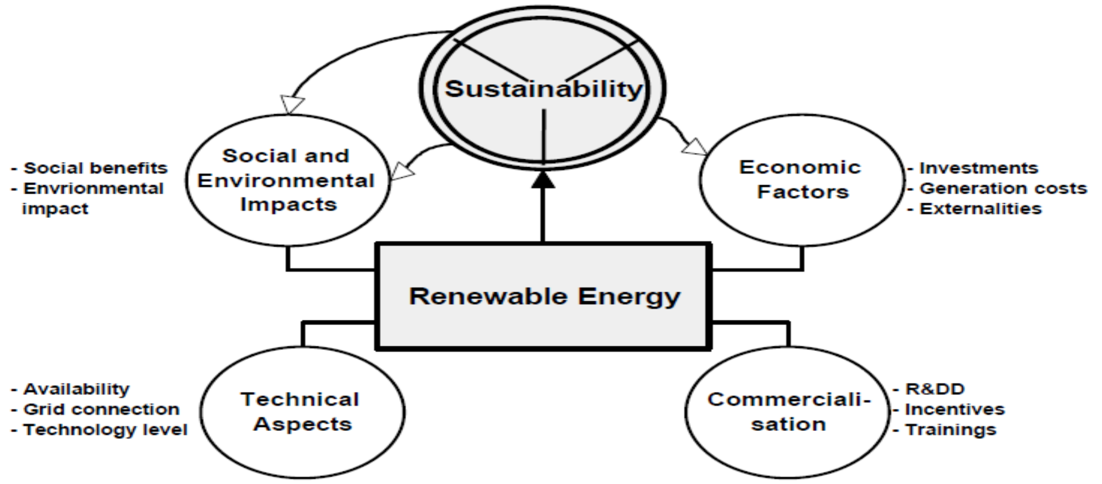
v) They are relatively independent of the cost of oil and other fossil fuels, which are projected to rise significantly over time. Thus, cost estimates can be made reliably for renewable energy systems;

vi) They are often advantageous in developing countries. In fact, the market demand for renewable energy technologies in developing nations will likely grow as they seek a better standard of living.

These reasons are strong enough to advocate the development of the RES. They may have some limitations, such as being regionally variable and sometimes intermittent, but these problems are often solvable and can be overcome.

Hui (1997) argues that, to seize the opportunities, a country should establish a renewable energy market and gradually build up the experience with the technologies. The barriers and constraints to the diffusion of renewables should be removed. The legal, administrative and financing procedure should be established to facilitate planning and application of renewable energy projects. Government could play a useful role in promoting renewable energy technologies by initiating surveys and studies to establish their potential in both urban and rural areas. The major considerations for developing renewable energy technologies, in which social and environmental impacts, economic factors, technical aspects and commercialization are considered as key issues in the debate of renewable energy sustainability are provided in the following figure.

Figure III.7: Considerations for Developing Renewable Energy Technologies



Source: Hui (1997).

In the study carried out by Hui (1997), several considerations are made to support the development of renewable energy technologies. According to the author, as the existing energy utilities play a key role in the adoption of renewable energy technologies, the utility strategy for integrating renewables should be reviewed. For instance, utility regulations should be framed to increase competitiveness and to facilitate the access of independent renewable energy production. The author also suggests different forms of support to new firms in the renewables market, namely financial incentives. It is important to get renewables into a reliable market at a competitive price and without disturbing local economies. Finally, education and training are considered as crucial factors in this process and a particular attention should be encouraged and reinforced regarding human resources with expertise in renewable energy technologies and energy research in this field.

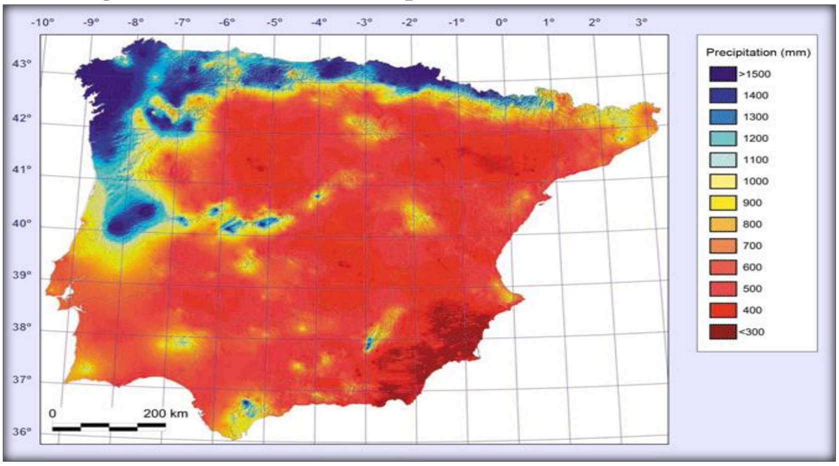
III.3. Renewables in Portugal: Current Status and Future Potential

Portugal's natural characteristics are particularly beneficial for the use of RES for electricity generation, presenting values well above the required minimum regarding to sun exposure, wind speed, river resources and forest area. In the next sections, we proceed to the description of the Portuguese potential and current situation regarding the use of different RES for electricity production. Moreover, we describe twelve power plants sited in different regions of continental Portugal. The selection of the following presented dams, wind farms (WFs), photovoltaic farms (PVFs) and forest biomass power plants (FBPPs) results from a selection based on the installations` relevance regarding its location, size and power generation. This detailed description results both from literature reviews and from an exhaustive field research, in which we visited the installations (both inside and outside) and conducted different CV questionnaires (a specific questionnaire was designed for each renewable) as in person interviews, allowing us to "listen" and understand the different perceptions and behaviours from the individuals living near these selected power plants.

III.3.1. Hydropower

Portugal is one of the European Union (EU) countries with the highest exploitable hydropower potential. One of the main drivers for this advantageous situation is the high rainfall that characterizes some areas of the country. The following figure presents the average annual precipitation map for the Iberian Peninsula, bringing out the strong influence exerted both by the Atlantic and by elevation. Annual precipitation is above 1500 mm for parts in northern Portugal, much of coastal Galicia and along the southern borders of the Pyrenees (Ninyerola *et al.*, 2005).

Figure III.8: Annual Precipitation in Iberian Peninsula



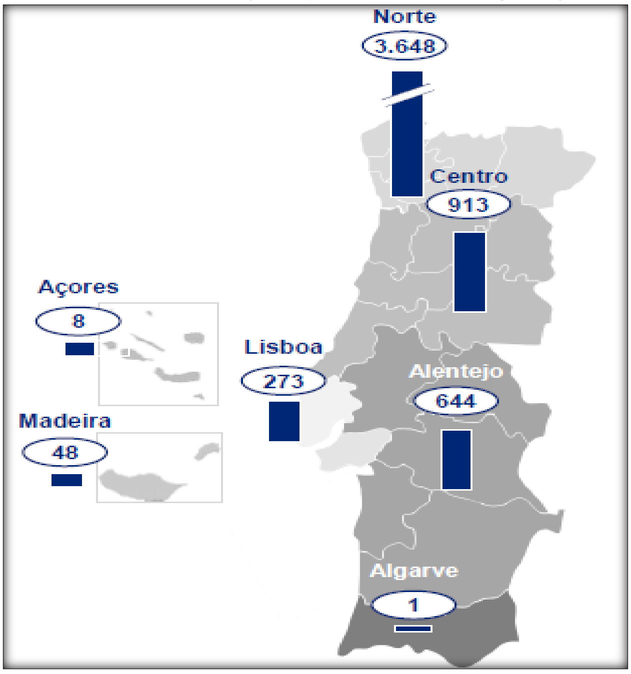
Source: Ninyerola *et al.* (2005)

Hydropower has traditionally played a significant role in Portugal' s power mix, and in recent years determinant steps were made in this sector with the approval by the Portuguese Government, in December 2007, of the National Programme of Dams with High Hydroelectric Potential (PNBEPH), and other projects, namely power reinforcement operations of several hydropower plants. The PNBEPH primarily aims to increase Portugal`s hydropower capacity and to exploit 70% of its hydropower potential.

If coupled with other initiatives for energy production from renewable sources, the PNEBPH is expected to achieve the 2020 target for renewable electricity, thereby contributing to reduce Portugal dependence on imported fuels and GHG emissions. Under this Programme, it was decided the construction of ten hydropower plants, representing a total potential capacity of approximately 1 100 MW and an estimated yearly gross electricity output of 1 630 GWh (OECD, 2011).

Between 2010 and 2013, the installed hydropower increased by about 13%. As shown in the figure below, about 2/3 of the installed hydropower in 2013 was concentrated in the North, followed by the Central region with about 16%. The Alentejo represented about 12% of the total power, knowing that almost 80% of that power concerns the Alqueva dam that doubled its power in 2012. Together the remaining regions accounted for only 6% of installed hydropower capacity (Deloitte, 2014).

Figure III.9: Distribution of Installed Hydropower in Portugal by NUTS II in 2013 (MW)



Source: Deloitte (2014)

<u>Portuguese Hydropower Plants Assessed</u>

We now present a detailed description of four hydropower plants: Picote (and the power reinforcement Picote II), Bemposta (and the power reinforcement Bemposta II), Aguieira, and Alqueva (and the power reinforcement Alqueva II). With distinct locations, sizes, installed power capacities and inserted in different social realities, these power plants provide a good sample of the current scenario of hydroelectricity in Portugal. During the months of June and October 2014, we developed a thorough research in the field, with the main purpose of increasing our knowledge not only on the technical issues of hydroelectricity, but above all on the local residents` welfare loss due to the activity of these power plants. To this end, we have conducted a contingent valuation (CV) survey through face- to- face interviews among the local communities in the surroundings of these four hydropower plants.

i) Picote Hydropower Plant

The Picote dam is located in the parish of Picote, near the village of Sendim, in the municipality of Miranda do Douro, district of Bragança, in the northeast of Portugal. This plant was built on the international water course of river Douro, downstream of the Miranda hydropower plant and upstream of the Bemposta hydropower plant. The Picote plant has a reservoir of 13,35 hm^3 of useful capacity and its area of influence covers the Portuguese municipality of Miranda do Douro and, in its left margin, spanish territory. The next two figures present, respectively, the exact location and a panoramic image of the Picote power plant.

Figure III.10: Location of Picote Dam

Source: Author`s elaboration

Figure III. 11: Panoramic Image of Picote Dam

Source: EDP:
http://www.a-nossa-energia.edp.pt/centros_produtores/fotos_videos.php?item_id=38&cp_type=he&section_type=fotos_videos

The Picote hydropower plant operates since 1958 and has an installed power of 195 MW (3 groups of 65 MW). This plant has recently been subject to a power reinforcement operation, being constructed a new underground plant with an installed power of 246 MW, known as Picote II. In this operation, EDP, the company owning these developments, invested a total of 140 million euros. The construction works began in March 2007 and ended in December 2011, giving temporary employment to 425 individuals (EDP, 2013). The next figure presents a panoramic image of Picote II plant.

Figure III.12: Panoramic Image of Picote II Plant

Source: EDP:
http://www.a-nossa-energia.edp.pt/centros_produtores/fotos_videos.php?item_id=85&cp_type=he&section_type=fotos_videos

Although a hydropower plant composition is not limited to its dam and reservoir (there are also turbines, alternators, transformers and pumps), we limit our analysis to these two components because the dam and the reservoir are the most visible parts of any hydropower plant. The table below presents the main technical characteristics of Picote and Picote II plants.

Table III.1: Technical Information of Picote and Picote II Plants

Picote	
Entry into service	1958
Water course	Douro
Type of exploitation	Run-of-water
Total installed power (MW)	195
Number of groups	3
Reservoir	
Hydrographic basin area (Km^2)	63 750
Useful capacity (hm^3)	13,35
Dam	
Type of dam	Vault double curvature
Maximum height (m)	100
Development of the crowning achievement (m)	139
Maximum capacity of discharge (m^3/s)	11 000
Producibility	
Annual average producibility (GWh)	866,6
Picote II	
Entry into service	2011
Static fall (m)	67
Total installed power (MW)	1x246
Average annual production (GWh)	244

Source: EDP:
http://www.a-nossa-energia.edp.pt/centros_produtores/info_tecnica.php?item_id=38&cp_type=he&section_type=info_tecnica
http://www.a-nossa-energia.edp.pt/centros_produtores/info_tecnica.php?item_id=85&cp_type=he&section_type=info_tecnica

ii) Bemposta Hydropower Plant

The Bemposta dam is located in the parish of Bemposta, municipality of Mogadouro, district of Bragança, in the northeast of Portugal. It was built on the international water course of the river Douro, downstream of the Picote plant, creating a reservoir with 20 hm^3 of useful capacity. Its area of influence covers, in the national territory, the municipalities of Miranda do Douro and Mogadouro, and, in its left margin, it covers Spanish territory. The next two figures present, respectively, the exact location and a panoramic image of the Bemposta plant.

Figure III.13: Location of Bemposta Dam

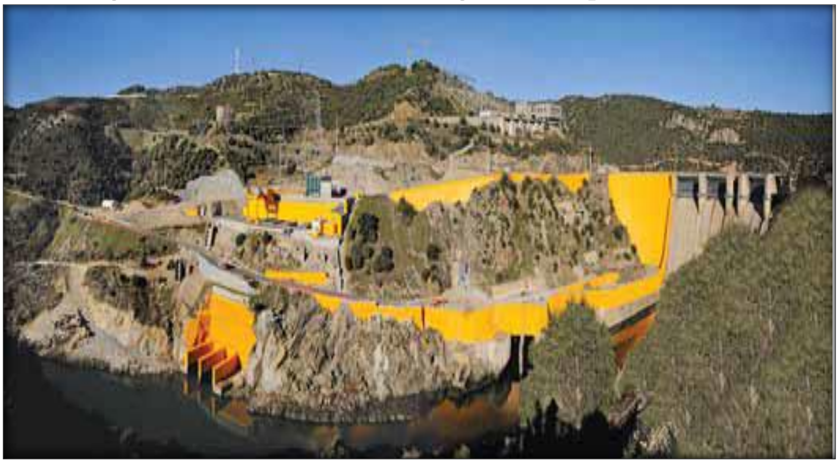
Source: Author`s elaboration

Figure III.14: Panoramic Image of Bemposta Dam

Source: EDP:
http://www.a-nossa-energia.edp.pt/centros_produtores/fotos_videos.php?item_id=10&cp_type=he&section_type=fotos_videos

The Bemposta hydropower plant, with an installed power of 240 MW (3 groups of 80 MW), began operating in 1964. Recently, taking advantage of the existing hydraulic infrastructures, an investment of 132 million euros was made in strengthening the installed power with the construction of a new central of 191 MW, known as Bemposta II. Its construction works began in January 2008 and almost four years later, more specifically in December 2011, Bemposta II began operating. It is also important to highlight that in this project, EDP (the owning company) intended to bring art into the dam, in order to mitigate its negative impacts on a landscape of recognized unique aesthetic value (Alto Douro wine region was considered by UNESCO, on 2001, World Heritage in the category of cultural landscape). This art project had a total cost of 150 thousand euros and was signed by the architect Pedro Cabrita Reis who entitled the project as “Of the Colour of the Flowers”. As seen in the figure below, there is a predominance of the yellow colour in the dam multiple surfaces, which, according to the author, is an allusion to the colour of the *maia*, a kind of giesta that covers the surrounding mounds from the end of May (EDP, 2013).

Figure III.15: Panoramic Image of Bemposta II Plant



Source: EDP:
http://www.a-nossa-energia.edp.pt/centros_produtores/fotos_videos.php?item_id=83&cp_type=he&section_type=fotos_videos

The table below presents the main technical characteristics of Bemposta and of Bemposta II plants.

Table III.2: Technical Information of Bemposta and of Bemposta II Plants

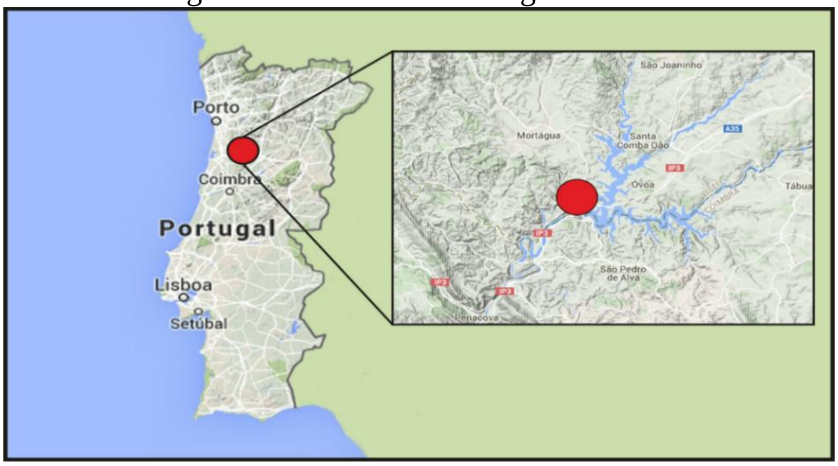
Bemposta	
Entry into service	1964
Water course	Douro
Type of exploitation	Run-of-water
Total installed power (MW)	240
Number of groups	3
Reservoir	
Hydrographic basin area (Km^2)	63 850
Useful capacity (hm^3)	20
Dam	
Type of dam	Arch slightly gravity
Maximum height (m)	87
Development of the crowning achievement (m)	297
Maximum capacity of discharge (m^3/s)	11 500
Producibility	
Annual average producibility (GWh)	924,1
Bemposta II	
Entry into service	2011
Static fall (m)	65
Total installed power (MW)	1x191
Average annual production (GWh)	134

Source: EDP:
http://www.a-nossa-energia.edp.pt/centros_produtores/info_tecnica.php?item_id=10&cp_type=he&section_type=info_tecnica
http://www.a-nossa-energia.edp.pt/centros_produtores/info_tecnica.php?item_id=83&cp_type=he&section_type=info_tecnica

iii) Aguieira Hydropower Plant

The Aguieira dam is located in the parish of Travanca do Mondego, municipality of Penacova, district of Coimbra, in the center of Portugal. It was built on the water course of the river Mondego, about 1.7 km downstream of the mouth of the river Dão. Creating a reservoir of 216 hm^3 of useful capacity, its zone of influence includes the municipalities of Penacova, Mortágua, Santa Comba Dão, Tábua, Tondela and Carregal do Sal. In the following two figures are presented, respectively, the exact location and a panoramic image of the Aguieira plant.

Figure III.16: Location of Aguieira Dam



Source: Author`s elaboration

Figure III.17: Panoramic Image of Aguieira Dam

Source: EDP:
http://www.a-nossa-energia.edp.pt/centros_produtores/fotos_videos.php?item_id=4&cp_type=he&section_type=fotos_videos

The Aguieira hydropower plant has an installed power of 336 MW and operates since 1981. Its main technical information are presented in the table below. It is also relevant to highlight that this dam, together with the Raiva dam (downstream), is part of a plan to take advantage of the river Mondego for multiple purposes. In addition to energy production, this plan aims to contribute to the regularization of the solid and liquid caudal by dampening the winter floods and summer droughts, and the creation of an irrigation system of the Baixo Mondego. The operation management of the Aguieira dam belongs to the company EDP (EDP, 2013).

Table III.3: Technical Information of Aguieira Plant

Entry into service	1981
Water course	Mondego
Type of exploitation	Reservoir
Total installed power (MW)	336
Number of groups	3
Reservoir	
Hydrographic basin area (Km^2)	3 113
Useful capacity (hm^3/GWh)	216 / 39,2
Dam	
Type of dam	Multiple vaults
Maximum height (m)	89
Development of the crowning achievement (m)	400
Maximum capacity of discharge (m^3/s)	2 080
Producibility	
Annual average producibility (GWh)	209,9

Source: EDP:
http://www.a-nossa-energia.edp.pt/centros_produtores/info_tecnica.php?item_id=4&cp_type=he&section_type=info_tecnica

iv) Alqueva Hydropower Plant

The Alqueva dam adopts the name of the parish covered by its right bank, belonging to the municipality of Portel, district of Évora, in the southeast of Portugal. It was built in the course of the Guadiana river water, creating the largest water reservoir in the country and the largest artificial lake in Europe, with its 25 000 hectares of flooded surface and over 1 100 km of margins covering the Portuguese municipalities Moura, Portel, Mourão, Reguengos de Monsaraz and Alandroal and on Spanish territory, the municipalities of Olivenza, Cheles, Alconchel and Villanueva del Fresno. It is important to note that the construction of the Alqueva power plant led to the submersion and the consequent translocation of the village of Luz (municipality of Mourão), which, lying at a quota below 152, was totally submerged by the big lake. In the following two figures are presented, respectively, the exact location and a panoramic image of the Alqueva plant.

Figure III.18: Location of Alqueva Dam

Source: Author`s elaboration

Figure III.19: Panoramic Image of Alqueva Dam

Source: EDP:
http://www.a-nossa-energia.edp.pt/centros_produtores/fotos_videos.php?item_id=5&cp_type=he&section_type=fotos_videos

The Alqueva hydropower plant is integrated in the EFMA, a "multi-purpose" enterprise for Alqueva, and its exploitation is a responsibility of the company EDP. The long period between the first studies and construction of the dam, about 50 years, made the "Alqueva" almost a myth among the population. After several years of advances and retreats, the Alqueva building works started in 1998 and were completed in January 2002, starting to operate in the following month. The Alqueva hydropower plant, with an installed power of 260 MW (2 groups of 130 MW) has been subject to a power reinforcement operation and, since December 2012, a new central known as Alqueva II is operating with 260 MW of additional power. The Alqueva II power enhancement deployed on the right bank of the river Guadiana, involves the construction of a new hydraulic circuit and a new central, excavated in the open, equipped with two reversible generators. Each has the maximum shaft power of 130 MW, which allows doubling of the current installed capacity. With a power of 520 MW, the central Alqueva is the second largest production center of the country, only dethroned by the central Alto Lindoso with 630 MW (EDP, 2013). The following figure presents a panoramic image of the Alqueva II plant.

Figure III.20: Panoramic Image of Alqueva II Plant

Source: EDP:
http://www.a-nossa-energia.edp.pt/centros_produtores/fotos_videos.php?item_id=82&cp_type=he&section_type=fotos_videos

The main technical characteristics of Alqueva and of Alqueva II plants are summarized in the table below.

Table III.4: Technical Information of Alqueva and of Alqueva II Plants

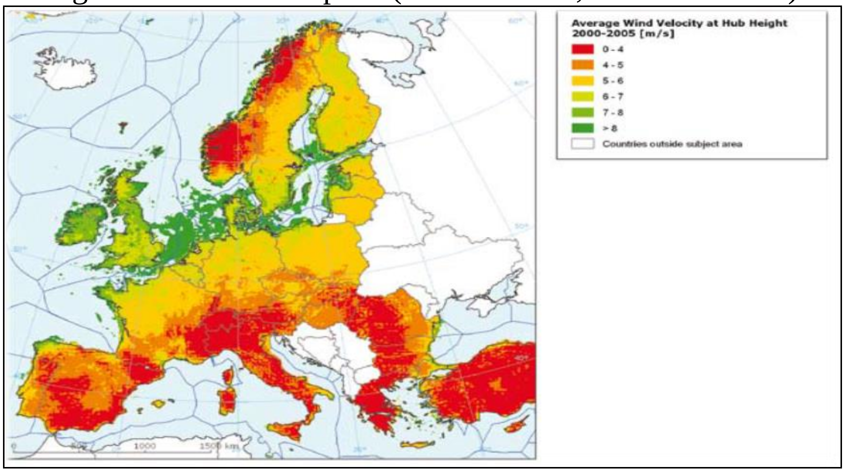
Alqueva	
Entry into service	2002
Water course	Guadiana
Type of exploitation	Reservoir
Total installed power (MW)	260
Number of groups	2
Reservoir	
Hydrographic basin area (Km^2)	55 000
Useful capacity (hm^3)	3 150
Dam	
Type of dam	Vault double curvature
Quota crowning achievement	154
Development of the crowning achievement (m)	458
Maximum height above the foundation (m)	96
Producibility	
Annual average producibility (GWh)	269
Alqueva II	
Entry into service	2012
Static fall (m)	72
Total installed power (MW)	2x130
Average annual production (GWh)	470

Source: EDP:
http://www.a-nossa-energia.edp.pt/centros_produtores/info_tecnica.php?item_id=5&cp_type=he&section_type=info_tecnica
http://www.a-nossa-energia.edp.pt/centros_produtores/info_tecnica.php?item_id=82&cp_type=he&section_type=info_tecnica

III.3.2. Wind Power

Wind is extremely valuable as an energy resource. The following figure presents a map with different wind speed regions estimated for different topographic conditions. The wind speed above which commercial exploitation can take place varies considerably between different regions: although countries such as Scotland clearly stand out for having an exceptional potential, we observe that every European county has a substantially technically and economically exploitable resource.

Figure III.21: Wind Speed (80 m onshore, 120 m offshore)

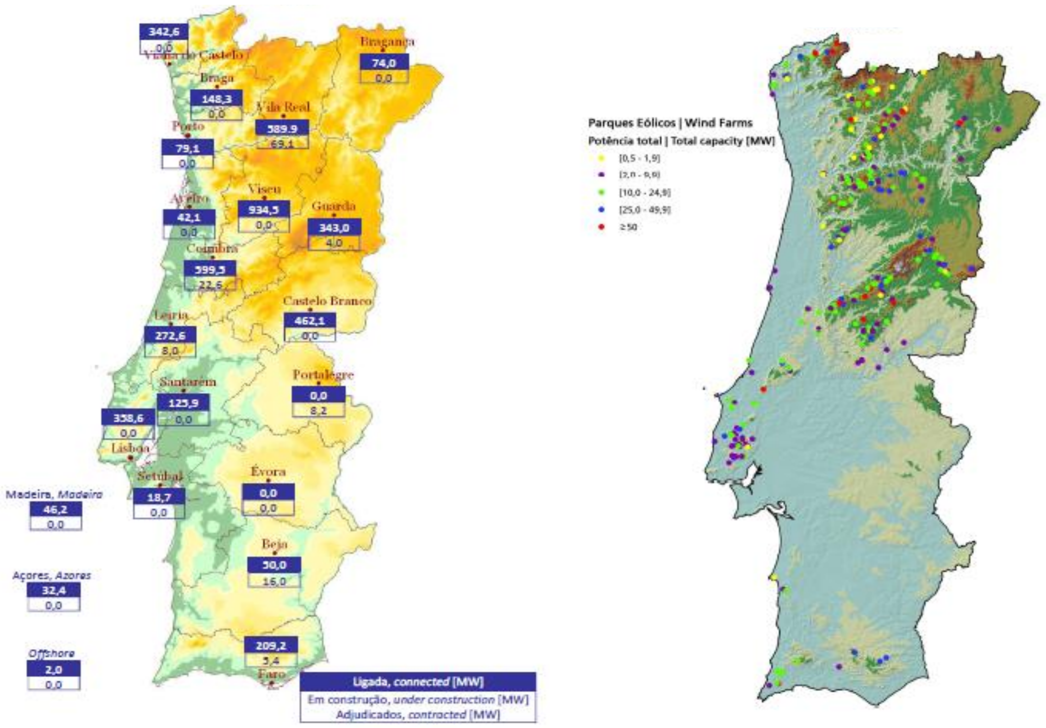


Source: EEA (2008)

Due to its geographic and geomorphologic characteristics favouring the production of wind energy, along with high investment levels on this energy source, Portugal, a small European Union (EU) country with about 10 million inhabitants, is placed amongst the top ten countries in the world with the highest cumulative wind power capacity at the end of 2013 (EWEA, 2014). In addition, while wind energy investments at the EU level are mostly offshore, all wind energy to date in Portugal is produced onshore (Azau, 2011). It is also important to highlight the important contribution of two essential tools, created with the purpose of developing an efficient assessment of wind power potential in Portugal: the database on wind power potential - EOLOS2.0, which provides information on the physical and energy characteristics of the atmospheric flow in 57 locations, on mainland Portugal; and the VENTOS software, which is used for computational simulation purposes of the behaviour of wind flow on complex terrains, whether or not arborized (DGEG, 2007).

Between 2010 and 2013, wind power in Portugal grew 812 MW (21% increase), reaching an installed capacity of 4728,5 MW. Wind farms are particularly concentrated in the Centre and North of the country, standing out the districts of Viseu, Coimbra, Vila Real, Lisboa, Guarda, Viana do Castelo, Leiria and Faro with the highest installed rated power, all presenting values above 200 MW by December 2013 (INEGI and APREN, 2013).

Figure III.22: Location and Installed Power of Wind Farms in Portugal



Note: The Portuguese offshore wind installed capacity consists on the concept demonstration project Windplus. Source: INEGI and APREN (2013)

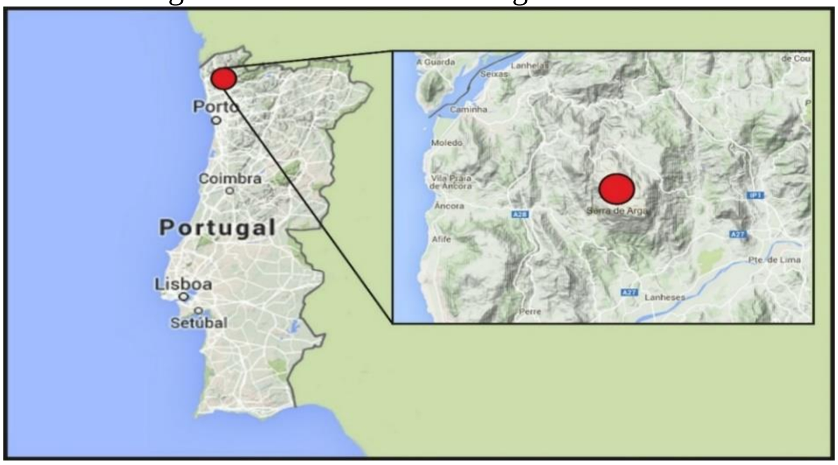
<u>Portuguese Wind Farms Assessed</u>

We now describe in detail three WFs: Arga, Negrelo & Guilhado (both in the north of Portugal), and Lousã II (in the centre of Portugal). Besides having different locations, these facilities differ in size, installed power capacity and are surrounded by different communities with specific social and cultural characteristics. During the month of May 2014, we have conducted a deep research among the residents in the local communities near these three WFs, with the application of a CV survey through face to face interviews.

i) Arga Wind Farm

The Arga wind farm, operating since April 2006, is located in the Serra de Arga, in the parishes of Arga de Cima and Arga de Baixo, municipality of Caminha, district of Viana do Castelo, at an average altitude of 750 meters. This wind farm has an installed capacity of 36 MW spread over 12 wind turbines Vestas model V90 with 3.0 MW of unitary potency, and with 80 meters height of the rotor axis. The construction and exploration of the Arga wind farm is the responsibility of the Portuguese company Empreendimentos Eólicos do Vale do Minho, S.A. (EEVM). The next two figures present, respectively, the exact location and a panoramic image of the Arga plant.

Figure III.23: Location of Arga Wind Farm



Source: Author`s elaboration

Figure III.24: Panoramic Image of Arga Wind Farm

Source: EEVM:
http://eevm.pt/index.php?option=com_content&view=article&id=337&Itemid=289

The table below presents the main characteristics of the Arga power plant.

Table III.5: Technical Information of Arga Plant

Number of wind turbines	12
Characteristics of wind turbines	Vestas V90
Wind turbines unitary power	3.0 MW
Installed rated power	36 MW
Forecast generating capacity	71.6 GWh per year
Operational in	April 2006
Developer	Empreendimentos Eólicos do Vale do Minho, S.A.

Source: DGEG (2007); APREN and INEGI: http://e2p.inegi.up.pt/index.asp#Tec3

ii) Lousã II Wind Farm

The Lousã II wind farm, with an installed capacity of 50 MW, is located in the Alto do Trevim, in the municipality of Lousã, district of Coimbra. This wind farm began operating in November 2008 (in full in early 2009) and aggregates 20 wind turbines Nordex model N90 - R80 with 2.5 MW of unitary potency. The exploration of the Lousã II wind farm belongs to the company Parque Eólico de Trevim, Lda. (Group Iberwind). The following two figures present, respectively, the exact location and a panoramic image of the Lousã II plant.

Figure III.25: Location of Lousã II Wind Farm

Source: Authors` elaboration

Figure III.26: Panoramic Image of Lousã II Wind Farm

Source: Iberwind:
http://www.iberwind.com/pt/parques/20/

The table below presents the main characteristics of the Lousã II power plant.

Table III.6: Technical Information of Lousã II Plant

Number of wind turbines	20
Characteristics of wind turbines	Nordex N90-R80
Wind turbine unitary power	2.5 MW
Installed rated power	50 MW
Forecast generating capacity	141 GWh per year
Operational in	November 2008
Developer	Parque Eólico de Trevim, Lda.

Source: Iberwind: http://www.iberwind.com/pt/parques/20/
APREN and INEGI: http://e2p.inegi.up.pt/index.asp#Tec3

iii) Negrelo & Guilhado Wind Farm

The Negrelo & Guilhado wind farm, with an installed capacity of 22,3 MW, is located in the Serra da Padrela, in the parishes of Soutelo de Aguiar and Vila Pouca de Aguiar, both in the municipality of Vila Pouca de Aguiar, district of Vila Real. This wind farm started operating in March 2009 with 10 wind turbines Enercon model E82 with 2.0 MW of unitary potency to which were added, in December 2011, an additional wind turbine Enercon model E82 with 2.3 MW of unitary potency. The construction of the Negrelo and Guilhado wind farm was promoted by ENERNOVA – Novas Energias, S.A., a company of the Group EDP Renováveis. The following two figures present, respectively, the exact location and a panoramic image of the Negrelo e Guilhado plant.

Figure III.27: Location of Negrelo & Guilhado Wind Farm

Source: Author`s elaboration

Figure III.28: Panoramic Image of Negrelo & Guilhado Wind Farm

Source: APREN and INEGI:
http://e2p.inegi.up.pt/index.asp#Tec3

The table below presents the main characteristics of the Negrelo e Guilhado power plant.

Table III.7: Technical Information of Negrelo & Guilhado Plant

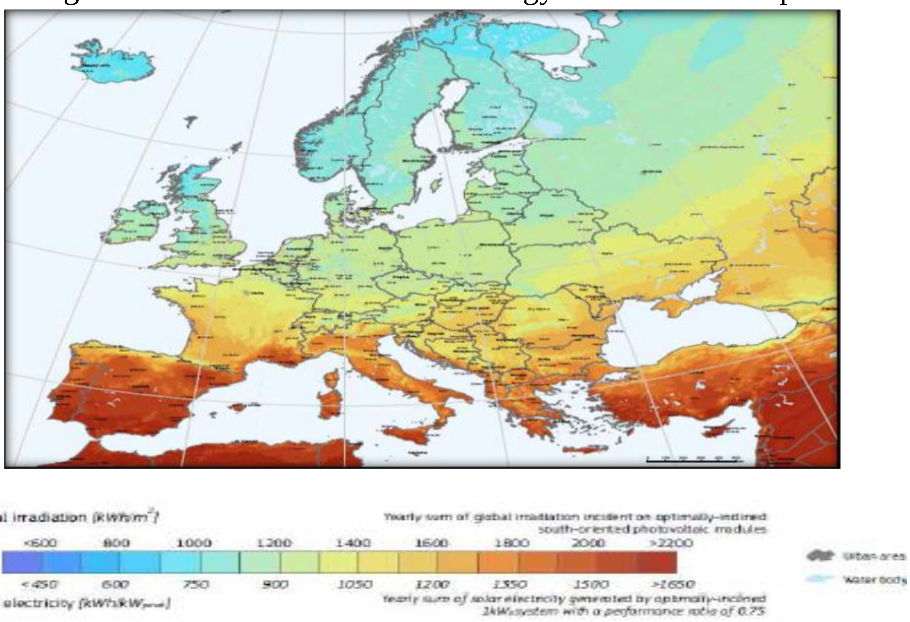
First stage	
Began operating	March 2009
Number of wind turbines	10
Characteristics of wind turbines	Enercon E82
Wind turbines unitary power	2.0 MW
Installed rated power	20 MW
Forecast generating capacity	53 GWh per year
Second stage (equipment increase)	
Began operating	December 2011
Additional wind turbines	1
Characteristics of the wind turbine	Enercon E82
Wind turbine unitary power	2.3 MW
Additional installed rated power	2,3 MW
Developer	Enernova – Novas Energias, S.A.

Source: APREN and INEGI: http://e2p.inegi.up.pt/index.asp#Tec3

III.3.3. Photovoltaic Power

The Sun annually provides to the atmosphere, a huge amount of energy corresponding to about 10 000 times the world energy consumption observed during the same period. In Portugal, the available potential is quite considerable, being one of the European countries with better conditions for exploitation of this resource. The average annual number of hours of sun ranges between 2200 and 3000 on the mainland, and between 1700 and 2200, respectively, in the Azores and Madeira (DGEG, 2014).

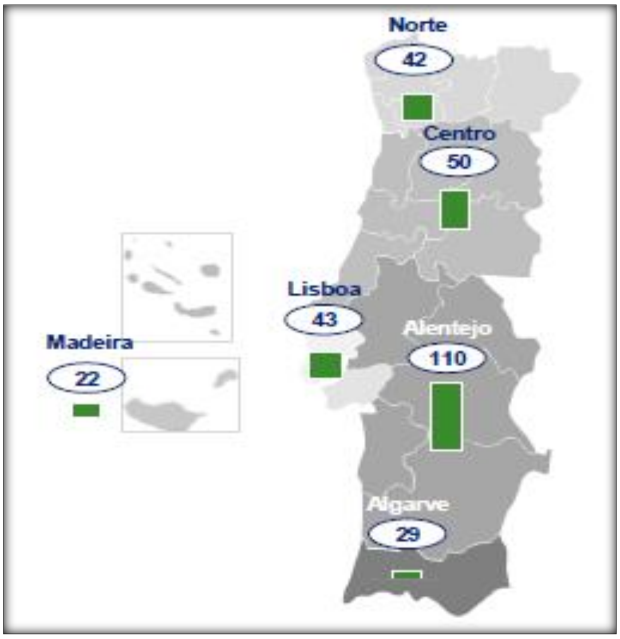
Figure III.29: Solar Photovoltaic Energy Potential in Europe



Source: DGEG (2010)

Despite its high potential, photovoltaic (PV) electricity generation still is underexplored in Portugal, with a modest implementation in the country until very recently. Between 2010 and 2013, there was a significant progress in the exploitation of this RES, with an increase of 122% of the installed PV power. As presented in the figure below, in 2013, about 37% of the installed PV power was concentrated in the Alentejo region, followed by the Central region with about 17%. The remaining regions together accounted for about 46% of installed PV capacity (Deloitte, 2014).

Figure III.30: Distribution of Installed Solar Photovoltaic Power in Portugal by NUTS II in 2013 (MW)



Source: Deloitte (2014)

This recent growth has been particularly important in contributing to demarcate the Baixo Alentejo as a place of reference of these technologies in Portugal. Unlike the mountainous regions of central and northern Portugal where most WFs are installed, the physical conditions of the Alentejo are less favourable to the installation of wind generators, but, on the other hand, they are quite favourable for the deployment of PVFs, due to its excellent sun exposure. Currently, the district of Beja has 13 of the 21 PVFs installed in the national territory. Moreover, being Alentejo a very inner region of the country, with some particularly problems associated (low population density, an aging rate above the national average and a high unemployment rate), the construction of these PV facilities represent a potential leverage to the region`s development (Junqueira *et al.*, 2013).

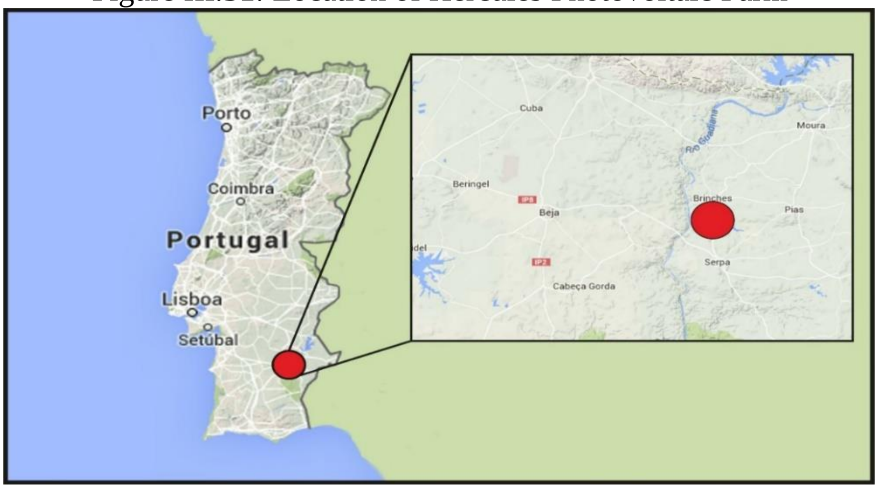
. Portuguese Photovoltaic Farms Assessed

Next we describe three PVFs installed in Alentejo: Hércules, Amareleja and Ferreira do Alentejo. Although installed in the same region of Portugal, these facilities operate with different technologies, occupy different areas of land and have distinct installed power capacities. Regarding the social involvement, our research in the field showed there were no major differences between the three PVFs. During May 2014, we conducted a CV survey among the residents of the local communities in the surroundings of these three installations, which allowed us to have a deeper and more personal perception of how the wellbeing of these individuals is daily affected by the activity of these plants.

i) Hércules Photovoltaic Farm

This PV power station is located in southern Portugal, 200 km southeast of Lisbon, in the agricultural region of Alentejo, more precisely in the parish of Brinches, municipality of Serpa. At the time of its inauguration, in 2007, it was the first large PVF to be installed in the country, generating enough electricity to power up to 8,000 homes. It occupies an area of 60 hectares, among olive trees on hillside pasture, with the concern of maintaining farmland productivity. Furthermore, panels were mounted two meters off the ground, allowing sheep to graze on the grass below (Maso, 2007; DGEG, 2007; GE Energy Financial Services, 2007). The following two figures present, respectively, the exact location and a panoramic image of the Hércules plant.

Figure III.31: Location of Hércules Photovoltaic Farm



Source: Author`s elaboration

Figure III.32: Panoramic Image of Hércules Photovoltaic Farm

Source: Maso (2007)

After eight months of construction, the project began feeding Portugal`s electricity grid in January 2007. GE Energy Financial Services owns the facility, Power Light Corporation designed the plant PowerTracker system, and Catavento, S.A., a major Portuguese renewable energy company, developed the project and is providing management services. The facility consists of a ground-mounted PV system that uses silicon solar cells to convert sunlight directly into energy. The use of the "PowerLight PowerTracker System", following the sun as it moves across the sky throughout the day, increases the system`s efficiency by permitting more than 200 kWp to be controlled by a single motor with a rated power of only 0,5 KW (Maso, 2007; DGEG, 2007; GE Energy Financial Services, 2007). The table below presents the main characteristics of the Hércules power plant.

Table III.8: Technical Information of Hércules Plant

Technology	PowerLight PowerTracker System
Installed rated power	11 megawatts (MWp)
Expected annual electricity generation	> 18 GWh
Equivalent consumption	8 000 homes
Modules (PV panels)	52 000
Start of construction work	May 2006
Grid connection	Completed in January 2007
Area occupied by power station	60 hectares

Source: Maso (2007); DGEG (2007); GE Energy Financial Services (2007)

ii) Amareleja Photovoltaic Farm

This PV plant is installed in the small parish of Amareleja, in the municipality of Moura, one of the most inner districts of Portugal, located on the border with Spain and in the right bank of the river Guadiana. The Amareleja parish is one of the largest of Moura, with 2,564 inhabitants and has the particularity of having the highest sun exposure of the country, a determinant factor in the sitting decision of the project (Junqueira *et al.*, 2013). The following two figures present, respectively, the exact location and a panoramic image of the Amareleja plant, in which is evident its large dimension, occupying a total of 250 hectares of land.

Figure III.33: Location of Amareleja Photovoltaic Farm

Source: Author`s elaboration

Figure III.34: Panoramic Image of Amareleja Photovoltaic Farm

Source: ACCIONA:
http://www.acciona-energia.com/activity_areas/solar_photovoltaic/installations/plantaamaraleja/amareleja-plant.aspx?id=2&desde=

The Amareleja PV plant was considered at the time of its inauguration, in 2008, the world`s biggest PV plant, producing enough clean energy to supply around 30,000 homes a year. This facility is owned and operated by ACCIONA, a Spanish multinational company with a prominent position in the area of the renewables. Despite having created 350 jobs during the plant construction, its operation only requires 15 employees. With the aim of adding value to the local community, the initial project also foresaw the construction and operation of a solar panel manufacturing plant to be installed on the Tecnopolo of Moura industrial property. However, what was actually built was a solar panel assembly plant, which imports all the panel components from China. This company, owned by the Spanish group Fluitecnik, was responsible for employing 100 workers, but since the middle of 2012 it has stopped producing. Also with the purpose to develop the local community, the company owning the Amareleja plant set up a 3 million euros social fund to foster development initiatives linked to renewable energy sources in areas such as R&D (a research laboratory), vocational training, community awareness, and support for microgeneration projects (DGEG, 2007; Delicado and Junqueira, 2013; Junqueira *et al.*, 2013). The table below presents the main characteristics of the Amareleja power plant.

Table III.9: Technical Information of Amareleja Plant

Technology	Photovoltaic solar with azimuth tracking
Installed rated power	45,78 megawatts (MWp)
Expected annual electricity generation	93 GWh
Equivalent consumption	30 000 homes
Modules (PV panels)	262 080 (104 x 2 520)
Start of construction work	November 2007
Grid connection	Completed in December 2008
Area occupied by power station	250 hectares

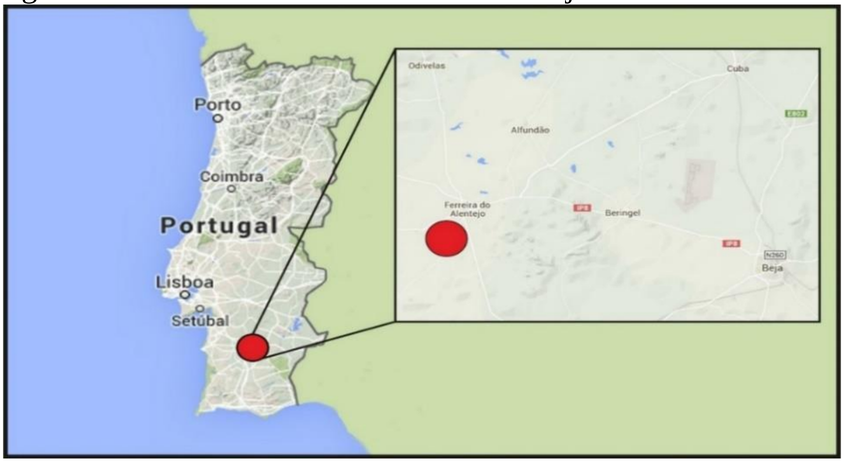
Source: ACCIONA:
http://www.acciona-energia.com/activity_areas/solar_photovoltaic/installations/plantaamaraleja/amareleja-plant.aspx?desde=

In the Amareleja power plant, 2,520 trackers follow the sun across the sky to optimize energy capture. Each tracker is associated with 104 modules used for capturing energy from the sun`s rays. The direct current generated by the modules is converted into alternate current by 70 inverters (each inverter receives energy from 36 trackers). In the transformer centers, the voltage of the electricity is raised from 0.22 to 20 kV. In order that the energy produced can be injected and transmitted through the grid to the points of consumption, the voltage is raised from 20 kV to 60 kV in the plant substation. All of these processes are supervised in the control center.

iii) Ferreira do Alentejo Photovoltaic Farms

In Ferreira do Alentejo, a Portuguese municipality in the district of Beja, in Alentejo, we can find more than one PV power plants built and operated by distinct companies. In the following two figures, we present, respectively, the exact location and a panoramic image of some of the PV plants installed in the municipality of Ferreira do Alentejo.

Figure III.35: Location of Ferreira do Alentejo Photovoltaic Farms



Source: Author`s elaboration

Figure III.36: Panoramic Image of Ferreira do Alentejo Photovoltaic Farms

Source: GENERG:
http://www.generg.pt/pt/portfolio/energia-solar/

Net Plan, a Portuguese renewable energy company, was the first to invest in this municipality, more specifically in the parish of Ferreira do Alentejo, with a PV project, including the construction of a group of five small plants. This project involved an investment of 7,4 million euros with the purpose of generating electricity for a period of

20 years. The installation of the PV plants, with a total of 43 000 PV panels and a power of 1,8 megawatts, began in October 2007 and was conducted in a phased way, so that that the first two plants being built started to produce and to inject energy into the national grid once completed its construction. In May 2009, the process was successfully ended and at that time all the five PV plants were fully functioning. It should also be noted that the used PV panels were built in a factory installed in the municipality of Oliveira do Bairro, in the district of Aveiro, and owned by the company Solar Plus, of which Net Plan is one of the Portuguese shareholders (Net Plan, 2011).

Located in an area of 40 hectares west of the town of Ferreira do Alentejo, there is another PV plant operating since September 2009. With an installed capacity of 10 megawatts, this PV plant uses 45, 440 polycrystalline silicon panels, with a peak power of 230 W, installed on single axis trackers. This is a project developed by Tecneira, a Portuguese engineering company dedicated to the exploitation of natural resources for generating electricity (http://en.tecneira.com/Ambiente-gua-e-Saneamento).

Finally, a third PV plant, covering an area of 58 hectares in the municipality of Ferreira do Alentejo, was built by the Portuguese Group Generg and is operating since December 2009. This project, with a total installed capacity of 12 megawatts and using 64 000 polycrystalline silicon modules, produces 21 GWh of electricity each year. This PV plant has the particularity of being the first in Portugal and one of the first five in the world to be awarded with the German TÜV Rheinland certification which attests the quality of the work, equipment and operation (Generg Group, 2012).

The table below presents the main technical characteristics of these PV power plants.

Table III.10: Technical Information of Ferreira do Alentejo Plants

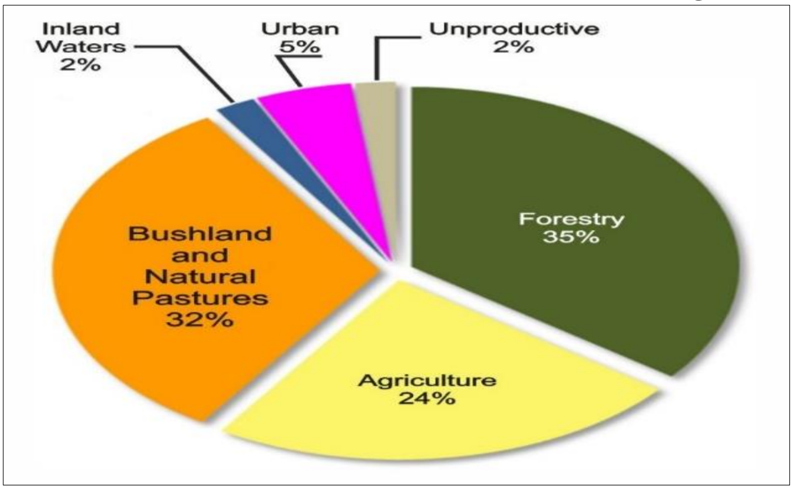
Companies	Net Plan	Tecneira	Generg
Technology	Photovoltaic panels Thin Film	Polycrystalline silicon panels, with a peak power of 220W, installed on single axis	Polycrystalline silicon panels, thin film CIGS and high concentration PV solar power
Installed rated power	1,8 MWp	10 MWp	12 MWp
Expected annual electricity generation	3 100 MWh	18,9 GWh	21 GWh
Equivalent consumption	n.a.	7 300 homes	9 000 homes
Modules (PV panels)	43 000	45 440	64 000
Completed grid connection	May 2009	September 2009	December 2009
Area occupied	5 hectares	31 hectares	58 hectares

Source: Generg Group (2012); INENERGI (2011); Net Plan (2011);
Tecneira: http://en.tecneira.com/Ambiente-gua-e-Saneamento

III.3.4. Forest Biomass Power

The Portuguese forest occupies 3,15 million hectares, representing 35,4 % of the national territory, a percentage that places Portugal in the average of the EU 27 countries (37,6%) Following are the bushland and natural pastures (32%), agriculture (24%), and the remaining 9% of the territory are urban areas, unproductive land and inland waters. Regarding the forest area, the dominant species are the eucalyptus (26%), followed by cork oak (23%) and maritime pine (23%) (ICNF, 2013). These figures are strong enough to justify the relevance of the use of forest biomass as a fuel for electricity generation.

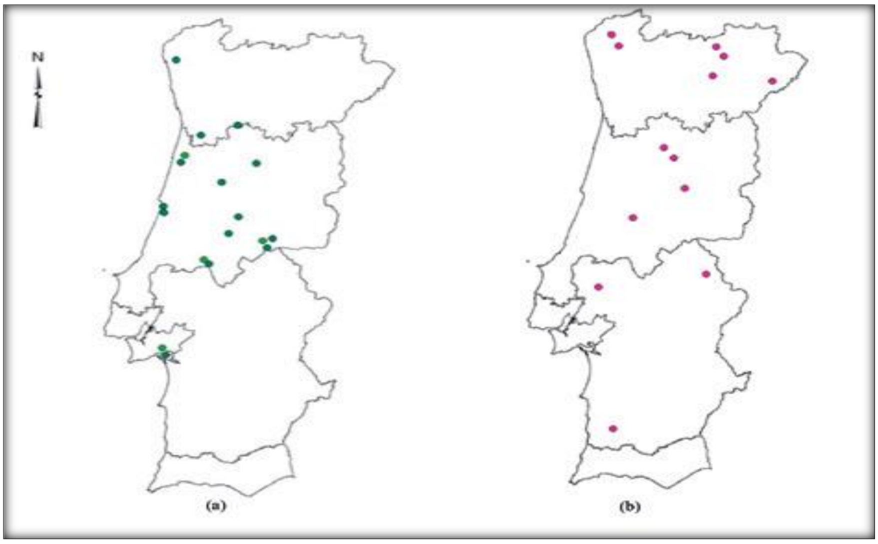
Figure III.37: Land Uses Distribution in Continental Portugal for 2010



Source: ICNF (2013)

In 2005 there were only 2 thermoelectric power plants operating and using exclusively forest biomass: the Mortágua plant, in the municipality of Mortágua, and the Centroliva plant, in the municipality of Vila Velha de Ródão. In the meantime, an important incentive was done in 2006, when the Portuguese government launched a program to increase the installed capacity for electricity production through forest biomass, focused on the construction of 15 new power plants, out of which 12 were to be located in the North and Centre of Portugal. These locations were selected taking into account the forest biomass availability and the structural risk of fire. Along with the purpose of increasing the quota of the renewables in the electricity generation mix, this program also intended to promote the development of harvesting forest residues. However, the results were not as expected: of the 15 power plants initially proposed to be built until 2010, 2 plants were definitely eliminated of the program, 11 plants are still in licensing process, and only 2 power plants are already operating. The failure of this program is a result of several factors, namely: lack of consensus among stakeholders regarding the location of some plants; high costs of raw materials; problems of supply, logistics and availability of raw materials; excessive bureaucracy in the process and, more recently, insufficient financing from the banks. These were the main reasons that made the proposed plants not attractive enough for the potential investors Nevertheless, outside the scope of this program, between 2007 and 2009, successfully initiatives have been developed, resulting in the implementation of 5 new forest biomass power plants, with a capacity of 78 MVA. Currently, there are 10 thermoelectric plants and 8 cogeneration plants operating in Portugal, corresponding to an installed capacity of 273 MVA. Moreover, the concretization of the implementation process of the 13 planned FBPPs will contribute with more 95 MVA of installed capacity (Enersilva, 2007; Freitas, 2009; CAM, 2013; Lopes *et al.*, 2013). The following figure shows the spatial distribution of current FBPPs, as well as those that are currently planned.

Figure III.38: Location of the Existing (a) and Planned (b) Forest Biomass Power Plants in Portugal.



Source: Lopes *et al.* (2013)

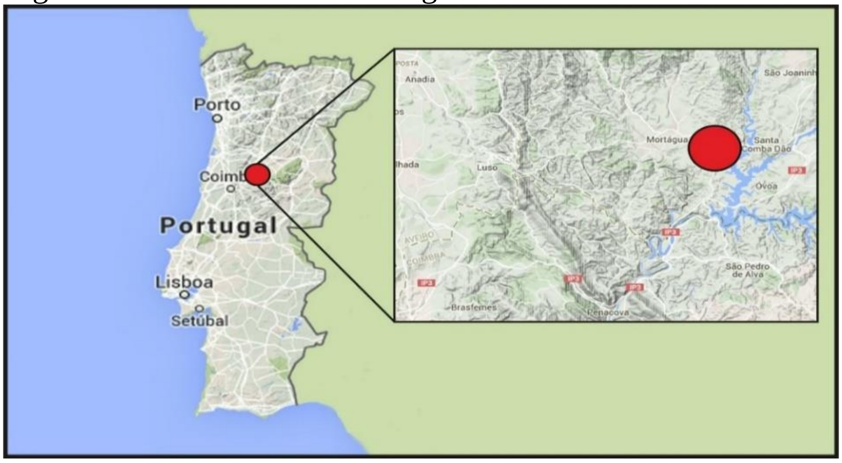
Forest Biomass Power Plants Assessed

We next describe in detail two FBPPs operating in central Portugal: Mortágua plant and Constância plants. Built with a decade of interval, these plants are a good sample of the reality of the use of forest biomass for electricity generation in Portugal. During June 2014, we conducted a deep research among the residents of the local communities near these two facilities in order to know personally how the individuals` wellbeing is affected by the FB plants activity.

i) Mortágua Forest Biomass Power Plant

The Mortágua FBPP is located in the parish of Mortágua, municipality of Mortágua, district of Viseu, in central Portugal, as shown in the following two figures. Created with the aim of reducing the risk of forest fires, this plant, operating since 1999, is fuelled exclusively by forest residues (natural gas is only used as a regulation and start-up fuel). According to Patrão (2011), Mortágua was considered a good location to implement the power plant, because the region has about 27% of the total Portuguese forested areas and produces around 480.000 tons/year of dry forest residues. Another important reason to choose this location was the high number of wood industries in the region, namely sawmills, which produce wood residues such as bark. The Mortágua power plant is owned and explored by the company EDP Produção – Bioeléctrica, S.A. (50% owned by Altri and 50% owned by EDP), which made an initial investment of around 25 million euros (DGEG, 2007; Patrão, 2011).

Figure III.39: Location of Mortágua Forest Biomass Power Plant



Source: Authors` elaboration

Figure III.40: Panoramic Image of Mortágua Forest Biomass Power Plant

Source: EDP:
http://www.a-nossa-energia.edp.pt/centros_produtores/fotos_videos.php?item_id=72&cp_type=te&section_type=fotos_videos

The Mortágua power plant, with an installed capacity of 10 MVA, produces 60 GWh of electricity and consumes 110 thousand tonnes of forest residues (pine and eucalyptus bark) annually (DGEG, 2007; Patrão, 2011). In a simplified form, the process of power generation in the Mortágua plant proceeds as follows: after crushed, the biomass enters a boiler where it is burned to produce heat which, in turn, causes the vaporization of water circulating on the walls of the boiler. This steam, obtained with adequate technical characteristics, enters a turbine which is coupled to a generator. Upon entering service, this generator produces electricity which is then sold to REN – Rede Eléctrica Nacional

(National Electricity Grid) through the so-called reception points, which allow the integration of the generated energy in the network (Patrão, 2011). This process involves several mechanisms (e.g. steam generators, turbines, alternators, transformers), but we only present in the table below some values, mainly for simplification reasons.

Table III.11: Technical information of Mortágua Plant

Entry into service	1999
Installed rated power	10 MVA (9 MW)
Annual generation at full load	60 GWh
Annual consumption of biomass	110 kton
Characteristics of the steam cycle	
Pressure	42 bar
Temperature	422 ºC
Flow	40 ton/h

Source: Patrão (2011)

It is also important to note that in the close proximity of the Mortágua thermoelectric plant, is operating, since April 2008, a factory of wood pellets (a natural product made generally from sawdust, shaving and shipping from sawmills). This plant is owned and explored by the company Gestinu and has a production capacity of 100 000 tonnes per year of wood pellets.

ii) Constância Forest Biomass Power Plant

Promoted by EDP Produção - Bioeléctrica, S.A. (owned by EDP and Altri), the Constância FBPP, installed in the industrial perimeter of the Caima pulp mill (owned by Altri), is located in the parish and municipality of Constância, district of Santarém, in central Portugal, as shown in the following two figures. Operating since 2009, the Constância power plant, fuelled exclusively by forest residues (natural gas is only used as a regulation and start-up fuel), is determinant both for the energy valorisation of the region forest resources and for reducing the risk of forest fires.

Figure III.41: Location of Constância Forest Biomass Power Plant

Source: Author`s elaboration

Figure III.42: Panoramic Image of Constância Forest Biomass Power Plant

Source: EDP:
http://www.a-nossa-energia.edp.pt/centros_produtores/fotos_videos.php?item_id=68&cp_type=te&section_type=fotos_videos

The Constância power plant, with an installed capacity of 14,5 MVA, produces 80 GWh of electricity and consumes 160 thousand tonnes of forest residues annually (Patrão, 2011). In the table below, we present some important values regarding the Constância thermoelectric power plant.

Table III.12: Technical Information of Constância Plant

Entry into service	2009
Installed rated power	14,5 MVA (13,5 MW)
Annual generation at full load	80 GWh
Annual consumption of biomass	160 kton
Characteristics of the steam cycle	
Pressure	64 bar
Temperature	440 ºC
Flow	50 ton/h

Source: Patrão (2011)

III.4. Impacts of Renewables Power Plants Activity

Renewable energy sources (RES) are commonly associated with lower external impacts in comparison to fossil fuel power plants and it is clear that the environmental impacts are significantly smaller: they produce no (or very little) greenhouse gases (GHG), namely CO_2 (the most important GHG for its dangerousness), no radioactive wastes and usually considerably low levels of other pollutants. These reasons are strong enough to understand why renewables are often called “green energy” or “environmentally friendly” energy sources.

However, despite the veracity of all the referred facts, RES are not completely "harmless" to the environment: they have important impacts, which differ either in kind or in intensity between the different technologies, and are more noticeable locally and immediately comparing to other energy sources. Therefore, the identification and valuation of these impacts are essential for an efficient energy decision making process in the renewables sector.

After a comprehensive literature review, we next present and deepen the main impacts associated with electricity production through each of the renewables, with particular attention to their environmental impacts.

III.4.1. Hydropower Impacts

The construction of dams, especially large dams[1], has been highly controversial and the debate over it has become more heated during recent years. In the origin of this controversy is the association of hydropower to a considerable number of different impacts. Following is a detailed description of the main impacts associated with hydropower development: energy impacts; socio-economic impacts; and environmental impacts, with particular emphasis to the environmental ones.

[1] According to the International Commission on Large Dams, a large dam is 15 m or more high from the foundation. If dams are between 5 and 15 m and have a reservoir volume of more than 3 million m^3, they are also classified as large dams (ICOLD, 1998).

1) Energy Impacts

In energy impacts, we include both positive and negative effects associated with hydropower deployment. As a RES, hydropower represents a large-scale alternative to fossil-fuelled generation, contributing only very small amounts to GHG and other atmospheric pollutants (Klimpt *et al*., 2002).

Hydropower is also responsible for the provision of significant supplies of low-priced energy and, as a domestic energy source, it is free from the uncertainties of the international oil market, representing in many countries an important boost of national electricity output and exportations (Jackson and Sleigh, 2000; Rashad and Ismail, 2000; Klimpt *et al*., 2002; Erlewein, 2013).

Furthermore, hydropower provides an exceptional level of service: its dynamic characteristics enable a nearly immediate response to load variations, and thus a fast adjustment between electric production and demand; it allows an increase of power system reliability, enabling a fast intervention in incident situations; it can also storage high quantities of energy; and in dams with pumped storage, it is possible to transfer energy produced in low cost hours to peak periods. These service qualities make hydropower a possible producer of base load, of peak load, of voltage and frequency regulation, of energy storage and of other services, which are not always available with other power generation options (Klimpt *et al*., 2002; Almeida *et al*., 2005).

However, the high dependence on the precipitation conditions is recognised as the major drawback of this RES. In his study, Akpinar (2013) refers to this fact and underlines that some countries face water scarcity in terms of usable water endowment, being highly dependent on precipitation levels, whose instability may have disastrous consequences to hydropower development.

2) Socio-Economic Impacts

Hydropower deployment also has socio-economic impacts. The construction of a dam has the advantage of stimulating and promoting different activities, namely improved navigation, angling activities and further development in tourism (Loomis, 1996; Jackson and Sleigh, 2000; Rashad and Ismail, 2000; Klimpt *et al*., 2002; Almeida *et al*., 2005; Pinho *et al.*, 2007; Zhao *et al*., 2012; Morgan *et al*., 2012). However, some specific river recreation activities are negatively affected, namely fly-fishing, canoeing and kayaking (Hynes and Hanley, 2006; Lewis *et al*., 2008; Robbins and Lewis, 2008; Gunawardena, 2010). Hydropower deployment may also be responsible for flooding significant areas of farmlands, affecting local agriculture. We may therefore conclude that, in some areas, new activities and jobs are created, while in other areas existing activities and jobs are destroyed.

Concerning RES employment impacts, most studies, both in the European and the US contexts, generally report a positive effect (Rashad and Ismail, 2000; Singh and Fehrs, 2001; Heavner and Churchill, 2002; Kammen *et al*., 2004; Lehr *et al.*, 2008; Del Río and Burguillo, 2008; Moreno and López, 2008; Blanco and Rodrigues, 2009; EC, 2009; Wei *et al*., 2010; IRENA, 2011). For the specific case of hydropower, research results indicate that most jobs created are mainly linked to indirect and induced activities (Silva *et al*., 2013). In the group of direct jobs, these are essentially associated with short-term employment in the dams construction and installation, where mainly less skilled labor is required, and a very small percentage of created jobs are employed permanently in operation and maintenance (O&M) activities (Moreno and López, 2008; Lehr *et al*., 2008).

The construction of a hydropower project also affects cultural resources: architectural, historical, archaeological sites and areas of unique importance (McGimsey, 1973; Canter, 1996; Awakul and Ogunlana, 2002; Pinho *et al*., 2007; Han *et al*., 2008; Gunawardena, 2010; Bakken *et al.*, 2012). In the specific Portuguese Foz Côa case, the construction of a dam already under way was abandoned in order to preserve prehistoric rock art engravings (Ferreiro *et al*., 2013).

Additionally, many hydropower plants have a negative influence on people`s health, especially in less-developed countries, where this effect is noted not only at the reservoir area, but also in upstream and downstream areas. Increases in the prevalence of schistosomiasis, malaria, encephalitis, hemorrhagic fevers, gastroenteritis, intestinal parasites, and filariasis have been documented after dam projects (Lerer and Scudder, 1999).

Another concern regarding hydropower deployment is the noise and vibration impact. Hydropower plants are, in most cases, built in rural areas, where local communities are used to the typical nature noises of the country life, in which eventually the only artificial noise and vibration source is from the road traffic, usually of small significance. Therefore, a dam installation means a new source of noise and vibration, with possible adverse implications on people`s health, including sleep problems and stress. Despite the main impact period is during the construction phase, noise and vibration problems still remain during the dams' operational phase. Besides the increased road traffic associated with the augmented number of tourists visiting the dam and the surrounding area, there is an additional traffic volume due to the plant supporting activities, generating an increased noise and vibration nuisance burden to local communities. Moreover, there is a noise disturbance from the sound of the constant outflow of dam water into the stilling basin and from the sporadically water discharges from the dam valves into the stilling basin. The significance of the noise and vibration impact on the local communities' residents is highly dependent on the distance between the dams and the residences (JKA, 2010).

Finally, the construction of large dams forces involuntary resettlement of people living in its proximity, which from an ethical perspective is a most serious issue, because people should matter the most in any infrastructure development (Jackson and Sleigh, 2000). To explain dam resettler behaviour, Scudder (1997) proposes a model with four sequential stages: planning; efforts to cope and to adapt following removal; economic development and community formation within resettlement areas; and handing over and incorporation. This process is complex, takes time and rarely is successful (Jackson and Sleigh, 2000; Awakul and Ogunlana, 2002). People involuntary resettlement results in a wide array of subsequent negative social impacts, namely: changes in household structure; changes in employment; changes in social networks and community integrity; changes in the nature and magnitude of health risks; and often a disruption of the psycho-social wellbeing of displaced individuals (Tilt *et al*., 2009). In southern Portugal, the village of Luz, with about 300 inhabitants and 180 houses, was submerged due to the construction of the Alqueva dam, forcing the relocation of the entire population. In this particular case, the village was transferred to another location purposely built to lodge these people who always refused a financial compensation, preferring to receive "house by house and land by land" in order to remain united as a community (Saraiva, 2007).

3) Environmental Impacts

Large scale hydroelectric development produces a broad range of environmental impacts. Following is a detailed description of these impacts.

i) Biodiversity Limitation

There are several definitions of biodiversity. One of the most cited states that "biodiversity is the variety of life and its process. It includes the variety of living organisms, the genetic differences among them, the communities and ecosystems in which they occur, and the ecological and evolutionary processes that keep them functioning, yet ever changing and adapting" (Noss and Cooperrider, 1994, p.5). Hydroelectric development causes serious impacts and losses on biodiversity. An extreme and permanent form of diversity limitation is the species extinctions caused by large dams (Rosenberg *et al*., 1997).

All the four habitats associated with the hydropower projects are affected: the reservoir catchment, the artificially created lake, the downstream reaches of the dammed river, and the estuary into the river flows. The environmental stresses are mainly caused by altered timing of river flow, increased evapotranspiration and seepage water losses, barriers to aquatic organism movement, thermal stratification, changes in sediment loading and nutrient levels, and loss of terrestrial habitat to artificial lake habitat (Abbasi and Abbasi, 2000).

ii) Impacts on Fauna and Flora

Hydropower deployment impacts on river ecosystems affect both fauna and flora in river region.

By fragmenting and interrupting the rivers connectivity, dams interfere negatively with the fish main biological processes such as feeding, growth, migration and spawning (Rosenberg *et al*., 1997; Tullos, 2009). Dams create obstacles for the movement of migratory fish species, leading to a decrease in its populations (especially anadromous fish such as salmon) and a fragmentation of non-migratory fish populations. Most fish injuries or mortalities during downstream movement are due to their passage through the turbines and spill ways (Loomis, 1996; Awakul and Ogunlana, 2002; Trussart *et al*., 2002; Wang and Chen, 2013). Also, the difference between the highest and lowest level of water surface reduces the food value in the water which, in turn, results in fewer and smaller fishes (Kataria, 2009). Another concern is the methylmercury bioaccumulation by fish and its consequent consumption by humans. It is an organic molecule produced mainly by bacteria from inorganic mercury naturally present in materials flooded during the course of reservoir creation. Methylmercury problems in fish are confined to the reservoirs themselves and short distances downstream (under 100 km). Temporally, methylmercury contamination in reservoirs can last 20 to 30 years or even more (Rosenberg *et al*., 1997).

Besides fish, other animals are also affected in different stages of their life cycles by the functioning of dams, including the benthic aquatic insect populations, a key indicator of ecosystem health used to document compliance with water quality standards (Lewis *et al*., 2008; Robbins and Lewis, 2008; Kataria, 2009). Water regulations are also responsible for changes and decreases of appropriate surroundings for the bird life (Kataria, 2009).

Dam construction also causes adverse impacts on flora, including deforestation, changes to the existing aquatic and terrestrial flora, and loss of some flora species (Han *et al*., 2008; Tullos, 2009).

iii) Emissions of Greenhouse Gases

There is worldwide interest in the greenhouse-gas (GHG) emissions from the hydropower chain, in particular those from the reservoirs, from upstream and downstream of the conversion step (electricity generation) and from activities before and after the operation of hydropower plants. The hydropower chain gives rise to GHG emissions from the various links of its energy chain, such as those associated with transportation, plant construction and storage of dismantling waste. Regarding specifically the hydroelectric production, it was until quite recently considered as relatively carbon neutral with close to zero-emission, but there is mounting evidence that reservoirs may in fact emit significant amounts of both carbon dioxide (CO_2) and methane (CH_4). These gases result from the considerable decomposition of flooded organic material that usually accompany the reservoir creation. However, it must be taken into account that CO_2 and CH_4 emissions vary greatly within and among reservoirs depending on geographic location, climate, morphometry and age of impoundments, watershed properties, and management practices. On a temporal scale, GHG emissions from reservoirs are dynamic, declining with time, but nevertheless they tend to stabilize at higher values than before reservoir creation. Spatially, GHG emissions probably represent the most extensive impact of large-scale hydroelectric development, as they may contribute to global climate change (Rosenberg *et al*., 1997; Rashad and Ismail, 2000; Teodoru *et al*., 2012).

iv) Water Resource Impacts

Water is one of the most precious natural resources and hydropower is expected to use it efficiently in the electricity generation process (Abbasi and Abbasi, 2000). In this context, hydropower presents some advantages: it provides an important contribution for water supply; it enables droughts and floods control; and it is a strategic water reserve on a large scale that may alleviate water scarcity and release water for irrigation purposes (Lerer and Scudder, 1999; Jackson and Sleigh, 2000; Rashad and Ismail, 2000; Klimpt *et al.* 2002; Almeida *et al.*, 2005; Han et al., 2008). Nevertheless, despite increased water availability and fields' irrigation are beneficial factors for agriculture development, the existence of a dam may also be responsible for some damage in this sector, by flooding large areas of agricultural land (Jackson and Sleigh, 2000; Abbasi and Abbasi, 2000; Rashad and Ismail, 2000; Wang *et al*., 2013).

Another major concern regarding this important resource is its quality. It is observed that water quality degradation is one of the major negative impacts on watershed ecosystem services caused by hydropower projects (Rashad and Ismail, 2000; Trussart *et al.*, 2002; Wang *et al*., 2010).

v) Landscape Impacts

Dam construction can affect a variety of processes in both inner and outer river areas. In the outer river area, landscape changes associated with land use and land cover change are the most obvious impacts of dam construction (Ouyang *et al*., 2010), and have a fundamental reciprocal relationship with ecological processes (Turner, 1989). A number of metrics have been developed to measure the influences of human activities on landscape structure (Theobald, 2010), such as the total land area and individual land use type areas, patch density, edge density, perimeter-to-area ratio, landscape diversity, and so on (Palmer, 2004; Morgan *et al*., 2010). Usually, researchers select metrics for quantification of landscape changes based on specific categories (e.g., fragmentation, shape and diversity) to avoid linearity and redundancy between metrics (Zhao *et al*., 2012). In general, whatever the metric used, the results show that the construction of dams produces significant changes in the surrounding landscape.

III.4.2. Wind Power Impacts

Power installed, production and the number of wind farms have all been increasing over the last decades, stimulating a growing debate on the environmental effects of this renewable (Álvarez-Farizo and Hanley, 2002). Many publications document the positive environmental aspects of wind power, one of the most efficient renewable energy sources and an important component of the energy mix in many countries. However, despite its advantages, wind power generation also comes along with considerable negative externalities, particularly experienced by local communities (Drechsler *et al*., 2011). These adverse impacts are due to the inherent operating characteristics of wind farms, justifying an increasing opposition to new wind farms from those living close to them, in contrast to a very positive public attitude for wind power on the part of the general public (Krohn and Damborg, 1999; Álvarez-Farizo and Hanley, 2002; Wolsink, 2005).

The environmental benefits of electricity production from wind power are well recognised and accepted, but the environmental costs are less known. These are difficult-to-quantify and are likely to be case-specific. However, any efficient economic assessment for expanding wind energy should attempt to incorporate the value of all environmental impacts, both positive and negative (Álvarez-Farizo and Hanley, 2002). The final aim of such analysis is to develop wind farms in such a way that maximises its positive impacts, including the environmental ones, and, at the same time, minimises its costs, without neglecting those only felt by local communities (Álvarez-Farizo and Hanley, 2002; Manwell *et al*., 2009).

Next we present a detailed description of the main impacts associated with wind farms: energy impacts; socio-economic impacts; and environmental impacts, with particular emphasis to the environmental ones.

1) Energy Impacts

In the energetic context, wind generation presents important advantages. According to Aubrey *et al.* (2005), wind energy is a significant and powerful resource. It is safe, clean, and abundant. Unlike conventional fuels, wind energy is a massive indigenous power source permanently available in virtually every nation in the world. It delivers the energy security benefits of avoided fuel costs, no long term fuel price risk, and avoids the economic and supply risks of imported fuels and political dependence on other countries.

Nevertheless, some drawbacks are associated with wind power, namely: the availability of wind does not always coincide with the period of necessity of power refuelling; there are some difficulties in the storing process of not consumed wind energy; and, in certain cases, some limitations and inefficiencies in the energy transmission lines were found (Coelho, 2007)

2) Socio-Economic Impacts

Several positive socio-economic impacts are associated with wind power deployment, namely: local revenues from lease contracts of lands allocated directly to wind farms; creation of jobs for the operation and maintenance of wind farms; electricity generation from a renewable source of energy, without emitting air pollutants; improved accessibility; source of didactic and tourist interest, enabling additional revenues for the local economy (Mendes *et al*., 2002).

Nevertheless, some community conflicts have been particularly pronounced in regard to wind energy projects. A fundamental question is why there can be strong local opposition to wind farms when there is a high level of public support for renewable wind energy (Devine-Wright, 2005). NIMBYism, the not-in-my backyard syndrome, is frequently used as a catch-all explanation for local opposition. The idea of NIMBY is rather simplistic as it suggests that people have positive attitudes towards wind power until they are actually confronted with it, and that they then oppose it for selfish reasons (Wolsink, 2000, 2007). The validity of this concept is, however, highly questionable, “because it leaves the cause of opposition unexplained” (Kempton *et al*., 2003, p.125). In fact, according to Devine-Wright (2005), the literature has been more successful in describing perceptions of wind farms rather than providing substantive explanations of these.

According to some authors, the opposition to wind farms is justified by more complex issues such as justice and fairness. In Gross (2007)`s research study, the author focuses on how individuals in a small rural community in Australia perceived the consultation process of installing a wind farm in the surrounding area and identified several issues which revealed to be determinant for developing some hostility regarding the wind farm installation process. The main complaints expressed by the interviewees were: they felt they were informed of the wind farm installation rather being consulted about it; they were not given the possibility to participate in any decision in the process; they had the perception that the decision makers did not allow people’s voice to be heard, views to be expressed, or debate and discussion to be enabled; and also felt that they had no information about important issues such as the size and placement of the turbines.

With the same point of view is Wolsink (2000, 2007) who emphasizes that attitudes towards wind farms can be crucially affected by institutional factors, namely how decisions concerning the siting of the turbines are made and how well-informed local communities are with regard to wind energy issues. The author also underlines that when local communities resist wind power installations, they actually express their disapproval either of the top-down decision-making procedures used by the developers and policy makers or of the incentives of the prospective developers.

In this context, we may suggest that conciliatoriness, transparency and openness from the decision makers and allowance for participation and involvement of the local people in the decision making procedures could considerably contribute to the prevention of local resistance towards wind farms developments. As Pasqualetti (2002, p.169) states, “The success of wind power depends on how well the wind industry learns to include the public in decisions, both for the opportunities this allows for broader dissemination of information about wind power and for the suggestions the public can contribute to the discussion of their concerns and how to accommodate them".

3) Environmental Impacts

Wind farms' operation produces a significant range of environmental impacts. Following, we present a detailed description of the main ones.

i) Landscape Impacts

One of the major public concerns and an important factor determining public opposition to wind farms is their visual impact. According to Wolsink (2007), visual evaluation of the impact of wind farms on landscape values is by far the dominant factor in explaining why some are opposed to wind power implementation and others support it.

From the landscape point of view, wind turbines are elements of subjective appreciation. Despite the predominant emphasis upon the negative visual impacts of wind turbines on landscape, in which most authors agree that "wind turbines somehow do not "fit" in the landscape" (Gordon, 2001, p.169), there is little evidence that wind turbines are universally perceived as ugly. In fact, we can find in the literature some examples of positive evaluations of the visual character of wind turbines, in which individuals choose the adjectives "beautiful" and "interesting" to describe the physical appearance of wind turbines (Devine-Wright, 2005)

The magnitude of a wind farm visual impact depends largely not only on the ability of the landscape to absorb the elements resulting from the installation of this technology, as well as the visibility of the wind farm, and the frequency and number of observers from accessible locations in its surrounding area (Mendes *et al*., 2002). Beyond the specific characteristics of the installation site of the wind farm, there are a number of factors that are determinant to its visual impact, such as: number of wind turbines; size of the wind turbines; configuration resulting from the distribution of the wind turbines, "design" and colour of the wind turbines, the time when wind turbines are moving or stationary, shadow flicker and blade glint caused by wind turbines, and distance of wind turbines from residential areas (Lubbers and Pheifer, 1993; Saidur *et al.*, 2011).

ii) Noise Impacts

Wind turbines are a new source of community noise to which relatively few people have yet been exposed. The number of exposed people is growing, as in many countries the number of wind turbines is rapidly increasing. The need for guidelines on wind turbine noise is urgent in order to avoid its possible adverse health effects (Pedersen *et al*., 2009).

Wind turbines have many parts that generate noise, but they can be broadly classified as either aerodynamic or mechanical. Mechanical sources of noise include the gearbox, cooling fans, the generator, the power converter, hydraulic pumps, the yaw motor and bearings. Aerodynamic noise sources are a function of blade geometry. Similar to a fan, the level of aerodynamic noise is highly correlated with the tip speed (Mendes *et al*., 2002; Björkman, 2004; Bastasch *et al*., 2006; Oerlemans *et al.*, 2007; NHMRC, 2010; Saidur *et al*., 2011).

Studies indicate that wind turbines differ in several respects from other sources of community noise. Modern wind turbines mainly emit noise from turbulence at the trailing edge of the rotor blades. The turbine sound power level varies with the wind speed at hub height. It also varies rhythmically and more rapidly as the sound is amplitude modulated with the rotation rate of the rotor blades, due to the variation in wind speed with height and the reduction in wind speed near the tower (Van den Berg, 2005, 2006). Amplitude-modulated sound is more easily perceived than is constant-level sound and has been found to be more annoying (Bradley, 1994; Bengtsson *et al.*, 2004). In addition, sound that occurs unpredictably and uncontrollably is more annoying than other sounds (Hatfield *et al*., 2002; Geen and McCown, 1984).

Nevertheless, complaints about wind turbine noise are not only a function of the ambient sound levels, but also of the nature of human perception of noise. According to Pederson and Waye (2005), annoyance increases with noise level, but factors other than noise levels also strongly affect annoyance. These authors found that people with negative attitudes toward wind turbines were more easily annoyed by turbine noise and people with positive or neutral attitudes toward wind turbines were rarely annoyed. Additionally, the fact that wind turbines are tall and highly visible, often being placed in open, rural areas with low levels of background sound and in what are perceived as natural surroundings. increases not just the odds of perceiving the sound, but also the odds of being annoyed, suggesting a multimodal effect of the audible and visual exposure from the same source leading to an enhancement of the negative appraisal of the noise by the visual stimuli (Pedersen *et al.*, 2007). Finally, studies also find that people who benefit economically from wind turbines are less likely to report noise annoyance, despite exposure to similar sound levels as those people who are not economically benefiting (Pedersen *et al*, 2009).

iii) Impacts on Fauna and Flora

Impacts on flora resulting from the implementation of a project of this nature are mainly due to land movements, deforesting and dust emissions associated with its construction. During the exploration phase, part of the previously affected vegetation can recover in the medium /long term, depending mainly on the adopted mitigation measures. However, as a result of an easier access of vehicles and people to the wind farm surrounding area, often located on mountains high with a significant environmental value, there is the occurrence of an increasing stepping of protected species, generating a negative impact on flora with a magnitude that depends on the specific characteristics of each zone (Mendes *et al*., 2002).

Concerning fauna, wind farms can involve negative impacts on birdlife. According to Travassos *et al.* (2005), birdlife impacts can be divided into two types: direct (resulting from the collision with existing structures in the wind farm) and indirect costs (loss of habitat, disturbance, etc.). There are also the cumulative impacts caused by the presence of several wind farms in the same region.

Regarding the dimension of wind farms impacts on birdlife, there is some lack of consensus among experts. Travassos *et al.* (2005) and Fielding *et al.* (2006) literature reviews indicate that studies in the field show heterogeneous results mainly due to the existent of several determinant factors, namely the location of wind farms, the type of birds analysed or even the weather conditions. Thus, although most studies conclude that wind farms are associated with an insignificant bird mortality, there are situations in which the results are quite different, with a significant bird mortality rate. These situations occur when wind farms are installed in areas of important migratory corridors or very frequent commuting movements, coastal zones with high avifauna abundance or bad weather.

In the last years, the decreasing of the number of accidents with birds in wind farms appears to be related with the technological development of wind turbine type, a greatest care in solving problems of site nature and adaptation of wind turbines operating conditions favorable to minimise accidents. However, even low rates of bird mortality may be very relevant to bird populations, especially for large species with long life, low densities, annual rate of low productivity and delayed sexual maturity (Travassos *et al.*, 2005).

In addition to the mentioned direct impacts, wind farms also interfere with the existing fauna in an indirect way, namely by changing the natural habitats conditions of several species living in the surrounding area. According to some studies (Rabin *et al.*, 2005, 2006; Kikuchi, 2008) the sounds emitted by wind turbines may interfere with the lives of animals such as the squirrels. As a result of an experiment carried out in Altamont Pass in the USA (Rabin *et al.,* 2006), the author observed several changes in the behaviour of the squirrels at the turbine site, namely: they were more vigilant overall, they had greater tendency to return to the area immediately around their burrows during playback, and they presented a constant perception of being under high risk.

Bat mortality is also associated with wind farms' operation. In addition to the evident risks of direct collision, recent work developed by Baerwald *et al*. (2008) suggests that a considerable number of the observed bat fatalities may be due to barotrauma, denomination adopted to describe the injury resulting from suddenly altered air pressure. Fast moving wind turbine blades create turbulence in their wakes and bats may experience rapid pressure changes as they pass through this disturbed air, potentially causing internal injuries leading to death, sometimes not immediately. According to the authors, 90% of bat fatalities involved internal hemorrhaging consistent with barotrauma, and that direct contact with turbine blades only accounted for about half of the fatalities.

These adverse impacts on wildlife must be avoided by full evaluation of suitable alternatives and by appropriate location and design (BirdLife, 2005; Manwell *et al.*, 2009).

iv) Electromagnetic Interference Effects

Electromagnetic interference is an electromagnetic disturbance that interrupts, obstructs, or degrades the effective performance of electronics or electrical equipment. Through electromagnetic interference, wind turbines can have negative impacts on a number of signals important to human activities such as television, radio, microwave/radio fixed links, cellular telephones, and radar (Manwell *et al*., 2009).

In practice, the blade construction material and rotational speed are key parameters. For example, the older wind turbines with blades made of metal presented a high electromagnetic interference in the surrounding area, but nowadays, this problem is less likely, because most blades are now made from composite materials. On the other hand, most modern machines have lightning protection on the blade surfaces, which can cause some electromagnetic interference (Manwell *et al*., 2009).

v) Land Use Impacts

Compared to other power plants, wind farms are sometimes considered to be more land intrusive rather than land intensive. However, if we consider the extent of land required per unit of power capacity, wind farms require more land than most energy technologies (Manwell *et al*., 2009).

The land use impact of wind farms varies substantially depending on the site: wind turbines placed in flat areas typically use more land than those located in hilly areas. Also, since wind generation needs consistent wind resources over a long period, wind farms are primarily installed in rural and relatively open areas, which are often used for agriculture, grazing, recreation, open space, scenic areas, wildlife habitat, and forest management (Denholm *et al*., 2009; Manwell *et al*., 2009).

It is important to note that the size of a wind farm is much more than the sum of the dimensions of each of its components. The wind turbines must be spaced approximately 5 to 10 rotor diameters (diameter of the wind turbine blades) apart. Thus, the turbines themselves and the surrounding infrastructure, including roads and transmission lines, occupy a small portion of the total area of a wind farm. The remainder of the land can still be used for namely livestock grazing, highways, and hiking trails (Denholm *et al.*, 2009). Nevertheless, there are some uses that may not be compatible with the existence of a wind farm in the surrounding area, namely some parks and recreational uses that emphasize wilderness values and reserves dedicated to the protection of wildlife, specially birds (Manwell *et al.*, 2009).

III.4.3. Photovoltaic Power Impacts

PV energy for the production of electric energy is one source of renewable energy which has been experiencing a considerable development in recent years. In countries with high solar radiation indices, as in the case of Portugal, this RES represents a preeminent choice in the range of available options for electricity production with increasing expectations of installation of large photovoltaic power plants. However, it must be realized that no manmade project can completely avoid some impacts, particularly to the environment, so neither can photovoltaics. These impacts depend on the size and nature of the projects and are often location specific. Next we present a detailed description of the main impacts of the PV power plants: energy impacts; socio-economic impacts; and environmental impacts, with particular emphasis to the environmental ones. In this analysis, we consider only the impacts of the photovoltaic plants installed on the ground, ignoring the urban photovoltaic applications on buildings.

1) Energy Impacts

Solar PV energy has become a promising alternative source, providing a feasible solution to society’s current dilemmas posed by the reliance on fossil fuel based power generation. Its abundance and renewability are two major key advantages (Singh, 2013). With the PV technology the energy of irradiated light is directly converted into electrical energy. This process is possible as long as the sun shines. According to Lackner and Sachs (2005), the Earth intercepts 170.000 TW of power from the sun and this solar flux exceeds human primary energy consumption by some four orders of magnitude. Thus, there is more than enough sunlight to easily provide global energy needs both now and in the future.

Furthermore, on a national scale, the adoption of PV energy, a domestic resource, is critical to energy security. This is particularly important to countries with scarce fossil energy resources, presenting a high dependence on foreign energy. Moreover, PV also presents the advantageous of being a strategic technology: as a distributed generation source, this technology acts as a network (like the internet), being therefore much less susceptible to large-scale power outages caused by natural (e.g. floods, storms, etc.) or manmade disasters (e.g. terrorism, warfare, etc.) (Pearce, 2002).

The production of electricity through PV also presents some limitations. One of the most often mentioned drawbacks associated with photovoltaic energy is the fact that solar cells only produce energy when illuminated. Therefore, the PV system requires energy storage to provide energy in the absence of insolation. Currently, batteries are most commonly used to store this energy. Several disadvantages are however associated with the use of these batteries, namely an augmented upkeep and an added initial capital investment. Also, in the absence of the appropriate measures at the end of its life cycle, batteries may be responsible for severe environmental impacts, due to their relative short life span and their heavy metal content (Pearce, 2002; Tsoutsos *et al.*, 2005; Singh, 2013).

Another important issue is the energy viability of PV technology. In the past, PV technology has been deeply criticised for requiring in the production process more energy than the energy produced in its operation, however, as a result of successive technological improvements, this reality has changed (Alsema, 2000; Alsema and Nieuwlaar, 2000; Knapp and Jester, 2001; Alsema *et al.*, 2006). Energy pay-back times are now between 1 and 2 years for locations with high solar radiation indices as in Southern-Europe, and between 1.7 and 3.5 for locations with low solar radiation indices as in Middle-Europe, depending on cell technology: in comparison to silicon, thin film technology presents a minimum pay-back time (Alsema *et al*., 2006).

Finally, as Singh (2013) stresses, despite its advantages such as being simple, reliable, available everywhere, in-exhaustive and suitable for off-grid applications, PV efficiency and manufacturing costs have not reached the point where photovoltaic power generation can replace conventional coal, gas, and nuclear powered generation facilities. Therefore, PV technology still requires public funding in order to ensure its economic feasibility (Chiabrando *et al*., 2009). According to Perce (2002), this frequent critique is however baseless when considered in the context of the massive public subsidies for the energy industry as a whole.

2) Socio-Economic Impacts

Among the socio-economic benefits of PV exploitation, Tsoutsos *et al.* (2005) stresses: increase of regional and national energy independency; diversification and security of energy supply; support of the deregulation of energy markets; acceleration of the rural electrification in developing countries; and provision of significant work opportunities.

Regarding direct jobs creations, there is not a consensual opinion. In fact, once installed, PV is virtually maintenance free and thus devoid of employment for energy production. Nevertheless, as focused by Pearce (2002), its manufacture and installation is extremely labor intensive, producing substantially higher levels of employment than equivalent levels of investments in conventional energy supplies.

PV power generation is also associated with health benefits. Due to the offset of air pollution (NO_x, SO_2, and particulate emissions) from coal produced electricity there are immediate health benefits such as reduction in premature mortality from respiratory disease and chronic bronchitis. Reduction in air pollutants also helps less serious maladies like reduction of asthma symptoms, acute lower respiratory symptoms, and restricted activity days (days in hospital) (Pearce, 2002).

Despite these advantages, the installation of PV plants is often perceived by local communities as a potential threat to their quality of life. This local opposition regarding photovoltaic developments justifies why sitting decisions have, in several cases, been dominated by intense conflicts and debate (Chiabrando *et al*., 2011). This lack of social acceptance regarding PV plants is common to other RES projects and may be explained on the basis of the NIMBY (Not In My Back Yard) syndrome. In this context, the public concern often originates from the fact that environmental advantages of the projects are perceived on a national level, whereas several adverse impacts of such systems only affect local habitants. This explanation is however considered as a simplistic explanation for people resistance to the installation of RES based projects in their vicinity. Local opposition may, for example, be attributed to habitants' skepticism towards the company responsible for the project or even may be due to people's unwillingness to the installation of any kind of facility in their vicinity. Individuals' opposition may also be a place-protective action arising when a new development disrupt pre-existing emotional attachments and threaten place-related identity processes. In some cases, environmental concerns are determinant, adversely affecting the implementation of photovoltaic projects: every energy production method has an adverse impact on the environment during construction, installation, operation and decommissioning phase (Kaldellis *et al.*, 2013).

According to Tsantopoulos *et al.*, (2014), the best way to facilitate the development of PV systems is through the creation of an institutional framework with the participation of all stakeholders in decision-making processes. The need for cooperation has been perceived by the broader public, in order to examine the process of project implementation. Lack of communication can only lead to problems, both pertaining to the public and also to local authorities, that often result in delays or even cancelled investments in certain cases. What frequently occurs, on behalf of the institutional bodies, is that they seek public participation only after a particular project has been announced.

3) Environmental Impacts

PV are seen to be generally of benign environmental impact, generating no noise or chemical pollutants during use, and being almost an infinite energy source when compared with fossil fuels. Nevertheless, it must be realized that no manmade project can completely avoid some impacts to the environment, so neither can PV. Potential environmental burdens depend on the size and nature of the project and are often location specific (Dubey *et al*., 2013). Some of these impacts are listed and analysed below. We stress that according to the purpose of this research study, we consider only the impacts of the PV power plants installed on the ground, ignoring the urban PV applications on buildings.

i) Land Use

The land use of PV is one of the greatest among the energy technologies (Sarlos *et al.*, 2003). In terms of energy, Lackner and Sachs (2005) find a PV land occupation between

28 and 64 km^2/TWh, having assumed an appropriate value for the useful lifetime of the modules and for solar radiation. Therefore, it is important to identify and consider in any project decision the impacts of the PV land use, especially on natural ecosystems. According to Tsoutsos *et al*. (2005), these impacts depend upon some factors, namely: topography of the landscape; area of land covered by the PV system; type of the land; distance from areas of natural beauty; and biodiversity.

ii) Reduction of Cultivable Land

If a medium and large PV plant is installed in previously cultivated areas, it represents not only a land use, but also a reduction of potentially cultivable land (Chiabrando *et al*., 2009; Tsoutsos *et al*., 2005). Therefore, electricity generation can be seen as competitive with food production (Srinivasan, 2009).

iii) Thermal Pollution

Large-scale PV land use also affects thermal balance of the area by absorbing more energy by the earth than otherwise would be reflected by the surface back to space. Also, additional heat might destroy a few species living in this environment. A possible solution to this problem would be the development of space PV power stations, but energy from these systems would be transported to the earth as microwave, which could cause radiation pollution and endanger bird life passing through the irradiated zone (Gunerhan *et al*., 2009).

iv) Countryside Fragmentation

This impact refers to the potential loss of the identity elements typical of countryside. Even if the site is not a cultivable land, the installation of a PV power plant may deplete the unitary characteristics of a specific countryside. In this context, fragmentation is considered as a negative impact, affecting nature conservation and biodiversity (Chiabrando *et al*., 2009).

v) Visual Impact on the Landscape

Most PV plants are located in rural environments, where the landscape has remained practically unaltered ever since extensive agriculture was introduced. Because of this, one of the most significant environmental impacts of this type of installation is the visual impact derived from the alteration of the landscape (Torres-Sibille *et al*., 2009). Nevertheless, the visual impact on the landscape is particularly critical to be assessed. It is necessary to establish to what extent the PV power plant affects the perception of the landscape in natural, agricultural or urban areas (Chiabrando *et al.*, 2009). The type of the scheme and the surroundings of the PV plant are important factors to consider. For instance, if the PV plant is installed near an area of natural beauty, the visual impact is significantly high (Tsoutsos *et al*., 2005).

vi) Impacts on Fauna and Flora

This impact concerns the change in the animal species on the site and in the vegetative life as a consequence of the installation and operation of the PV plant (Chiabrando *et al*., 2009).

vii) Glare

With the growing numbers of PV installations around the world, solar glare is becoming an increasing concern. According to Chiabrando *et al*. (2009, p. 2446), glare can be defined as a "temporary loss of vision or reduction in the ability to see the details of the human eye as a result of a surface whose luminance at a given point in the direction of the observation exceeds the luminance that can be perceived by the human eye". PV systems can generate glare due to optical reflections and hence might be a serious concern. On the one hand, glare could affect safety, e.g. regarding traffic. On the other hand, glare is a constant source of discomfort in vicinities of PV systems. Hence, assessment of glare is decisive for the success of renewable energies near municipalities and traffic zones for the success of solar power. Several courts decided on the change of PV systems and even on their de-installation because of glare effects (Rose and Wollert, 2014). Thus, location-based assessments are required and some regulations are being thought in order to prevent unwanted glare from PV installations, namely the demand of a quantitative glare analysis before any new PV installation near airports (Clifford, 2013).

viii) Electromagnetic Fields

This is the impact of any electrical equipment operating in medium voltage and transforming electricity from low to medium voltage power transmission. In this context, the PV equipments should be designed and built following the current technical standards in the electricity sector, namely the cables in medium voltage and low voltage should be buried in order to decrease the intensity of the magnetic field generated (Chiabrando *et al.*, 2009).

ix) Construction and Waste Management Impacts

The impacts during the construction of a PV plant are associated with the work to build the structures of the system and of the connection to the network, generating, for instance, an uncomfortable noise affecting local animal and vegetal species (Chiabrando *et al.*, 2009; Tsoutsos *et al*., 2005). Hazardous emissions connected to PV technology are primarily related to energy consumption in the manufacturing process (PV modules production is still conventional and rather energy intensive), as direct process emissions are almost zero. Also determinant is the disposal stage of a PV system, which takes place usually after at least 20-25 years of operation. It is characterized by the production of the waste of the support structures (usually aluminium), foundations (usually in reinforced concrete) and electric material. The disposal of the modules, especially cadmium tellurium (CdTe) modules, should be made with great care: its risks appear to be quite low, provided that the material is kept well-encapsulated (double-glass encapsulation) and that it can be recovered from waste modules (Alsema *et al*., 2006; Fthenakis *et al*., 2008).

III.4.4. Forest Biomass Power Impacts

Biomass is a very heterogeneous aggregation of different feeding materials, conversion technologies and end-uses. In accordance with the Directive 2001/77/EC, “biomass shall mean the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste" (EC, 2001, p.35). Although the scope of the biomass concept is relatively broad, we focus our analysis in the forest biomass, more specifically in the so-called primary forest biomass (PFB), i.e. the biodegradable fraction of products generated in the forest and which are processed for energy purposes, such as forest residue (branches and tops that are left after the extraction of stemwood) and a range of timber use waste from felling, thinning, cleaning and other timber operations (Enersilva, 2007; Skogsstyrelsen, 2002). Although not covered in this study, there is also the so-called secondary forest biomass (SFB), which includes residual organic matter generated in the processes of the wood processing industry (sawmills, pulp mills, lumber and plywood, carpentries and furniture industries) and wood remains from other industrial activities (pallets and packaging) and from municipal waste (Enersilva, 2007).

Following is a detailed description of the main impacts associated with forest biomass development: energy impacts; socio-economic impacts; and environmental impacts, with particular emphasis to the environmental ones.

1) Energy Impacts

In Europe, a major incentive is to improve security and diversity of energy supply (Stupak *et al*., 2007). Among the renewable energy sources, the use of forest biomass for energy purposes has revealed to be an important factor in achieving this goal: besides reducing energy dependence of imported non-renewable fossil fuels, it contributes to diversify the energy *mix* and increase the security of energy supplies (Armolaitis *et al*., 2013; Stupak *et al*., 2007; Teixeira, 2009).

Furthermore, biomass is one of the few resources whose availability does not depend on weather conditions, seasonal or diurnal variations and can be stored, for use on demand. It can therefore provide a reasonably predictable baseload capacity (Thornley, 2006).

Finally, the use of forest biomass for energy production allows the energetic valuation of forestry products, in in which Portugal is particularly well endowed.

2) Socio-Economic Impacts

The use of forest biomass for energy purposes allows the creation of economic and social opportunities. With the use of forest biomass, it is valued an endogenous resource for wealth creation and producing essential goods as electricity and heat (Enersilva, 2007).

Additionally, the implementation of biomass crops represents an important contribution to rural economic diversification and more opportunities for farm workers, especially in winter months, increasing their income possibilities (Stupak *et al.*, 2011; Thornley, 2006).

Regarding the employment opportunities, the use of forest biomass for energy purposes stimulates direct and indirect jobs creation, especially upstream of the central (forestry services and cargo transport), with the respective monetary gains. It provides opportunities for differentiated and undifferentiated employment, allowing to employ people with different levels of education and thereby promotes a greater social stability (Boersboom *et al*., 2002; Enersilva, 2007; Stupak *et al*., 2011).

Also, forest management and the removal of residues contributes to reducing fire risk, especially in forests that are currently unmanaged.

The development of forest biomass for power generation is, however, also associated with some negative socio-economic impacts. According to Bhattacharya (2002), there are five major barriers to biomass energy development: the lack of understanding about the use of biomass for energy generation; the perception of the existence of risks associated with biomass conversion technologies; financial concerns, since the cost of energy from biomass is normally higher compared with fossil fuels; eventual conflicts mainly arising out the network involving farming/forestry communities and power producers; and finally an insufficient policy support for energy crops.

Finally, it is important to “listen” to the opinion of the local community. It is observed that one of the main obstacles to the implantation of a biomass electricity plant is local opposition, a social factor of utmost importance, but often neglected by policy decision makers. Upreti and Horst (2004) identify some major concerns expressed by opponents to the deployment of a biomass power plant in the proximity of their residences, which include: inappropriate location; close proximity to residents; emission of noxious gases; unpleasant odour; emission of light at night; vibration and noise from the power plant; fear of public health hazards; increase in traffic and consequent nuisance; accidents and noise; fear of negative impacts to ecosystems; negative effect on local weather; undermining openness; negative impact on landscape; negative effects on heritage; low benefits to local community compared to the associated social and environmental costs; negative effect on tourism and business; no compensation to local people; negative effect on property prices; and no significant employment opportunity for local people.

3) Environmental Impacts

Although biomass electricity plants in general have fewer environmental impacts than plants which use fossil fuels, such impacts exist, especially at local level, and should not be ignored (Upreti and Horst, 2004). Next we deepen the most relevant environmental impacts.

i) Soil Fertility Loss

Forests may contribute significant amounts of biomass for energy production, but the practices introduced for this purpose may compromise the forests sustainability (Armolaitis *et al*., 2013). One of the major concerns is the increased removal of forest biomass causing soil nutrient and organic matter depletion, soil acidification, and physical damage (Lamers *et al*., 2013). All these impacts lead to significant losses in soil fertility and productivity.

In the process of energy generation based on forest biomass, all logging residues are used, increasing considerably the removal of nutrients, since the predominant part of the nutrient content of a tree is in its branches, needles and tops, which are exported in addition to stemwood. According to some studies, the amount of nutrients lost due to biomass removal has been calculated to increase 1.5-5 times compared to traditional stemwood harvesting (Armolaitis *et al.*, 2013; Skogsstyrelsen, 2002). This mineral nutrients removal cannot be fully compensated by weathering and deposition and, consequently, the supply of mineral nutrients available to plants diminishes.

Furthermore, the extraction of aboveground forest biomass reduces the input of organic matter to the soil and thereby short-term, and possibly also the long-term, carbon stocks in the soil (Repo *et al*., 2011, 2012).

Thiffault *et al.* (2011) also highlights the problem of base cation (Ca, Mg, K) losses. These are responsible for buffering soil acidity and have a relatively high concentration in foliage and branches. With the increased biomass removal, the presence of base cations is reduced and, consequently, the soil acidity increases.

Growth reduction has also been recorded after removal of logging residues. Most often the growth reductions are attributed to the reduced input of nitrogen (N) that would otherwise become available from the decomposing residues, but on some site types, the decreased input of other nutrients may also be involved (Skogsstyrelsen, 2002; Thiffault *et al.,* 2011).

Physical soil damage and reduced water quality are other impacts associated to the use of forest biomass for energy purposes. These impacts are due to intensive management methods, such as increased machine traffic, site preparation or stump harvesting (Stupak *et al*., 2011).

Finally, it is important to note that some agents when faced with decreases in productivity and soil fertility due to the removal of nutrients and organic matter, resort to the use of fertilizers, which are clearly not harmless to the environment (Stupak *et al.,* 2011).

ii) Biodiversity Limitation

Biodiversity is a broad concept, for which there are several definitions. According to the United Nations Environment Programme (UNEP), biodiversity means the variability among living organisms from all sources including terrestrial, marine and other aquatic systems and the ecological complexes of which they are part (Heywood, 1995).

Forest biomass consists mainly of logging residues that were formerly left to decay on clear cuts. Removing this material affects biodiversity because lower amounts of wood in the forest imply fewer habitats for species using wood for breeding (Jonsell, 2007). Such species, which depend on wood for their survival, are termed saproxylic, most of which are fungi and insects (Speight, 1989; Siitonen, 2001). They are threatened in two different ways. One is the loss of habitat, i.e. dead wood, in itself. Another is the risk that insects which colonize wood bound for the heating plants, and thus are trapped in wood that is burned (Jonsell, 2007). Other species could also be affected because removal of logging residues alters the structures on the ground and the amount of nutrients. The removal of wood from managed forest has been identified as one of the main reasons for why many forest species have declined and even gone regionally extinct (Jonsell, 2007).

On the other hand, removal of logging residues and whole trees might decrease the risk of damage to vulnerable stands due to decreased amounts of breeding material for pest insects (Stupak *et al*., 2007).

iii) Air Emissions from Combustion

As with other forms of combustion, the wood fuel combustion process emits air pollutants. The amount and types of pollutants depend both on the specific combustion process involved, as well as the extent of controlled burning. Compared with fossil fuels, combustion plants fired with forest residues emit similar levels of nitrogen oxides, but significantly less sulfur dioxide (Miranda and Hale, 2001).

The controversy over the role of carbon emissions in global climate change calls for special treatment in monetizing carbon externalities. Many argue that carbon dioxide emissions are irrelevant because forest residue carbon is part of the natural carbon cycle, and will eventually be taken up again in new forest biomass (thus delivering carbon neutrality). However, studies indicate that carbon uptake by growing biomass occurs much more slowly than carbon release during combustion, estimating that 13% of the carbon released from residue combustion remains in the atmosphere after 80 years (Miranda and Hale, 2001).

Furthermore, if we examine the full system of energy generation through forest biomass, we find that production, harvest, transport, and conversion require significant inputs of energy and that this energy is generally provided by fossil fuels, which, in turn, also require significant amounts of energy for their production and transport (Schlamadinger and Marland, 2001).

iv) Landscape Impacts

Public understanding of "landscape" as a term or concept is not straightforward, even if in the academic context is increasingly accepted as meaning an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors” (Council of Europe, 2000). Most people`s main engagement with the landscape is passive and primarily visual. Landscape is more than areas of protected scenic beauty, it is also the surroundings for a variety of activities. It is important that policy makers recognize this concept and consider in their decisions that “the rest” of the landscape is as well as “the best”, which includes those areas forming the backdrop to daily life (Conrad *et al*., 2011; Swanwick, 2009).

Biomass energy generation process relies on both crops and power plants infrastructures. Additionally, there are the transport infrastructures to carry crops to the power plants where they are burned.

The magnitude of visual impacts from operation of a biomass power plant is dependent upon factors such as: its distance from the viewer, the view duration, and the quality of the landscape. Power plant lighting would adversely affect the view of the night sky in its immediate vicinity. Some infrastructures such as the power plants` towers are more visible, causing an higher level of visual intrusion. According to some studies (Dockerty *et al*., 2012; Upreti, 2004; Upreti and Horst, 2004), visual intrusion affecting the existing landscape is one of the reasons for the local opposition to biomass power plant installation.

III.5. Social Acceptance in the Debate on the Renewables

Social acceptance as a decisive factor of renewables implementation was extensively ignored in the eighties when the policy programs began. Most decision-makers (energy companies, authorities, and private local investors) thought that implementation was not a problem, mainly because the first surveys on the public acceptance of renewables (in particular wind power) revealed very high levels of support. However, the first studies analyzing the conditions determining the effective support to the renewables already showed that public support could not be taken for granted. Carlman (1984), one of the first researchers to assess this question, carried out a study on the acceptance of wind power among decision-makers and concluded that siting wind turbines was closely related to important issues such as: public, political, and regulatory acceptance. Other studies followed and revealed a growing concern in key aspects, such as the lack of support from key stakeholders, lack of commitment and dedication from policy makers and the lack of understanding of public attitudes regarding renewables and the underestimation of the importance and significance of issues such as effects on the landscape (Wüstenhagen *et al*., 2007).

The debate on social acceptance is extremely rich and continuously changing, because there are several features of renewable energy innovation that bring constantly new aspects to consider. First, renewable energy plants tend to be of smaller scale than conventional power plants, increasing the number of location decisions to be made. Secondly, given the widespread presence of externalities of the energy sector, most renewable energy technologies do not compete with existing technologies on the same level, thus making their acceptance a choice between short-term costs and long-term benefits. Thirdly, resource extraction in fossil or nuclear energy happens below the earth` surface and thus is invisible to most of the citizens, while in renewable plants the energy production is highly visible and closer to where the energy consumer lives: the "backyard" (Wüstenhagen *et al.*, 2007). This has been heavily discussed, generating some controversial opinions. We now discuss key aspects concerning this debate:

i) NIMBYism

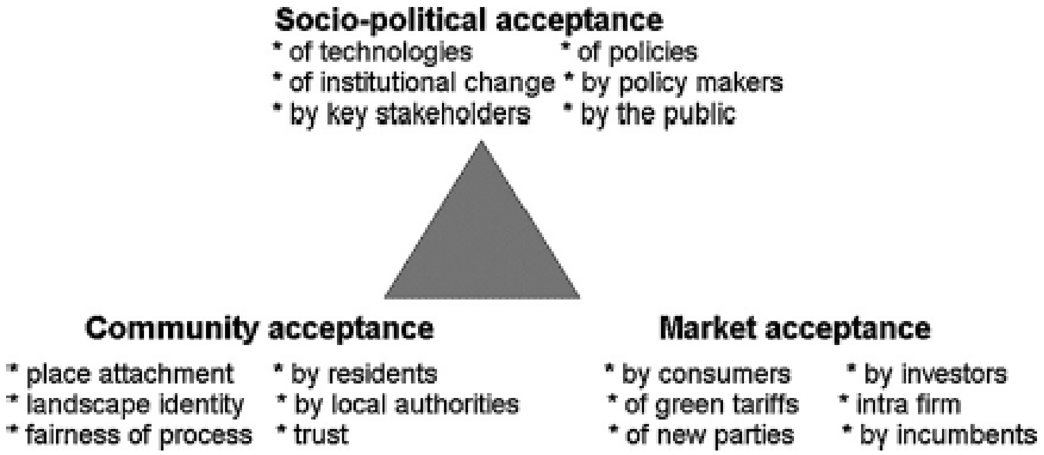
Although the existing research shows that renewable energies are generally supported by the public opinion, when deciding the location of specific renewable energy projects, these often face resistance from the local population. This local resistance towards renewable energy developments is often explained by the Not-In-My-Backyard (NIMBY) syndrome, which has been questioned by some authors such as Wolsink (1994, 2000, 2006, 2007) who has studied the validity of the NIMBYism for the specific case of wind power. According to Wolsink, the NIMBY explanation is too simplistic and considers it at most only a secondary issue for people opposing local renewable energy projects. Instead, Wolsink considers that institutional factors are highly important and that open collaborative approaches from the involved actors are crucial to the development of the renewable energy technologies. In another study, Bell et al. (2005, p.460) stated that “the NIMBY concept has rightly been criticised on the grounds that it fails to reflect the complexity of human motives and their interaction with social and political institutions”. Many studies have concluded that the NIMBY concept is inadequate, but few have proposed alternative solutions. A notable exception is Devine-Wright (2009)’s work in explaining NIMBY responses as “place-protective actions”. This new “psychological framework” reframes the issue stating “that so-called “NIMBY” responses should be re-conceived as place-protective actions, which are founded upon processes of place attachment and place identity. This enables a deeper understanding of the social and psychological aspects of change arising from the siting of energy technologies in specific locations” (Devine-Wright, 2009, p. 432). Knowing this, one could hardly expect a confined acronym such as NIMBY to fully capture oppositional attitudes toward RES.

ii) A Three Dimension Model for Social Acceptance of Renewable Energy Innovations

There are several indicators that can be used to measure social acceptance in a particular context (e.g. Moula *et al.*, 2013; Venkatesh and Bala, 2008; Devine-Wright, 2008). Among these there are the participants, their socio-economic background, age group, political beliefs, attitudes and behaviour. Moreover, the perceived usefulness, intention to use, facilitating conditions, cost, trust, place, participants position in relation to the renewable energy all play a vital role.

There is no doubt about the complexity involving the debate around social acceptance of renewable energy innovations. In the study developed by Wüstenhagen *et al.* (2007, p. 2684), the authors present a multi dimension model to clarify the concept of social acceptance of renewable energy innovations, introducing important concepts such as socio-political acceptance, community acceptance and market acceptance. This original model was then adapted and enriched with some additional details by Wolsink (2012, p. 827) as the following figure shows.

Figure III.43: The Triangle of Social Acceptance of Renewable Energy Innovation



Source: Wüstenhagen *et al*. (2007); Wolsink (2012)

Socio-political acceptance is considered by Wüstenhagen *et al.* (2007, p. 2684) as "social acceptance on the broadest, most general level". Policies and technologies can be subject to societal acceptance (or lack thereof). Socio-political acceptance helps establish conductive conditions for implementing innovations. It is about the willingness among actors (public, key stakeholders and policymakers) to generate institutional changes and policies that create favourable conditions for new technologies (Wolsink, 2012). Several indicators demonstrate that public acceptance for renewable energy technologies and policies is high in many countries and this is confirmed by opinion polls where broad majorities of people tend to agree with the idea of public support for renewables. For instance, the results of a survey taken among the European population showed that almost nine out of 10 (88%) expect that in 2050 Europe will use more renewable energy (EC, 2011, p.40). This positive overall picture for renewable energy has (mis)led policy makers to believe that social acceptance is not an issue. However, as several authors proved, namely Toke (2002) and Bell *et al*. (2005), although public opinion surveys have consistently revealed high levels of public support, the reality reveals that only a part of contracted renewable energy capacity is actually commissioned. We may conclude that there is indeed a problem that needs to be thoroughly analysed so that it may be better understood.

Besides socio-political acceptance, community acceptance and market acceptance are crucial for the renewables integration at a particular location and in a community.

Community involvement and acceptance are essential to renewables deployment. Walker *et al*. (2010, p. 2655) argues that "A community approach will change the experience and outcomes of energy technology implementation, in ways which can, for instance, avoid the recent history of opposition to wind farm development, promote locally appropriate and beneficial technology trajectories and generate greater understanding and support for renewable energy investments". Studies on this subject show that some factors seem to be crucial to a successful renewable project, namely: a collaborative decision-making process, employing effective forms of community involvement; projects which the community can strongly identify with, as a result of effective involvement and participation in the sitting process or due to high community involvement in the management and/or ownership; the perception of how well the new system "fits" into the identity of the community; decision-making process perceived as being fair; and the existence of mutual trust between community members and the investors and owners of the infrastructure (Devine-Wright *et al.,* 2007; Walker and Devine-Wright, 2008; Walker *et al*., 2010; Wolsink, 2012). The existence of trust is indeed very important as Walker *et al*. (2010, p. 2662) highlight by stating "Trust between local people and groups that take projects forward is part of the package of conditions which can help projects work and for local people to feel positive about getting involved and about process of project development". However, it must be noted that community cohesion and trust is not universally ensured just because a project is given a community label: what is possible in one context, may not be elsewhere and in this sense understanding the social context of innovation and technology diffusion is just as important as its technical dimensions (Berkhout, 2002).

Finally, we have market acceptance, or the process of market adoption of an innovation. One of the main problems associated with the green power marketing (and trading) is the separation between (physical) supply and demand. In the renewable energy market, residents have the opportunity to "switch" to renewable energy supply without being actually involved in the physical generation. However, if consumers demand increasing amounts of green power, there still need to be sitting processes for power plants to supply this demand. This lack of equilibrium and consensus is identified in several countries, namely in the Netherlands, in which there is a lot of demand for renewable energy but not enough social acceptance to build the corresponding supply infrastructure (Wüstenhagen *et al.,* 2007). In the context of market acceptance, the actors (incumbents, investors, new firms and consumers) have an important role and their willingness-to-pay (WTP) or to invest in renewable energy projects is extremely important (Wolsink, 2012). There are several studies trying to establish estimates of WTP for renewables and a vast number tends to focus on the "green tariffs". For instance, in the study carried out by Diaz-Rainey *et al*. (2009), the authors tried to explain the large disparities observed between green energy tariffs and WTP for such tariffs. The reality shows that the number of consumers who opt for green tariffs is far below the stated preferences estimates made in the numerous WTP studies. These disparities are explained by several factors, namely by the upward response bias and by the free rider problem, among others, but the main conclusion of Diaz-Rainey *et al*. (2009, p.13) is that a "high energy price environment may be inconsistent with policies to support voluntary consumer contributions towards renewables investment through green energy". Therefore, the effectiveness of the voluntary green tariffs in increasing the investment in renewables may be questionable without other policies to encourage renewables growth, namely feed-in systems that generate rewards for any actor that directly invests in renewables (Wolsink, 2012). To better understand the concept of market acceptance, it is important to extend our analysis beyond the consumer and highlight also the investor (note that consumers can simultaneously be investors). For instance, large renewable energy firms are subject to several path dependencies and issues such as how social acceptance is built between these firms (intra-firm acceptance) are relevant. Moreover, other aspects to consider are: how international companies act in different countries, how their position (usually important) affects the opportunities of other potential investors and how they use their influence in the crucial political decisions (Wüstenhagen *et al.,* 2007).

This model has the merit of clarifying the complex concept of social acceptance through its different components. Factors influencing socio-political, community and market acceptance are increasingly being recognized as crucial to understand the apparent contradictions between general public's support for the renewables and the difficult implementation of specific projects.

III.6. Concluding Remarks

In this Chapter, we proposed to demonstrate that despite the unquestionable advantages of using RES, it is crucial to identify and consider its negative impacts; they exist and must not be ignored in any analysis on the renewables that aims to be complete and efficient.

The use of the renewables for energy generation offers several advantages, namely: they cause less environmental impacts in comparison to fossil fuel resources; they cannot be depleted; they are relatively independent of the cost of oil and other fossil fuels; and are particularly advantageous in developing countries, representing a key contribution to the achievement of better standards of living.

In the specific case of Portugal, a privileged country in terms of sun exposure, wind speed, river resources and an extensive forest area, the use of the renewables for electricity generation seems to be a good decision. However, RES are not free of negative impacts and, although the public attitude towards them is generally positive, local people may react negatively to some specific projects. This lack of acceptability is justified by some adverse environmental impacts caused by the activity of the power pants. As common effects of renewables are the impact on landscape; the occupation of land and the opportunity cost of the area occupied; and the effects on fauna and flora. More specific to each source is the noise effect in the case of wind power, and to a less extent hydropower; specific to photovoltaic solar energy is the glare effect and the rise in soil temperature. Hydropower dam installation implies, in most cases, the destruction of some heritage, which may represent a significant social impact.

CHAPTER IV: SURVEY CONSTRUCTION AND DESIGN ISSUES

IV.1. Introduction

In this study, we use two stated preference (SP) methods: the contingent valuation (CV) and the discrete choice experiments (DCE) methods. These are survey-based approaches that use constructed or hypothetical markets to elicit preferences for specified policy changes. In order to attain our main goal, that is, to contribute to the economic valuation of environmental impacts generated by electricity production through renewable energies in Portugal, we have constructed CV and DCE surveys to be distributed among the Portuguese population. As far as we know, no national survey has been conducted and no data is currently available concerning the environmental impacts of the renewables in Portugal. Even in the international context, we find studies on the environmental impacts of renewable energy, but most of these only focus on a single renewable energy source.

The use of CV and DCE questionnaires is a key tool in our study, allowing us to gather determinant data, namely on individuals` perceptions about the renewables environmental impacts, on individuals` preferences in hypothetical circumstances, and socio-demographic features. The design and construction of a good questionnaire is far from an easy task, but it is crucial to obtain accurate answers and, as stressed by Arrow *et al.* (1993), the burden of proof of a study reliability rests on the survey designers. Aware of this fact, in addition to literature reviews and experts consultations, we have resorted to the use of qualitative research methods which have proved to be extremely helpful in distinct stages of the questionnaires` design.

This Chapter is organized as follows. Section IV.2 provides some insights on the individuals` "rational" behaviour when expressing their preferences and the importance of an accurate survey design process in order to achieve "rational" answers. Then, in Section IV.3, it is explained the importance of the use of qualitative research methods, such as the focus groups and the "think aloud" technique. Sections IV.4 and IV.5 focus, respectively, on the main issues regarding the DCE and the CV survey design processes. Finally, Section IV.6 concludes.

IV.2. Rationality in Individuals` Answers

The concept of "rationality" and "rational" choices has been a key subject widely debated in Economics (e.g., Simon, 1959; Sugden, 1991; Smith, 1991; Palma *et al*., 1994; McFadden, 1999; Ben-Akiva *et al.*, 1999). Normative accounts of rationality assume that individuals make use of all available information to form perceptions and beliefs following strict Bayesian statistical principles, and then choose the option that maximise utility given constraints, irrespective of context (San Miguel *et al*., 2005). As stressed by Simon (1959), the rational man of economics is a maximiser, who will settle for nothing less than the best.

This study relies on the use of two stated preference (SP) methods to elicit individuals` preferences: the contingent valuation (CV) and the discrete choice experiments (DCE) methods. In these approaches, surveys represent a key tool to gather reliable data on respondents. In the CV approach, the survey is designed to elicit information about respondents WTP or WTA for environmental goods. In the DCE approach, individuals are presented with different choice sets and are asked to choose one of the options for each choice set. In both techniques, a good questionnaire design is crucial to ensure that individuals are answering in a "rational" way such that responses can be interpreted as being meaningful.

It is however important to underline that the respondents' task of answering the SP questionnaires, particularly the DCE questionnaires, is far from being simple. It involves comprehension, construction, translation and editing. The complexity of these tasks varies from technique to technique. Typical CVM applications require respondents to consider the details of a base case and one alternative scenario, and then to answer one dichotomous choice question. Typical CM applications, such as DCE, require respondents to understand, in general terms, the attributes of an option, the way those attributes may vary across a number of levels and the way various combinations of attributes at varying levels may result from the alternative resource use options under consideration. They also require respondents to make a number of choices between multiple alternatives. Clearly the task complexity and cognitive burden facing DCE respondents is likely to exceed that of CVM in most cases. In general, the complexity of a given conjoint task depends inter alia on the number of alternatives in each sub-task or choice set, the number of attributes used to describe the alternatives, the correlation structure of the attributes among alternatives, and the number of repetitions (Bennet and Blamey, 2001).

Faced with this task complexity, in conjunction with the limited time and/or cognitive abilities of respondents, respondents' behaviour when expressing their preferences is often not as "rational" as one would expect, namely: instead of existing prior to the task, many preferences are constructed by individuals only at the time the valuation question is asked (Payne *et al.*, 1992; 1999); in many situations, individuals make choices based on a single attribute which they consider to be a priority and avoid making tradeoffs between decreases in certain attributes for increases in other (Payne *et al.,* 1993;1999; Gigerenzer *et al*., 1999; Luce *et al.*, 1999); when faced with complex decisions, individuals often rely on a number of simplifying heuristic principles, leading to severe and systematic errors (Tversky and Kahneman, 1974; Bennet and Blamey, 2001; Cairns *et al*., 2002; Cheraghi-Sohi *et al*., 2007); and individuals may show some fatigue in executing their task of responding to the questionnaires, which may lead to an increasing error component (Bennet and Blamey, 2001). These examples of "irrationality" in respondents' preferences may be due to an improper SP questionnaire design. For instance, if task instructions and questions are poorly worded, ambiguous or even misleading, it is unlikely to obtain reliable and valid results (Lancsar and Louviere, 2006).

However, it may be possible to avoid or, at least, minimize such errors or misunderstandings by carefully designing and piloting questionnaires with these issues in mind. One avenue for investigation is the increased use of qualitative research methodologies, such as the focus groups and the "think aloud" technique. These methods are crucial for understanding respondents` ideas, beliefs and behaviours, providing valuable information to be used in the design of reliable and complete CV and DCE surveys.

IV.3. Qualitative Research Methods: Focus Groups and "Think Aloud" Technique

Qualitative research is the method of choice when the research question requires an understanding of processes, events and relationships in the context of the social and cultural situation. Instead of generating numerical data, qualitative research aims to produce factual descriptions based on face-to-face knowledge of individuals and social groups in their natural settings (Sullivan and Ebrahim, 1995). Qualitative research includes specialized techniques for obtaining in-depth responses about what people think and how they feel (Dongre *et al.,* 2010). In this study, we used the focus groups and the "think aloud" technique.

Focus groups have its origins in group interviews (Banks, 1956; Goldman, 1962), but were brought into prominence by market researchers during the late 70s and 80s (Bellinger *et al*., 1976; Calder, 1977; Linda, 1982), particularly in social research (Stycos, 1981; Morgan and Spanish, 1984; Basch, 1987). Today, they are used widely by all kinds of social researchers. According to Krueger and Casey (2009, p.6), five characteristics define a focus group: "(1) people, who (2) possess certain characteristics, (3) provide qualitative data (4) in a focused discussion (5) to help understand the topic of interest". Each group is typically composed of 5 to 10 homogeneous participants, led by a skilled interviewer who is not in a position of power influence: his role is to ask questions, listen, keep the conversation on track and make sure everyone has a chance to share. In a focus group study, researchers carefully plan discussions specifically designed to listen, obtain perceptions and better understand how people feel or think about a certain issue. The resulting qualitative data offers a robust alternative to more traditional survey methods when absolute numbers of respondents are less important than is a rich investigation of content (Dawson *et al*., 1993; Krueger and Casey, 2009; Massey, 2011).

In this study, we used the focus group method with the purpose of confirming if the attributes and levels selected through literature reviews and expert consultations were the same identified by the focus groups participants or even if we should consider more attributes.

"Think aloud" is the other valuable qualitative research technique used in this study. This method has long been used in psychological research in order to study task-based cognitive processes. The theoretical framework for "think aloud" experiments is provided mainly by the work of Ericsson and Simon (1984) who base their theory of verbalization on the information-processing approach in cognitive psychology, i.e., they assume that human cognition is information processing. Today, the "think aloud" method is accepted and considered a useful method by a large part of the scientific community (Someren *et* *al.*, 1994). The “think aloud” technique is used to investigate respondents` choices. With this purpose, cognitive interviewing is employed, where participants are asked to think aloud as they complete the questionnaires, verbalizing all thoughts that would normally be silent. Participants are not asked to explain the reasons for their thoughts, or provide any commentary, but just report the information that they are currently thinking about. With this method, we get direct data on the ongoing thinking process of respondents during their activity of answering our questions (Ericsson and Simon, 1984; Someren *et al.*, 1994; Gilhooly and Green, 1996). This is known as the concurrent “think aloud”, but relevant qualitative data can also be obtained through the retrospective “think aloud” in which respondents are asked to describe what they were thinking after the task has been completed (Ericsson and Simon, 1984; Ryan *et al.*, 2009). In this study, we adopted the combination of these two “think aloud” techniques, with the main concern of verifying whether the information provided in the questionnaires was correctly interpreted and understood by respondents.

IV.4. DCE Survey Design

Discrete choice experiments (DCE) is a survey-based methodology for modelling preferences for goods, in which goods are described in terms of their attributes and of the levels that these take. Respondents are presented with various alternative descriptions of a good, differentiated by their attributes and levels, and are asked to choose their most preferred. By including price/cost as one of the attributes of the good, WTP can be indirectly recovered from people`s choices.

IV.4.1. Defining Attributes and Levels

Choosing the attributes and levels to be included in the choice set is a task of crucial importance in any discrete choice experiment. The selected attributes and levels must respect a number of requirements. First, the attributes and levels included in the experiment should be relevant for the policy making process as well for the different renewables producers. This implies, in general, that attributes and levels included in the experiment should ideally be associated with actual potential measures or choices. For instance, the location of different renewables’ power plants (dams, wind farms, photovoltaic farms and biomass power plants) is a highly relevant issue. If the producers of these renewables are interested in differentiating and developing their product in accordance with what electricity consumers actually prefer they should locate new renewables power plants where the perceived negative environmental impacts are relatively small. Similarly, if a renewable specific adverse environmental impact is judged to constitute a significant negative attribute, the energy companies will have an incentive to lower this impact. These choices could also be influenced by the policy making process through regulation and/or different economic instruments. Second, the respondents must also perceive the attributes and levels as relevant. This implies that the environmental impacts that are considered important by the public should also be included as attributes in the choice experiment. Furthermore, the attributes should vary across levels that are considered realistic by respondents. If the included attributes or the levels attributes are not perceived as relevant by respondents or if an attribute considered as important is excluded, this could influence the respondents negatively and the number of valid responses would decline (Garrod and Willis, 1999, Bennet and Blamey, 2001, Ek, 2002).

Identifying the set of attributes and the levels these take is a key phase in DCE design. This is done through literature review, expert consultations and focus groups.

IV.4.1.1. Literature Reviews and Expert Consultations

In this research study, the attributes and associated levels are the renewables main impacts on the environment and people`s lives. After an extensive literature review on this subject and consultations among the experts on this subject, we have selected a significant set of attributes and levels for each renewable energy source.

Regarding wind power, a thorough review of the literature indicates landscape intrusion (e.g. Wolsink, 2007; Gordon, 2001), land use impacts (e.g. Manwell *et al*., 2009; Denholm *et al.*, 2009), noise pollution (e.g. Pedersen *et al.*, 2009; Van den Berg, 2005, 2006), impacts on fauna and flora (e.g. Mendes *et al*., 2002; Travassos *et al*., 2005), and electromagnetic interferences (e.g. Manwell *et al*., 2009) as the most significant negative effects associated with the operation of the wind farms.

Hydropower also presents negative impacts. According to the existing literature on this renewable, dams are responsible for causing adverse impacts on the natural and social environments of the local communities, including biodiversity limitation (e.g. Rosenberg *et al.*, 1997; Abbasi and Abbasi, 2000), impacts on fauna and flora (e.g. Awakul and Ogunlana, 2002; Han *et al.*, 2008; Tullos, 2009; Wang and Chen, 2013), flooding of large areas of farmable land (e.g. Rashad and Ismail, 2000; Wang *et al.*, 2013), water quality degradation (e.g. Rashad and Ismail, 2000; Wang *et al.*, 2010), landscape intrusion (e.g. Ouyang *et al.*, 2010; Theobald, 2010; Morgan *et al.*, 2010; Zhao *et al.*, 2012), destruction of architectural, historical and archaeological sites (e.g. Pinho *et al.*, 2007; Han *et al.*, 2008; Gunawardena, 2010; Bakken *et al.*, 2012; Ferreiro *et al.*, 2013), noise (e.g. JKA, 2010), among others.

In relation to photovoltaics, the literature stresses that some of the environmental burdens caused by the operation of the photovoltaic farms affecting considerably the local communities` wellbeing are land use impacts (e.g. Sarlos *et al.*, 2003; Lackner and Sachs, 2005), eventual reduction of farmable land (e.g. Tsoutsos *et al.*, 2005; Srinivasan, 2009), thermal pollution (Gunerhan *et al.*, 2009), fragmentation of the countryside (e.g. Chiabrando *et al.*, 2009), landscape intrusion (e.g. Tsoutsos *et al.*, 2005; Torres-Sibille *et al.*, 2009), impacts on fauna and flora (e.g. Chiabrando *et al.*, 2009), glare effect (e.g. Clifford, 2013; Rose and Wollert, 2014), and electromagnetic interference (e.g. Chiabrando *et al.*, 2009).

Finally, the literature on forest biomass associates forest biomass power plants to some adverse impacts, affecting particularly the wellbeing of the residents living in the proximities of the facilities. Soil fertility loss (e.g. Lamers *et al*., 2013; Armolaitis *et al.*, 2013), biodiversity limitation (e.g. Jonsell, 2007; Siitonen, 2001), air emissions from combustion (e.g. Miranda and Hale, 2001; Schlamadinger and Marland, 2001) and landscape intrusion (e.g. Dockerty *et al*. 2012; Upreti, B. and Horst, D. 2004) are some of the environmental burdens associated with the operation of the FBPP, causing a considerable welfare loss for the local communities

Additionally, there is the cost attribute, which allows the estimation of the monetary amount individuals are willing to pay for having electricity generated by a specific renewable energy source. The cost attribute is of particular importance in a discrete choice experiment since the cost coefficients (when interpreted as an estimate for the marginal utility of income) can be used to calculate the marginal WTP for the other attributes included in the discrete choice experiment. Studies have been made investigating how the cost attribute and different level ranges affect preferences (e.g., Hanley *et al*., 2005; Mørkbak *et al*., 2010; Ryan and Wordsworth, 2000; Pedersen *et al*., 2011). The use of different payment vehicles has also been shown to have an impact on preferences (e.g., Ratcliffe, 2001; Skjoldborg and Gyrd-Hansen, 2003), just as the ordering of the attributes has been shown to influence the estimates, leading to a recommendation of placing the cost attribute at the bottom of the choice sets to follow a precautionary principle (Kjær *et al*., 2006). For instance, Carlsson *et al*. (2007) examined how different cost levels within the same range affected preferences, i.e. they compared a DCE with a cost attribute with varying levels to a discrete choice experiment with a cost attribute with a constant positive level, and found that the different inclusions of the cost attribute not only affected preferences but also affected the ranking of the preferences.

Taking into account these theoretical considerations on the cost attribute, we have chosen the monthly electricity bill as the payment vehicle, a common form of payment to all households and which does not raise any doubt in practical terms. For this attribute, we have initially selected three levels: 6 €, 10 € and 14 €, but after a further reflection namely on the current low purchasing power of most Portuguese households and after "listening" the opinion of the participants in the focus groups and "think aloud" sessions (see next section), we have decided to reduce these values to: 4€, 8€ and 12€.

IV.4.1.2. Focus Groups

In this stage of eliciting attributes and levels, the use of a qualitative research method such as focus groups may be extremely useful, allowing to gather qualitative data on individuals` thoughts, beliefs and doubts. In this study, we used the focus group technique with the purpose of confirming if the attributes and levels selected through literature reviews and expert consultations were the same identified by the focus groups participants or even if we should consider more attributes. We next describe the recruitment, procedures and results of focus groups discussions conducted in the context of our study.

Recruitment

The participants of the focus groups were recruited through a face-to-face approach. The recruitment took place in a higher education school in Coimbra, Portugal, where individuals are mainly students and are over 18 years old. The recruitment was made by a teacher of the school. There were no specific eligibility criteria: all individuals were invited to participate in the study, regardless of age (but over 18), gender, occupation (besides studying) or any other specific characteristic. A total of 25 participants were recruited. These individuals had in common certain characteristics: they were all aged over 18 and were higher education students, ensuring a certain homogeneity in the group.

Procedures

On November 21, 2013, 25 participants were recruited and separated into 3 groups: the first group with 10 elements, the second with 8 elements and the third with 7 elements. These groups' compositions between 7 and 10 elements are important to simultaneously ensure a certain diversity of opinions and avoid the tendency for the group to fragment. The procedures were the same for all the three groups, differing only in the starting time of each discussion. Each group was sent to a room, considered to be a comfortable and permissive environment, where participants sat around a table in order to maintain visual contact with each other. Then, the interviewer succinctly presented the study, described the proposed task, informed participants that the session would be audio-recorded, and that collected information would be confidential and only used for this study. Next, all respondents received and signed an informed consent form.

Following these procedures, the interviewer presented for discussion the following three questions through a questioning route:

Question # 1: "*You might have already heard of renewable energy to produce electricity. Do you know any? Which do you know?"*

Question # 2: *"What are the impacts or effects on the environment and people's lives of using these energies?"*

Question # 3: *"Which impacts do you think are the most important or most serious?"*

As soon as the first question was made, participants voluntarily began giving their opinions and talking to each other. Then, when the interviewer considered the question was completely discussed, the second question was made and, after its discussion, the interviewer presented the third and last question, following the planned questioning route. During the session, the three questions were only supplemented with additional questions when required for clarification or to get more detail on a particular issue. It is important to emphasize that the role of the interviewer is mainly to be a moderator, i.e., to ask questions, listen, keep the conversation going, ensure that all participate, without giving his opinion nor exercise any kind of influence on the participants responses. This task lasted between 21 and 34 minutes, it was audio-recorded with the consent of all respondents and then all speech during the task was transcribed verbatim.

Results

With the three focus groups we obtained important qualitative results. The participants' answers and comments allowed us to conclude that individuals were familiar with most of the renewables, specially wind power, hydropower and photovoltaic energy. Regarding biomass, however, we observed that the majority of respondents did not know any specific biomass plant, they presented many doubts about the involved electricity generating process and consequently were not able to talk about the impacts associated with this energy source. Therefore, we conclude that biomass is the least known of the four RES in analysis. The following quotations confirm this lack of knowledge and doubts about biomass:

I have already heard of biomass, but I did not know there was one in Mortágua. [Respondent 2/Group 2]

I do not know how to explain it, but I think that biomass has to do with materials that are degradable… and then there is a kind of process that can turn the heat into energy… I'm not sure how it is. [Respondent 3/Group 3]

I do not know if it's good, if not... [Respondent 2 /Group 2]

It maybe causes pollution, no? [Respondent 6 /Group 2]

Regarding renewables' impacts on environment and people's lives, the results are also very enlightening. Most respondents were able to identify the impacts associated with each RES, with the exception of biomass. In the specific case of wind power, all respondents knew well this energy source and were able to identify at least one of its main impacts, namely visual impacts, impacts on fauna or flora, and noise impact. The following quotations show some of these impacts:

They are not exactly beautiful. [Respondent 2 /Group 1]

If I had to listen to that noise all day, maybe bother me. [Respondent 4 /Group 1]

I do not know to what extent that is true about migratory birds because the winds ... if this is true, it is a negative point. [Respondent 3 /Group 2]

The wind makes a bit of noise. [Respondent 3 /Group 3]

We get used, but is never comfortable. [Respondent 4 /Group 3]

Hydropower is also well known by respondents and its main impacts were also identified by the majority, namely visual impacts, impacts on fauna or flora, and heritage impacts. It should also be noted that an additional impact was identified by one participant: the noise impact, affecting resident population near a dam (Respondent 5 /Group 2). The following quotations confirm the respondents' ability in identifying these impacts:

It interferes with ecosystems, creating a barrier for certain ecosystems that did pass by there… and can no longer make this passage. [Respondent 6 /Group 1]

It destroys habitats and landscapes! [Respondent 1 /Group 3]

It was build a dam and the village was drowned there and then the village had to be transplanted to other place. [Respondent 3 /Group 3]

It was in Alqueva dam… homes were underneath. Many people were left homeless because of the construction of that dam. [Respondent 4 /Group 3]

My grandparents live near the dam of Castelo de Bode and I do not really like the sound of running water. When the floodgates open, the noise bothers me. [Respondent 5 /Group 2]

Photovoltaic energy is another renewable analysed in this study. Respondents shown to be quite familiar with this energy source and its impacts: visual impacts, impacts on fauna or flora, and light reflection. The following quotations exemplify the identification of some of these impacts:

If I was in my house and in front was a field of photovoltaic, it would not be a very beautiful landscape. Besides that should do some interference... should do the mirror effect... [Respondent 7 /Group 1]

The solar panels make more confusion… It is less pleasing to the eye. [Respondent 7 /Group 2]

The light is reflected off. [Respondent 5 /Group 3]

The application of focus group technique allowed us to conclude that participants were familiar with the concept of renewable energy source and knew relatively well wind power, hydropower and photovoltaic energy. However, the participants showed a serious lack of knowledge about biomass. Participants also revealed being aware that RES have disadvantages to the environment and people's lives and they were able to identify the main impacts involved. In the case of hydropower, an additional attribute was identified by participants: the noise impact, which we decided to include in our DCE questionnaires. Due to some doubts presented by some participants, we also decided to complement the questionnaires with images of each renewable technology. The table below presents the resulting selection of attributes and levels for each RES.

Table IV.1: Selection of Attributes and Levels

RES	Attributes	Levels
Wind power	i) Significant impact on landscape	Yes; No
	ii) Significant impact on Fauna/Flora	Yes; No
	iii) Production of noise affecting population	Yes; No
	iv) Increase in the monthly electricity bill	4€; 8€; 12€
Hydropower	i) Significant impact on landscape	Yes; No
	ii) Significant impact on Fauna/Flora	Yes; No
	iii) Production of noise affecting population	Yes; No
	iv) Heritage destruction	Yes; No
	v) Increase in the monthly electricity bill	4€; 8€; 12€
Photovoltaic	i) Significant impact on landscape	Yes; No
	ii) Significant impact on Fauna/Flora	Yes; No
	iii) Reflection of light affecting population	Yes; No
	iv) Increase in the monthly electricity bill	4€; 8€; 12€
Forest Biomass	i) Significant impact on landscape	Yes; No
	ii) Significant impact on Fauna/Flora	Yes; No
	iii) Production of odor affecting population	Yes; No
	iv) Increase in the monthly electricity bill	4€; 8€; 12€

Source: Author`s elaboration

IV.4.1.3. "Think Aloud" Technique

After concluding this initial stage of attributes and levels selection, we have designed a first version of four individual questionnaires, one for each RES, and three comparison questionnaires (hydropower versus wind power; hydropower versus photovoltaic energy; wind power versus photovoltaic energy), excluding biomass of this comparison analysis, mainly due to the lack of knowledge that most focus groups participants expressed regarding this energy source.

In each questionnaire, different questions were presented in order to gather concrete information from individuals' answers and choices: in an introductory section, questions were made to assess the degree of respondents` familiarity with renewables; then follows a section of choices in which individuals were presented with several choice sets, each consisting of a number of attributes with different levels and asked to choose between two distinct forms of electricity production; in a third section, questions intended to know respondents general opinion about renewables; and finally, in a last section specific questions were made to collect information about individuals` socio, economic and demographic characteristics.

In this stage of the DCE questionnaires design process, it was important to verify whether the information provided and the questions presented in the questionnaires were correctly interpreted and understood by respondents. In order to accomplish this task, we used another valuable qualitative research technique: the “think aloud”. As the name suggests, in this approach, participants are asked to think aloud as they complete DCE questionnaires, verbalizing all thoughts that would normally be silent. This is known as the concurrent “think aloud”, but relevant qualitative data can also be obtained through the retrospective “think aloud” in which respondents are asked to describe what they were thinking after the task has been completed. In this study, we adopted the combination of these two “think aloud” techniques, which have proven to be determinant tools in the process of designing accurate questionnaires. We next describe the recruitment, procedures and results of “think aloud” sessions conducted in the context of our study.

Recruitment

As with the focus groups, recruitment took place in a higher education school in Coimbra, using a face-to-face approach. The recruitment was made by one teacher of the school and there were no specific eligibility criteria: all individuals were invited to participate in the study, regardless of age, gender, occupation or any other specific characteristic. A total of 8 respondent were recruited, individuals with different ages (but all over 18), different genders, different occupations (besides studying) and coming from different regions of Portugal. It is important to note that none of the participants of this “think aloud” session participated in the previous focus groups. Additionally, and with the intent of achieving greater variability in participants’ socio demographic characteristics, some recruitment was done in a church quire in Braga (City in north Portugal). Only 3 participants were recruited. As such, and to ensure anonymity we will not discriminate the two types of participants, such that the presented results are for the total respondents, including both samples from Coimbra and Braga. However, we stress that the Braga sample was composed by older (between 57 and 80 years old) and less educated people (with a maximum of 6 years of formal schooling).

Procedures

The think aloud sessions took place in Coimbra on November 28, 2013 and in Braga on December 11, 2013. All participants agreed to be audio-recorded while thinking aloud and answering the DCE questionnaires. Before commencing the “think aloud” task, each participant was read the following instructions, adapted from a set of “best practice” instructions for “think aloud” studies (Ericson and Simon, 1984; Green and Gilhooly, 1996):

We need your collaboration in a research project conducted by researchers of the University of Minho. Its main objective is the valuation of the environmental impacts associated with each of the various renewable energy sources. The following questionnaire is anonymous and confidential. Please respond with the greatest possible sincerity. We want to check that people understand the questions in the way that we meant them. To do this, I am going to ask you to think aloud as you complete the questionnaire. What I mean by “think aloud” is that I want you to tell me everything you are thinking as you read each question and decide how to answer it. I would like you to talk aloud constantly. I don`t want you to plan out what you say or try to explain to me what you are saying. Just act as if you are alone in the room speaking to yourself. If you are silent for any long period of time, I will ask you to talk. Please try to speak as clearly as possible, as I shall be recording you as you speak. Do you understand what I want you to do?

Any queries were dealt with at this stage by the main researcher and then, individuals received and signed the informed consent form. Once participants began the task proposed, they were not interrupted, unless they fell silent for about 10 seconds, in which case the main researcher prompted them to “keep talking” or “tell me what you are thinking”, in accordance with the “think aloud” protocol (Ericson and Simon, 1984; Green and Gilhooly, 1996; French *et al*., 2007; Darker and French, 2009). In some cases, participants preferred to answer the questionnaire first, and then replicate the though process developed. Retrospective think aloud was applied in these circumstances. Following this task, the main researcher asked respondents how they found the choices they were presented with. Each individual took approximately 30 to 40 minutes to complete the task, their speeches were audio-recorded with the consent of all participants and then were transcribed verbatim.

Results

By listening to respondents` thoughts as they were answering the DCE questionnaires, we obtained important qualitative results. Our sample is composed by a total of eleven individuals with the following socio demographic characteristics: six males (54,54%), seven aged between 18 and 29 years (63,63%), eight singles (72,72%) and eight currently studying in higher education school (72,72%). It is important to emphasize that, despite the small sample size, it represents a valuable insight for our study, providing researchers with important qualitative data. In several studies on qualitative research, the authors minimise or even deny the relevance of generalization (Denzin, 1983; Marshall and Rossman, 1989; Denzin and Lincoln, 1995). What really matters is the richness of the data obtained and the efficiency of the process of data collection, providing the reader with the information necessary to decide whether the findings might be transferable and relevant in other settings (Payne and Williams, 2005).

As already observed in the focus groups, in this "think aloud" session respondents demonstrated knowing relatively well all RES analysis, with the exception of biomass: 11 (100%) respondents said they knew well wind power and photovoltaic power; 9 (81,81%) knew well hydropower, but only 4 (36,36 %) reported having some knowledge on biomass. The following quotations are from some of the respondents who did not know biomass:

Biomass ... I do not know what it is. [Respondent 9]

I do not quite understand what it is. [Respondent 11]

In a DCE, it is important that individuals are willing to trade between attributes, avoiding making choices based on only a single dominant attribute. In this session, a significant percentage of respondents (54,54%) claimed to have made their choices based on all attributes. However, when asked to rank the impacts according to their importance in their decisions, respondents considered impacts on fauna and flora, impacts on landscape and low prices as the most important, followed by reflection of light impacts and impacts on heritage. The odor impacts were considered the less significant. The following quotations illustrate some comments made by respondents:

I always gave more attention to the landscape. [Respondent 2]

For me, I think the noise is the most important... and also the cost [Respondent 5]

Not destroying plants nor animals is important ... the houses are also important, but these can be rebuilt ... animals and plants cannot. [Respondent 11]

Regarding the cost attribute, respondents adopted distinct behaviours. In the DCE questionnaires, this attribute was associated with three different levels: 4€, 8€ and 12€. These values have been carefully chosen, taking into account the current economic context of the Portuguese families. In our sample, the majority of respondents belong to households composed by 3 or 4 elements (54,54%), earning a monthly income between 501 and 1000 € (72,72%) and paying a monthly electricity bill between 0 and 50 € (54,54%). The payment vehicle considered was the electricity bill. However, respondents were explicitly informed that there was no intention to introduce this extra cost on the basis of the answers obtained. It was observed that some individuals gave an extremely high importance to this attribute. The following quotations clear illustrate this behaviour:

In all the choices, I looked only to the value ...I always chose the lowest, because I'm not rich. [Respondent 3]

I really just thought about the price, because in my opinion it is what counts most. Things are very complicated, so I answered it based on the price of things. Independently of the others, I always chose the one with the lowest price. [Respondent 7]

It is also important to note that individuals stated they would buy most of the forms of electricity they have chosen at the associated prices (72,72%), with 50% of the choices made with a high degree of certainty (between 6 and 8 in a scale of 0 to 10) and 30% with a very high degree of certainty (between 9 and 10 in a scale of 0 to 10).

After completing the proposed task of concurrent thinking aloud while answering the questionnaires, each participant was asked to make a retrospective “think aloud” exercise, allowing researchers to access their thoughts and listen their opinions about the task they have just completed. In general, we observe that respondents understood the proposed task and, despite being unfamiliar with the questionnaire´s format, the majority of respondents found it reasonably easy to understand, getting used to it after a few scenarios. This is expressed in the following quotations:

I had no difficulty in making choices... [Respondent 1]

It was accessible. [Respondent 2]

At first I did not understand these tables here, but then I understood well. [Respondent 4]

I think the questions were clear...It did not raise any difficulty. [Respondent 5]

I knew more or less what the questionnaire was asking. [Respondent 6]

The language used was a coherent language. [Respondent 8]

Nevertheless, some respondents criticized the questionnaires for being too long, with many similar scenarios, generating some confusion expressed in the following quotations:

There were some choices that were a bit similar. [Respondent 5]

I think it is a bit confusing on the part of the choices ... It has many similar questions and it is a bit confusing. The choices are indeed very similar. [Respondent 7]

I think the questionnaire was a bit long and very repetitive ... The questions were often repeated. [Respondent 8]

These are just some of the comments obtained from the interviewed during the "think aloud" sessions and which were critical to the questionnaires improvement process, allowing us to carry out key changes in order to make the questionnaires more accurate, more realistic and more easily understandable by the general population.

IV.4.2. Key Issues in DCE Questionnaires

Considering all the comments gathered with the use of qualitative research techniques, particularly with the "think aloud" sessions, we proceeded to important changes in the DCE questionnaires with the main aim of simplifying the respondents' choice tasks. One of the main alterations regards the attributes composing each choice set. Initially, we have considered the attribute "size of the facility" with the levels "big" and "small", but then we have decided to remove it, since we have concluded that the dimension is not important by itself: what really matters is the intensity of the renewables impacts, which, in most cases, is associated to the facilities` dimension. In the case of the hydropower questionnaire, besides removing the "size" attribute, we added the attribute "noise affecting population", due to the fact that some respondents living near dams complained about this problem in the focus groups and "think aloud" sessions.

Associated with the latter change, there was a reduction in the number of scenarios combinations for each RES, excepting for the hydropower questionnaire. In the questionnaires of biomass, wind and photovoltaics, we reduced the number of choice sets from eight to six. In the hydropower questionnaire, we maintained the eight choice sets, due to the incorporation of an additional attribute. It is important to underline that in this choice experiment study, a full factorial design would involve a considerable high number of different choice sets, which would be a quite burdensome task for the respondents. Orthogonal main-effects design selects the combinations of attributes to be used by sampling from the full factorial (Louviere *et al.*, 2000). This experimental design procedure allowed us to reduce the number of choice sets to be presented to respondents, so that they do not consider the questionnaires too long and tiresome.

Another important alteration in the DCE questionnaires was: instead of having a comparing questionnaire for each pair of renewables (hydropower versus wind; hydropower versus photovoltaics; and photovoltaics versus wind), we adopted a single questionnaire comparing all the renewables where the energy source is an attribute with three levels renewables (biomass was intentionally excluded, due to the respondents lack of knowledge regarding this energy source). In this DCE questionnaires, respondents were presented with nine choice sets.

We have also changed the presentation of the alternatives in the choice experiments from the specific form (labelled) to the generic form (unlabelled). This alteration from labeled to unlabeled was particularly important. If labeled alternatives offer some advantages such as the reduction of the respondents' cognitive burden, since respondents may associate the label with the context, on the other hand, it has the disadvantage of leading respondents to focus on the label rather on the attributes and levels associated with the alternative. For instance, if one of the alternatives is labeled as the "green" hydropower alternative, environmentally oriented respondents may be prompted to choose that "green" alternative as a result of its label rather than after considering the levels of the attributes included in the alternative (Bennet and Blamey, 2001; Alpizar *et al*., 2001; Ek, 2002). Hence, we chose to use unlabeled rather than labeled alternatives, since the major focus in our analysis is on the marginal rates of substitution between the attributes and levels.

Finally, after realizing that if some respondents were highly familiarized with the renewables facilities (dams, wind farms, photovoltaic farms, and biomass power plants), there were others that presented some lack of knowledge regarding some or several renewables' infrastructures, we added some photography to the questionnaires. Hence, individuals were presented with a photograph of a dam, a wind farm, a photovoltaic farm, and a biomass power plant, which revealed to be a valuable tool, particularly for the respondents less familiarized with the RES.

After taking into account these changes, the final DCE questionnaires were divided in four parts. First, the degree of respondents` familiarity with renewable energy sources (RES) was assessed. Second, there was the DCE section, the main section, where individuals were presented with several choice sets (six choice sets for the forest biomass, wind power and solar photovoltaics questionnaires, eight choice sets for the hydropower questionnaire, and nine choice sets for the questionnaire considering all the renewables), each consisting of a choice between two alternative ways of producing electricity through the renewable being valued, differing on the levels of specific attributes. Due to its key role in the questionnaire, we next present one example of a choice set used in one of the renewables survey (we have chosen arbitrarily an example from the wind power questionnaire).

Table IV.2: Choice Set Example from the Wind Power Questionnaire

Consider the choice between form A of electricity production through wind power and form B of electricity production also through wind power. Please tick your preferred option:

	Form A	**Form B**
Significant impact on landscape	Yes	Yes
Significant impact on Fauna/Flora	No	Yes
Noise affecting population	Yes	No
Increase in the monthly electricity bill €	12	8
Your choice:	▢	▢

In this case, if, for instance, the respondent chose the option A, it means he chose to have in his home electricity produced through wind power that has a significant impact on the landscape, produces noise affecting the population, but has no impact on fauna and flora and costs more 12 euros per month. Instead of electricity produced by form B, which, despite being cheaper and not producing noise affecting the population, affects the fauna and flora. This choice allow us to conclude that this respondent prefers to pay more 12 euros per month to avoid negative impacts on fauna and flora, accepting the installation of a wind power facility which has significant impacts on landscape and generates noise affecting the population.

Each choice set was followed by specific questions to measure the degree of certainty with which individuals would really be willing to pay the amount associated to their choice. The questions were presented as follows:

Would you be willing to buy electricity the way you chose at the specified price?
▢Yes ▢ No

On a scale from 0 to 10, where 0 corresponds to "very little certainty" and 10 "absolute certainty", say with which degree of certainty you would pay the amount stated in your choice.
0▢ 1▢ 2▢ 3▢ 4▢ 5▢ 6▢ 7▢ 8▢ 9▢ 10▢

Although facing hypothetical scenarios, it is important to know the degree of certainty with which individuals evaluate their WTP in a real situation. Most of the studies on this issue confirm that individuals tend to overstate their actual preferences when asked a hypothetical question (Shogren, 1990; Seip and Strand, 1992; Neil *et al*., 1994; List and Gallet, 2001; Botelho and Pinto, 2002). Nevertheless, although possible biased, hypothetical valuations convey useful information about individual`s real WTP.

This section was followed by a third part of the questionnaires in which respondents answered questions concerning their general opinion about renewables. Finally, a last section included questions on individuals` socio, economic and demographic characteristics (e.g., gender, educational level, family situation, income, etc.) and environmental preferences.

Regarding the DCE questionnaire comparing all the renewables (biomass excluded given the lack of knowledge demonstrated by the general population with respect to this energy source) they present a similar structure, but with nine choice sets, each consisting of a choice between two alternatives ways of producing electricity, in which the energy source is an attribute with three levels renewables. One example of a choice set used in this survey is given in the following table.

Table IV.3: Choice Set Example from the DCE Questionnaire comparing all the Renewables

Consider the choice between form A and form B of electricity production. Please tick your preferred option:

	Form A	**Form B**
Significant impact on landscape	No	No
Significant impact on Fauna/Flora	No	Yes
Destruction of heritage	Yes	No
Noise affecting population	No	No
Energy source	Hydropower	Photovoltaic
Increase in the monthly electricity bill €	8	12
Your choice:	▢	▢

In this case, if, for instance, the respondent chose the option B for electricity production, it means the respondent chose to have in his home electricity generated by a photovoltaic farm that does not produce a significant effect on the landscape, does not destroy heritage, nor produces noise, but has a significant impact on fauna and flora and costs more 12 euros per month. Instead of electricity produced through hydropower, which, despite being cheaper and not affecting fauna and flora, destroys heritage. Given this respondent`s choice, we may conclude that the respondent prefers to pay more 12 euros per month to avoid heritage destruction, accepting a photovoltaic facility which has a significant impact on fauna and flora.

Similarly to the other individual renewable energy sources questionnaires, each choice set was followed by specific questions to measure the degree of certainty with which individuals would really be willing to pay the amount associated with their choice. The entire DCE questionnaires can be found in the appendix, the English version in appendix 1.

IV.4.3. Survey Logistics

Following the recommendations of most literature on non-market valuation (e.g., Arrow *et al.,* 1993), we used a face-to-face approach to present the DCE questionnaires. Despite having some disadvantages, such as the high administration cost and the possibility of introducing "interviewer bias", it presents several advantages, namely it allows the use of visual material and it usually generates high response rates.

During the first semester of 2014, a total of 1800 questionnaires were collected from a national sample as in-person interviews. Given the high number of questionnaires, this task was granted to a specialist firm properly trained for this purpose. For each renewable energy source questionnaires, we obtained 250 responses. For the questionnaire comparing all the renewables, we obtained 800 responses.

IV.5. CV Survey Design

As a stated preference (SP) method, the contingent valuation (CV) approach is based on the use of questionnaires, a crucial tool for gathering information. The validity and reliability of the obtained results are deeply related to the quality of the questionnaires design process. According to Carson and Hanemann (2005), a CV survey should contain: i) an introductory section that helps set the general context for the decision to be made;

ii) a detailed description of the good to be offered to the respondent; iii) the institutional setting in which the good will be provided; iv) the manner in which the good will be paid for (the payment vehicle); v) a method by which the survey elicits the respondent`s preferences with respect to the good; vi) debriefing questions about why respondents answered certain questions the way that they did; and vii) a set of questions regarding respondent characteristics including attitudes and demographic information.

In order to obtain an accurate CV survey, the researcher must take particular care with some key issues (Whitehead, 1999, 2006; Carson and Hanemann, 2005). A first critical issue regards the information provided to respondents. If on one side the interviewees need to be sufficiently informed to be able to make a decision, on the other, they should not be overwhelmed by the information. Furthermore, the provided information must be realistic, simple and not too extensive. A second issue concerns the "payment vehicle", that is, the way of paying for the change in resource allocation. Typical payment vehicles include increases in water or electricity bills, increases in state taxes, increases in related goods prices, fishing and hunting licenses stamps, and contributions or donations to special funds. It is essential that the payment vehicle be realistic, believable, and neutral. A third critical issue is the formulation of questions to help explain respondent WTP or WTA for the good. This procedure enhances faith in the responses reliability. Another issue that needs to be addressed in a CV survey is making respondents feel comfortable with making either a "favor" or "oppose" decision. In particular, respondents need to feel that while the technical details of the proposed program have been well-worked out, the implementation of the program is not at all a foregone conclusion and the public`s input via the survey will play an important role in that decision. One last critical issue concerns the choice of stimulus, such as cost amounts and the range of other attribute levels. Here, the use of qualitative research methods, such as focus groups and "think aloud" techniques, may be extremely valuable for the researcher by helping to elicit realistic and plausible attributes' levels. Being the CV surveys among the most challenging surveys to design, these issues are just some of the many key issues in the CV surveys (see Tourangeau *et al*., 2000; Mitchell, 2002; Whittington, 2002; Bradburn *et al*., 2004; Presser *et al*., 2004).

IV.5.1. Key Issues in CV Questionnaires

As in the DCE, in the CV questionnaire design process, the information collected from the literature reviews, expert consultations and qualitative research techniques were crucial to obtain accurate final versions of CV surveys. While in the DCE questionnaires, as we have already observed, the central part is the choice sets section, in the CV questionnaires the valuation question section is the most important part, allowing researchers to estimate the maximum willingness to pay (WTP) amount or the minimum willingness to accept (WTA) amount for an environmental good.

In this study, we have designed four CV questionnaires, one for each RES (hydropower, wind power, solar photovoltaics and forest biomass) in which the main aim was to estimate the amount that respondents were willing to accept as a compensation to all the burdens caused by the presence of a specific renewable energy source facility in the proximity of their residence. In the CV questionnaires, most questions were formulated as closed question, as they represent a lower burden on respondents, the only exception is the valuation question, which is formulated as an open ended question. The choice of an open-ended format was guided by the fact that using a closed format is only the best choice if there is some prior information of the distribution of WTA values in the population that can guide the choice of the WTA amounts proposed in the questionnaire. Given the total absence of this information we had no alternative to formulating the valuation question as an open-ended. Another important design choice concerns the payment vehicle. In this application the most obvious payment mechanism was a return in the monthly electricity bill, due to the fact that most households are familiarized with this payment form.

Following Whitehead (2006), each questionnaire was composed of four sections. After an introductory section with general questions on the renewables, section 2 presented several questions on the production of electricity from the renewable being valued, of which we highlight, for its relevance, the valuation question and the question on respondent's certainty regarding the stated WTA amount. Due to the fact that we had no prior information on the distribution of respondents' valuation for choosing the thresholds for a discrete-choice format, the valuation question was formulated as an open question.

The payment vehicle chosen was a return in the electricity bill. For instance, in the forest biomass CV questionnaire, these questions were made as follows:

Taking into account your income and your usual expenses, answer the following question:

What is the minimum amount that you would be willing to receive as compensation for the inconvenience that the presence of the biomass thermoelectric plant causes to you? The amount would be credited to your monthly electricity bill.

You would be willing to receive? _______________ *Euros per month.*

This question was followed by a specific question to measure the degree of certainty associated with the sated WTA amount. This questions was presented as follows:

On a scale from 0 to 10, where 0 corresponds to "very little certainty" and 10 "absolute certainty", say with which degree of certainty you would be willing to accept the amount stated in the prior answer.

0▢ 1▢ 2▢ 3▢ 4▢ 5▢ 6▢ 7▢ 8▢ 9▢ 10▢

For the respondents who stated a WTA amount of 0 euros, an additional question was made to understand the reasons justifying this answer. For instance, this question in the biomass questionnaire was made as follows:

If you answered zero, please indicate (with a cross) which of the reasons best justify your answer:

I do not consider relevant the impacts caused by the biomass power plant (they do not affect me)	
I do not think the impacts caused by the biomass power plant may be somewhat compensated by the payment of a monetary amount	
The biomass power plant has advantages	
I do not believe that anyone is willing to do this discount	

Then, section 3 of the questionnaire contained some additional questions on respondents' preferences and opinions on different energy sources, renewable and non-renewable. Finally, the questions in section 4, were made to gather information on the individuals' socio, economic and demographic characteristics (e.g., gender, educational level, family situation, income, etc.). The entire CV questionnaires can be found in the appendix 2.

IV.5.2. Survey Logistics

During the months of May, June and October of 2014, a total of 216 questionnaires were collected in the vicinity of 12 RES power plants sited in different regions of continental Portugal. Regarding hydropower, a total of 50 questionnaires were collected among the residents near four hydropower plants in the districts of Coimbra, Évora and Bragança. Regarding wind power, a total of 57 questionnaires were collected among the residents near three WFs in the districts of Vila Real, Viana do Castelo and Coimbra. Regarding photovoltaic power, a total of 61 questionnaires were collected among the residents near three PVFs in the district of Beja. Finally, regarding forest biomass power, a total of 48 questionnaires were collected among the residents near two FBPPs in the districts of Viseu and Santarém.

The sampling process consisted in inviting the population to participate in the survey by personal address in public places in the villages such as, public squares, coffee shops, commercial business and the like. All interviews were done privately by a research team including Professor Lígia Costa Pinto and Sara Sousa.

IV.6. Concluding Remarks

In this Chapter, the main issues regarding the DCE and CV survey designing process were discussed. In these SP approaches, the questionnaires are a key tool, allowing researchers to gather crucial data on the individuals` preferences and perceptions about the RES impacts, and socio-demographic features. In order to design accurate and reliable questionnaires, we used information collected from the literature review and expert consultations. Furthermore, we applied qualitative research methodologies, such as focus groups and “think aloud” technique, which were essential to ensure that the language and the content of the questionnaires were considered realistic, relevant, credible and easily understood by respondents. This intensive process of questionnaires` design resulted in five DCE questionnaires (besides the four individual questionnaires, an additional questionnaire was designed for all the RES, excepting the biomass) and four CV questionnaires (each questionnaire concerns a single renewable). All these stated SP questionnaires were conducted among different respondents, residing in different regions of continental Portugal, through a face-to-face approach, which allowed us to use visual material and to gather a considerable number of responses.

CHAPTER V: ECONOMIC VALUATION OF THE RENEWABLES ENVIRONMENTAL IMPACTS

V.1. Introduction

This chapter presents the results obtained from the data collected with the questionnaires discussed in Chapter IV. In total 2016 questionnaires were collected during the year of 2014. The objective of this chapter is to compare the preferences of residents in the vicinity of power plants with the preferences of the general population, and to compare residents' preferences between RES as well as general population preferences between RES.

To conduct the welfare analysis of residents in the vicinity of power plants we applied the CV surveys (appendix 2). In total 216 questionnaires were collected: 48 questionnaires in the vicinity of Constância and Mortágua forest biomass power plants; 50 questionnaires in the vicinity of Bemposta & Picote, Alqueva and Aguieira Hydropower Dams; 57 questionnaires in the vicinity of Caminha and Vila Pouca wind farms; and 61 questionnaires near Amareleja, Hércules and Ferreira do Alentejo solar photovoltaic farms. The data collected allows the estimation of residents' minimum willingness to accept (WTA) compensation. We assume that in deciding the amount of compensation, residents perform a two-stage process where they first decide whether they are entitled to compensation and then, if yes, what is the minimum amount (in integer numbers) they require as compensation. These two decisions may result from distinct processes, thus requiring the use of mixture models. The first decision is translated into a binary yes/no variable while the second is translated into an integer, positive number. In addition, WTA data is usually characterized by the existence of an excess number of zeros, and there might be over-dispersion of the data. To accommodate these specificities of the data collected we use a zero-inflated binomial model in the econometric analyses of the WTA decisions.

To elicit the preferences and welfare changes of the general population regarding RES power plants we used five different DCE surveys: four individual questionnaires for each renewable energy source (photovoltaics, wind, forest biomass, and hydropower), and one comparison questionnaire in which the source of energy is a choice variable (appendix 1). In total we collected 1800 questionnaires, 250 for each individual source and 800 for the comparison questionnaire. The questionnaires were administered by a professional firm on a national sample (Continental Portugal) through personal interviews. In our DCE surveys, respondents are asked to choose between two alternative forms of producing electricity with RES for a specified price increase. Thus, each subject is observed in several repeated choices transforming our data set into a panel. As the choices are binary and we have repeated observations for the same respondent, we model the data with a binary logit model with observations clustered at the individual level.

The selection of explanatory variables was firstly guided by previous studies. However, estimation feasibility due to data specificities, namely perfect collinearity between independent variables was also a necessary consideration.

In addition to the introduction, this chapter is composed of six sections. Section V.2 describes the samples using descriptive statistics. Sections V.3 to V.6 are devoted to the analysis of the data pertaining to each RES, and section V.7 is dedicated to the comparison between sources. These sections contain a summary of the main econometric results obtained from the data. Section V.8 concludes the chapter.

V.2. Sample Description

The samples can be organized in two groups, the local residents samples (Table V.1) and the general population samples (Table V.2), which vary geographically and also in the valuation method used. The local residents' samples answered the CV questionnaire, while the general population samples answered the DCE questionnaire.

Table V.1: Local Residents` Samples – Descriptive Statistics: Relative Frequencies and Means

	Forest Biomass	Wind	Photovoltaic	Hydropower
Environmental problems				
Climate change	0.5435	0.2542	0.5075	0.6600
Air pollution	0.7609	0.5763	0.6119	0.7000
Water pollution	0.7826	0.6780	0.5970	0.6400
OverexploitationNR	0.2391	0.0847	0.0896	0.0800
Lower biodiversity	0.4348	0.2542	0.2388	0.2200
Waste	0.4348	0.7288	0.5373	0.3400
Familiarity w/ RES				
Wind	0.9565	1.000	0.9104	0.9000
Solar photovoltaic	0.8261	0.7458	0.9701	0.7800
Forrest biomass	0.9565	0.3051	0.3433	0.3600
Hydropower	0.9348	0.9492	0.9403	0.9000
Visibility				
Hydropower	0.9778	0.8136	0.8955	0.9200
Wind	0.8696	0.9492	0.4154	0.5200
Solar photovoltaic	0.7333	0.1864	0.8333	0.5333
Forest biomass	0.9333	0.0339	0.1061	0.3556
Visible from home	0.7609	0.9492	0.7165	0.7600
Self-interest	0.5435	0.2373	0.4030	0.4800
Electricity bill	59.84 (25.90)	71.55 (68.08)	76.32 (58.62)	67.63 (64.02)
Opinion on RES				
Portugal good conditions	1.000	0.9808	0.9692	0.9778
Benefits population	1.000	0.8000	0.8657	0.8542
Renewable source	0.6304	0.2727	0.3793	0.5854
Non polluting emissions	0.7391	0.3409	0.5345	0.7561
Climate Change Reduction	0.6522	0.2955	0.4655	0.7073
Creates employment	0.2826	0.4546	0.4828	0.3659
Lower external dependency	0.1522	0.5000	0.5862	0.3659
WTA	16.74 (24.43)	35.96 (40.69)	27.34 (48.05)	20.42 (71.90)
Socio-demographic				
Gender	0.4783	0.4915	0.5522	0.7000
Age	55.0435 (16.7584)	59.8305 (16.2206)	52.0597 (17.7456)	50.7200 (17.6844)
Income per capita	449.06 (380.86)	251.88 (162.15)	429.59 (301.70)	374.40 (318.77)
Primary education	0.4348	0.6271	0.2388	0.3800
Importance of RES	0.3478	0.6034	0.7313	0.6531

Note: In parentheses are presented the standard deviations.

The local residents' average age varies between 51 years in the hydropower sample and approximately 60 years in the Wind sample, while for the general population the age range is lower (47 to 52), approximately. The samples also differ in terms of education and income, with local residents being less educated (higher fraction of respondents with primary school) and having lower household per capita income. In local residents opinion, the most important environmental problem in Portugal nowadays is water pollution, waste and air pollution (though the frequency varies between RES subsamples), which does not coincide with the opinion of the general population for whom water pollution is also very significant in addition to air pollution and waste treatment and collection.

The questionnaires also assessed respondents' familiarity and opinion on RES. The least familiar energy source is forest biomass, across all samples; the most familiar are wind energy and hydropower. Also expressing the familiarity with RES, respondents were asked if they see a RES power plant daily. In the general population, between 18% and 34% see a RES power plant daily and they most frequently see it from their homes. In the local residents' samples the visibility depends greatly on the sample, as the most visible is the one located nearby. However it should be stressed that between 72% (in the case of PVFs) and 95% (in the case of wind farms) of the respondents see the power plant from their residence.

Table V.2: General Population`s Samples – Descriptive Statistics: Relative Frequencies and Means

	Forest Biomass	Wind	Photovoltaic	Hydropower	Global*
Environmental problems					
Climate change	0.4760	0.3936	0.4240	0.4360	0.4838
Air pollution	0.6800	0.5480	0.5520	0.5920	0.4150
Water pollution	0.6280	0.4040	0.5680	0.4840	0.5025
OverexploitationNR	0.1000	0.0280	0.0560	0.0743	0.1163
Lower biodiversity	0.1767	0.0520	0.1400	0.1325	0.2025
Waste	0.5542	0.4520	0.6520	0.4080	0.4413
Familiarity w/ RES					
Wind	0.9880	0.9800	0.9560	0.9960	0.9900
Solar photovoltaic	0.9960	0.9200	0.9880	0.9920	0.9300
Forrest biomass	0.6320	0.5080	0.5240	0.5743	0.5050
Hydropower	0.9760	0.9600	0.9880	0.9839	0.9288
Visibility					
Visible any RES	0.1960	0.2088	0.1800	0.2080	0.3388
Visible_home	0.6122	0.8077	0.4222	0.5769	0.4502
Visible_commuting	0.4490	0.3846	0.5556	0.4038	0.6015
Visible_Hydropower	0.1250	0.0385	0.1333	0.2500	0.1255
Visible_Wind	0.6667	0.7692	0.7778	0.6923	0.6937
Visible_Solar photovoltaic	0.2917	0.3654	0.1556	0.1154	0.4207
Visible_Forest biomass	0.0417	0.0000	0.0220	0.0192	0.0330
Electricity bill	69.20 (37.10)	69.59 (81.83)	75.19 (43.60)	76.91 (77.75)	60.53 (63.05)
Opinion on RES					
Portugal good cond	0.9960	0.9800	0.9920	0.9840	0.9813
Benefits population	0.9960	0.9237	0.9160	0.9800	0.9813
Renewable source	0.3669	0.0826	0.4160	0.3494	0.5796
Non polluting emissions	0.5703	0.4913	0.6560	0.5381	0.6879
C C Reduction	0.5261	0.4367	0.4120	0.4177	0.6662
Creates employment	0.4597	0.2304	0.2680	0.3213	0.3903
Lower ext. dependency	0.4217	0.4348	0.4880	0.5743	0.6573
Socio-demographic					
Gender	0.4400	0.4400	0.4680	0.4560	0.4663
Age	49.4680 (17.2644)	52.2209 (17.6609)	50.2160 (17.2807)	49.5880 (17.0764)	46.9900 (16.3014)
Incomepc	605.4875 (388.16)	319.15 (140.35)	No obs	No obs	442.57 (326.17)
Primary education	0.1560	0.2240	0.1880	0.1720	0.0613
Importance of RES	0.5280	0.6880	0.3720	0.6400	0.6800

Note:*Global corresponds to the sample receiving the global questionnaire comprehending source of energy as a choice variable.

For the general population the most frequently seen RES power plants are wind farms. Regarding respondents' opinion on RES, it is almost unanimous that Portugal has good conditions to explore RES for the production of electricity. However, there is no unanimity on which are the benefits: many respondents select bringing benefits for the population, while quite a lower percentage select the creation of employment and the reduction of the external dependency of the economy as benefits.

Table V.3: Local Residents` Samples: Environmental Friendliness by RES (%)

	Don't know	Not friendly	A bit friendly	Friendly	Very friendly	Extremely friendly
Forest biomass sample						
Hydropower			2.17	4.35	52.17	41.30
Forest biomass	4.55	20.45	11.36	4.55	36.36	22.73
Wind	8.89	2.22		2.22	37.78	48.89
Photovoltaic	11.11	2.22		2.22	37.78	46.67
Wind sample						
Hydropower	15.25	5.08	10.17	5.08	27.12	37.29
Forest biomass	68.97	3.45	5.17	3.45	8.62	10.34
Wind	1.69	13.56	15.25	6.78	16.95	45.76
Photovoltaic	33.33	1.75	1.75	1.75	21.05	40.35
Photovoltaic sample						
Hydropower	1.56	1.56	1.56	3.13	29.69	62.50
Forest biomass	38.33	5.00	8.33	8.33	20.00	20.00
Wind		6.06	1.52	4.55	15.15	72.73
Photovoltaic		3.08	1.54	1.54	15.38	78.46
Hydropower sample						
Hydropower	10.00	12.00	10.00	4.00	44.00	20.00
Forest biomass	44.90	18.37	2.04	12.24	8.16	14.29
Wind	8.16		2.04	2.04	28.57	59.18
Photovoltaic	22.45			4.08	20.41	53.06

Regarding the friendliness of each RES, respondents were asked the degree of environmental friendliness on a 5 point scale. For the general population sample, the source that is considered most friendly is wind followed by photovoltaics, but overall all sources are considered friendly. The only source that is considered unfriendly by some respondents is forest biomass, which is also the source many respondents declare not knowing whether it is environmentally friendly or not (Table V.4). The results with the local residents' sample are slightly different (Table V.5). In particular, the frequency of "don't know" answers is higher and unfavorable opinions are more frequent namely with respect to the renewable source they live close to.

Table V.4: General Population`s Samples: Environmental Friendliness by RES (%)

	Don't know	Not friendly	Bit friendly	Friendly	Very friendly	Extremely friendly
Forest biomass sample						
Hydropower	4.40	0.80	2.80	3.60	44.00	4.40
Forest biomass	2.80	0.40		1.20	14.80	80.80
Wind	4.00			0.80	16.00	79.20
Photovoltaic	28.40	5.60	3.60	1.20	20.80	40.40
Wind sample						
Hydropower	9.20	3.60	5.20	5.20	36.00	40.80
Forest biomass	3.60	0.80	0.40	2.80	30.80	61.60
Wind	7.20	1.20	0.80	3.60	26.80	60.40
Photovoltaic	34.00	4.80	3.60	9.60	14.00	34.00
Photovoltaic sample						
Hydropower	8.40	3.20	0.80	1.60	37.20	48.80
Forest biomass	5.60	0.80	0.40	0.40	26.00	66.80
Wind	5.60	0.40		1.60	22.00	70.40
Photovoltaic	55.20	2.00	1.20	8.00	12.00	21.60
Hydropower sample						
Hydropower	4.80	2.00	3.20	0.40	29.20	60.40
Forest biomass	2.80	1.20		0.40	15.20	80.40
Wind	4.80	0.40		0.40	13.20	81.20
Photovoltaic	40.00	5.20	2.00	2.00	18.80	32.00
Global sample						
Hydropower	2.75	2.00	10.63	6.38	43.13	35.13
Forest biomass	1.63	0.13	0.38	2.13	19.25	76.50
Wind	2.00	0.38	0.25	2.88	15.25	79.25
Photovoltaic	15.13	1.88	4.00	9.13	28.38	41.50

Finally, to characterize local residents' preferences and opinions on RES they were asked the degree of annoyance caused by the presence of the specific power plant in the vicinity, and also the degree of annoyance felt regarding particular environmental impacts (Table V.5). Annoyance in general is lower for photovoltaic farms (94% of residents consider themselves not annoyed), while for wind energy only 49% of the respondents do not feel any annoyance and 27% consider themselves very or extremely annoyed. Similarly, for forest biomass power plants, only 43% do not feel annoyed, and about 28% of the respondents feel very or extremely annoyed. Examining the specific environmental impacts, for the case of forest biomass power plants there is no single specific impact that is considered seriously annoying by a significant proportion of subjects, but changes in the landscape and impacts in the fauna are considered the most annoying. In the case of wind farms, noise and landscape intrusion are the most significant. Impacts on the fauna and flora are also considered the most annoying in the case of hydropower plants. It is interesting to observe that the average amount of willingness to accept is highest for the residents living close to wind farms, where annoyance is also higher.

Table V.5: Local Residents` Samples: Relative Frequency of Annoyance Intensity by Type of Annoyance (%)

	Not annoyed	**A bit annoyed**	**Annoyed**	**Very annoyed**	**Extremely annoyed**
Forest biomass sample					
Annoyance	43.48	13.04	15.22	13.04	15.22
Noise	65.22	15.22	8.70	6.52	4.35
Odor	56.52	4.35	8.70	13.04	17.39
Landscape	56.52	6.52	10.87	10.87	15.22
Fauna	67.39	15.22	8.70		8.70
Flora	52.17	17.39	13.04	6.52	10.87
Person-movement	91.30	2.17	4.35	2.17	
Wind sample					
Annoyance	49.15	15.25	8.47	8.47	18.64
Noise	37.29	11.86	6.78	15.25	28.81
Access open	75.00	5.36	14.29	1.79	3.57
Landscape	50.85	6.78	10.17	10.17	22.03
Fauna	60.00	14.55	7.27	9.09	9.09
Flora	69.81	16.98	1.89	5.66	5.66
Person-movement	69.64	8.93	17.86	1.79	1.79
Photovoltaic sample					
Annoyance	93.94	4.55			1.52
Landscape	71.88	14.06	3.13	3.13	7.81
Fauna	76.19	11.11	4.76	1.59	6.35
Flora	75.81	12.90	4.84		6.45
Person-movement	84.13	6.35	4.76		4.76
Glare	84.38	4.69	6.25		4.69
Hydropower sample					
Annoyance	74.00	4.00	6.00	6.00	10.00
Landscape	89.58		6.25	2.08	2.08
Fauna	44.90	8.16	20.41	8.16	18.37
Flora	42.86		20.41	14.29	22.45
Person-movement	0.8919	0.027	0.027		0.0541
Noise	90.00	2.00	6.00		2.00
Heritage	40.82	2.04	14.29	4.08	38.78

In order to predict the amount of compensation demanded by local residents and determine who amongst these are most affected while, at the same time, understand the value that the general population is willing to pay to avoid the impacts of the use of RES, we next present the results of the estimation of the valuation function for local residents by source and for the general population by source and also comparing between sources. The reunion of the perspective of these stakeholders aims to devise a method for aiding policy makers in their decisions of which RES to use, the mix of RES as well as determining the best design of Power plants with respect to location and size considering the effects on local residents` wellbeing.

V.3 Hydropower: Economic Valuation of Environmental Impacts of Dams

V.3.1 Local Residents' Valuation

The use of a mixture model to estimate the valuation function requires the choice of the variables to explain the first binary decision, where subjects decide whether they are entitled to compensation or not, and also the choice of explanatory variables for the decision regarding the amount of compensation. To explain the first decision we chose whether or not the respondent feels annoyance with the presence of the hydropower plant (annoyance_yn) and whether the respondent or family members or close friends presently work or have worked in the hydropower plant (self-interested, taking the unit value if someone has worked and zero otherwise). For the second decision, in addition to socio-demographic variables we also include location (the omitted category is Aguieira). In total 50 questionnaires were collected: 16 in the vicinity of Aguieira dam, 23 near Alqueva and 11 near Douro International (composed of Bemposta and Picote dams, located 21km from each other).

Table V.6: Zero-Inflated Negative Binomial Model - Dams

Dependent Variables	**Explanatory Variables**	**Coefficient** (Robust Standard error)	
WTA (yes/no)	Annoyance_yn	0.9711	(1.0696)
	Self-interested	1.3033**	(0.6164)
	Constant	-0.5899	(0.4190)
WTA (amount)	Incomepc	0.0000	(0.0002)
	Gender	0.7266***	(0.2753)
	Annoyance	0.3622	(0.2206)
	Alqueva	1.0887***	(0.3521)
	Douro International	-1.1498***	(0.3093)
	Constant	2.0966***	(0.3571)
	Ln(alpha)	-1.1363***	(0.3334)
Number observations: 50; Non-zero: 23; Zero: 27; Wald chi2(4) 103.22***			

Note: *Significance level of 10%; ** Significance level of 5%; *** Significance level of 1%.

According to the results presented in the table V.6 we conclude that self-interest is the most important determinant of the decision to receive compensation, with respondents having a self-interest in the dam being more likely to demand compensation. Regarding the amount of compensation demanded, Location is an important determinant, residents in Alqueva demand higher amounts of compensation, while residents in Douro International demand lower amounts than residents in Aguieira, on average. This result might be explained by the morphology of the area, as Douro International´s dams are in deeper and narrower valleys than those of Aguieira and Alqueva. The difference between Alqueva and Aguieira might rest on the age, size of the dams or the morphology of the area. Alqueva is significantly more recent and bigger. It is plausible to assume that with time the population experiences some degree of accustomedness with the presence of the dam and consequently demands lower amounts of compensation. Alternatively, the morphology of the area and the size of the dam may constitute important determinants of the welfare loss. Unfortunately we are unable to disentangle the two hypotheses. Socio-demographic characteristics are not significant but for gender which is positive and statistically significant. Based on the regression model we predict that the amount of compensation would be on average 24.1 Euros per month, being 7.9 Euros in Aguieira, 45 Euros in Alqueva and 4.2 Euros in Douro International. Thus, compensation amounts are clearly site specific. Also relevant is the fact that self-interest and demographic characteristics play some role in the computation of the welfare cost.

V.3.2. General Population's Valuation

DCE allows the estimation of the value attributed to each of the environmental impacts considered. As explained in chapter IV, the attributes considered that formed the basis for the elaboration of 8 different choice sets were: (i) significant impact on the landscape; (ii) significant impact on fauna and flora; (iii) noise production that significantly affects local population; (iv) heritage destruction and (v) a cost attribute (increase in the monthly electricity bill). Two levels were defined for each attribute except for the cost attribute, which had three levels (4, 8 and 12 Euros). The inclusion of the cost attribute allows the estimation of the monetary amount individuals are willing to pay for having a certain scenario of hydroelectricity generation associated with different environmental impacts levels, by diving the negative of the coefficient on the attribute by the coefficient on price. Table V.7 presents the estimates of the marginal effects of the attributes on respondents' wellbeing and estimates of respondents' WTP for the same attributes. All estimates are statistically different from zero at 1% significance level.

Table V.7: Binary Logit Model Estimates - Dams

Variables	**Partial Effects** (standard errors)	**WTP** (standard errors)
Landscape	-0.1073 (0.0190)	5.8300 (1.1782)
Fauna/Flora	-0.2936 (0.0297)	15.1030 (3.8913)
Noise	-0.1677 (0.0127)	9.1016 (2.3059)
Heritage	-0.0777 (0.0156)	4.1770 (1.5732)
Price	-0.0185 (0.0044)	
Log-likelihood function		-2489.91546

Note: all estimates and the overall regression are statistically significant at 1%.

The attribute (environmental impact) that is considered most important and that impacts respondents' utility most drastically is the impact on fauna and flora. The second most important attribute is the impact of noise; with considerably less importance are the attributes landscape intrusion and destruction of heritage. Avoiding significant impacts on the fauna and flora increases the probability of choosing that alternative by 30 percentage points relative to having significant impacts. The effect of significant impacts on landscape, noise and heritage on the probability of choosing any alternative is 10, 16 and 7 percentage points respectively, i.e., if an alternative avoids significant impacts on noise it is 1percentage points more likely to be chosen relative to one that does not avoid noise impacts. In line with the marginal effects, respondents are willing to pay, on average, 15 Euros more in their monthly electricity bill to avoid significant impacts of hydropower on the fauna/flora; to avoid significant inconvenience of noise to populations, they are willing to pay on average an increase in their electricity bill of 9 Euros. To avoid significant damages to the landscape and heritage they are willing to pay on average 5.83 Euros and 4.18 Euros, respectively.

In interpreting these results it should be stressed that these estimates of welfare loss imposed by the presence of dams are not additive. The results obtained contain important implications for the location decision regarding dams as the location crucially influences the severity of the impacts, namely the morphology of the place. Thus, the decision to locate a dam should pay particular attention to the specific impacts in each location. Finally it is important to signal that respondents attach significantly more importance to the impacts on fauna and flora, than impacts on human and natural assets, like landscape and heritage.

V.4.Wind Power: Economic Valuation of Environmental Impacts of Wind Farms

V.4.1. Local Residents' Valuation

In order to identify the determinants of respondents` WTA amount we estimate a zero-inflated negative binomial model. The only variable selected to explain the decision to receive compensation is annoyance-yn since prefect collinearity and/or perfect prediction of the outcome variable precluded the inclusion of other considered explanatory variables. Moreover, although this sample only had 3 zero observations, we decided to maintain the model specification for consistency with the analysis regarding other RES. The explanation of the amount of compensation demanded (reported in the second panel) relies on socio-demographic variables, location and also the degree of noise-annoyance. The sample is constituted by 57 observations: 25 collected in Arga, 12 in Lousã and 20 in Vila Pouca (villages of Guilhado and Negrelo).

Table V.8: Zero-Inflated Negative Binomial Model – Wind Farms

Dependent Variables	**Explanatory Variables**	**Coefficient** (Robust Standard error)	
WTA (yes/no)	Annoyance_yn	-17.8136***	(0.7209)
	Constant	-2.5567***	(0.6895)
WTA (amount)	Incomepc	-0.0008	(0.0007)
	Age	-0.0164*	(0.0097)
	Noise Annoyance	0.0259	(0.0858)
	Lousã	-0.0507	(0.4370)
	Vila Pouca Aguiar	0.5317**	(0.2755)
	Constant	4.4761***	(0.5736)
	Ln(alpha)	-0.5890***	(0.1890)
Number observations: 57; Non-zero: 54; Zero: 3; Wald chi2(4) 9.85*			

Note: *Significance level of 10%; ** Significance level of 5%; *** Significance level of 1%.

According to the results presented in table V.8, general annoyance is a significant determinant of the decision to be compensated, although it influences it negatively (we stress however that only 3 respondents did not demanded compensation). Concerning the amount of compensation, the results show that older respondents demand, on average, lower amounts than younger respondents. Location is also relevant for determining the amount of compensation. Residents living close to Vila Pouca wind farms demand, on average, significantly higher amounts than residents in Lousã and Arga. Based on the regression model we predict that the amount of compensation would be on average 34.8 Euros per month, being 28.6 Euros in Arga, 34.6 Euros in Lousã II and 42.8 in Vila Pouca Aguiar. The reduced size of the sample collected, resulting from the fact that the villages nearby wind farms have very few residents, requires some caution in interpreting the results but it does not preclude drawing some important implications from the analysis : (i) local populations feel annoyed by the presence of the WF which influences their decisions; (ii) the amount of compensation demanded is location specific, and (iii) socio-demographic characteristics play some role on the amount of compensation demanded.

V.4.2. General Population's Valuation

The environmental attributes included in the DCE were: (i) significant impact on landscape; (ii) significant impact on fauna and flora; (iii) noise that significantly affects local population and (iv) price attribute (an increase in the monthly electricity bill). Two levels were defined for each attribute except for the price attribute, which had three (4, 8 and 12 Euros). By choosing the preferred alternative presented in each of the different choice sets and making trade-offs between different prices and environmental impacts, individuals' responses allow us to derive the marginal willingness to pay (WTP) estimate for each attribute.

Table V.9: Binary Logit Model Estimates – Wind farms

Variables	**Partial effects** (standard errors)	**WTP** (standard errors)
Landscape	-0.1062 (0.0221)	3.1509 (0.7675)
Fauna/Flora	-0.2696 (0.0272)	7.80352 (1.2952)
Noise	-0.2368 (0.0257)	7.3099 (1.3036)
Price	-0.03336 (0.0040)	
Log-Likelihood function		-1858.4726

Note: all estimates and the overall regression are statistically significant at 1%.

Analysis of Table V.9 shows that all the attributes describing the wind energy source have a negative and statistically significant influence on the utility of an alternative. As expected, the impact on the fauna/flora, on the landscape, the emission of noise and the price (in the form of an increase in the value of the monthly bill) are significant determinants of the disutility associated with the production of electricity through wind farms. Moreover the most important determinant is the impact on fauna and flora, followed by the impact of noise, and the impact on the landscape appears in the third place. Finally the impact of price of electricity is the smallest of the three. Predictions for respondents' WTP to avoid environmental impacts range from 3.15 Euros per month to avoid significant impacts on the landscape, to 7.80 Euros per month to avoid significant impacts on the fauna/ flora domain. Respondents' predicted average WTP to avoid production of noise that significantly impacts the local population is approximately 7.31 Euros, thus very close to the value attributed to the impact on fauna and flora.

V.5. Solar Photovoltaic: Economic Valuation of Environmental Impacts of Photovoltaic Farms

V.5.1. Local Residents' Valuation

Data from residents nearby solar photovoltaic farms was collected in the villages of Brinches (Hércules PVF), Amareleja and Ferreira do Alentejo. In total 61 questionnaires were collected (Hércules 15, Amareleja 22 and Ferreira do Alentejo 24). The first panel of Table V.10 reports the results on the decision to receive compensation, while results on the demanded compensation amount are reported in the second panel. To explain the decision to receive compensation or not, we include some socio-demographic variables and the location of the farm where Amareleja is the omitted location. The explanation of the amount rests on the degree of annoyance caused by the glare effect, on socio-demographic variables and on location.

Table V.10: Zero-Inflated Negative Binomial Model –Photovoltaic Farms

Dependent Variables	**Explanatory Variables**	**Coefficient** (Robust Standard error)	
WTA (yes/no)	Hércules	-16.4196***	(2.0700)
	Ferreira Alentejo	2.1858***	(0.7691)
	Retired	-3.6206**	(1.6422)
	Gender	-0.2039	(0.8348)
	Age	0.0363	(0.0312)
	Incomepc	0.0024	(0.0016)
	Constant	-3.4649**	(1.6617)
WTA (amount)	Glare Annoyance	0.3756***	(0.1160)
	Retired	0.9091**	(0.4594)
	Gender	-0.0081	(0.2843)
	Age	-0.0367***	(0.0104)
	Incomepc	-0.0007	(0.0005)
	Hércules	-0.8972***	(0.2976)
	Ferreira Alentejo	-0.6193*	(0.3162)
	Constant	5.4350***	(0.5726)
	Ln(alpha)	-0.5598*	(0.3131)
Number observations: 61; Non-zero: 39; Zero: 22; Wald chi2(7) 40.17***			

Note: *Significance level of 10%; ** Significance level of 5%; *** Significance level of 1%.

According to the results in table V.10, location is the most important determinant of the decision to receive compensation: relative to residents in Amareleja, residents in Ferreira do Alentejo are more likely to demand compensation, a clearly distinct behaviour of the residents near Hércules plant. Socio-demographic characteristics are not statistically significant but for retired variable which is negative. Regarding the amount of compensation decision, results show that retired respondents demand, on average, higher amounts, although they are less likely to demand compensation; residents who feel annoyed by the glare effect also demand significantly higher amounts than those that do not feel annoyed. On the other hand, older respondents and residents living close to Ferreira do Alentejo and Hércules PVFs demand, on average, lower amounts of compensation. This might be justified by the differences in the size of the PVFs: Amareleja plant is the biggest (250 ha), followed by Ferreira Alentejo (58+31+5 = 94 ha) and Hércules (60 ha) plants. Based on the regression model, we predict that the amount of compensation would be on average 28.67 Euros per month, being 53.03 Euros in Amareleja, 21.35 Euros in Hércules and 10.92 Euros in Ferreira Alentejo. The results allow us to conclude that: compensation amounts are clearly site specific; socio-demographic characteristics also influence the respondents` decision on the amount to be compensated; and, finally, local populations feel annoyed by the presence of the PVF, particularly due to its glare effect, demanding higher amounts of compensation.

V.5.2. General Population's Valuation

As explained in chapter IV, the attributes included in the DCE questionnaire for photovoltaic farms are: (i) significant landscape impact; (ii) significant fauna and flora impact; (iii) glare production that significantly affects local population, and (iv) an increase in the energy prices (specifically via increases in the monthly electricity bill). Again, two levels were defined for each attribute except for the price attribute, which had three levels (4, 8 and 12 Euros). Table V.6 reports the results of the estimation of the binary logit model with standard errors clustered at the individual level.

Table V.11: Binary Logit Model Estimates – Photovoltaic Farms

Variables	**Partial effects** (standard errors)	**WTP** (standard errors)
Landscape	-0.3120 (0.0223)	7.1243 (0.7494)
Fauna/Flora	-0.3713 (0.0236)	8.1294 (0.8486)
Glare	-0.1852 (0.0140)	4.8365 (0.5790)
Price	-0.0401 (0.0018)	
Log-Likelihood function		-1531.5316

Note: all estimates and the overall regression are statistically significant at 1%.

Table V.11 reports the estimated partial effects of each attribute on individual choice and also respondents' predicted average willingness to pay to avoid each of the considered environmental impact. All estimates are statistically significant. On average, respondents are 37 percentage points less likely to choose a form of producing electricity in PVFs with impacts on the Fauna/Flora than they are if this impact is avoided. Likewise, the presence of significant impacts on landscape decreases the probability of the alternative being chosen by the respondents by 31 percentage points, on average. The attribute that most significantly affects respondents' preferences for the form of production is the impact on Fauna and Flora: on average respondents are willing to pay a price premium of 8.13 Euros per month to avoid this impact. To avoid significant impacts on landscape they are willing to pay on average 7.13 Euros monthly. The least significant impact is the glare effect, with an average willingness to pay of only 4.84 Euros per month to avoid it.

In sum, the results show that all attributes considered are statistically significant in explaining respondents´ choices. In addition, we are able to elicit the order of importance concluding that the impacts on fauna and flora are the most important determinants followed by the effect on the landscape. Least important are the glare effect and the effect of the increased electricity bill. In terms of policy implications, our preliminary results indicate that PV farms, as perceived by the general population, are seen as affecting most significantly the fauna, flora and the landscape; thus the location decision should contemplate these impacts seriously. In addition, it is important to develop more effective information campaigns aimed at reducing the eventual misinformation regarding some of the impacts of this energy source.

V.6: Forest Biomass: Economic Valuation of Environmental Impacts of Forest Biomass Power Plants

V.6.1. Local Residents' Valuation

Local residents' valuation of the annoyance felt and the amount of compensation that would made them whole was estimated considering that location was the determinant of the decision to be compensated, while the amount of compensation was assumed to be explained by the household income per capita, location, annoyance and whether the respondent had any self-interest in the power plant. Data was collected from residents near the FBPPs of Constância (20 observations) and Mortágua (28 observations).

Table V.12: Zero-Inflated Negative Binomial Model – Forest Biomass Power Plants

Dependent Variables	Explanatory Variables	Coefficient (Robust Standard error)	
WTA (yes/no)	Mortágua	2.0017***	(0.7048)
	Constant	-1.2546**	(0.5739)
WTA (amount)	Incomepc	-0.0005***	(0.0001)
	Annoyance	0.3349***	(0.0821)
	Self-interested	-0.3297**	(0.1713)
	Mortágua	0.1379	(0.2728)
	Constant	2.8567***	(0.3654)
	Ln(alpha)	-1.8661***	(0.2196)
Number observations: 46; Non-zero: 23; Zero: 23; Wald chi2(4) 42.22***			

Note: *Significance level of 10%; ** Significance level of 5%; *** Significance level of 1%.

According to the results in table V.12, we conclude that location is an important determinant of the decision to receive compensation, with residents close to the FBPP in Mortágua being more likely to demand compensation than residents in Constância. With respect to the amount of compensation demanded, people feeling more annoyed with the presence of the FBPP demand significantly higher amounts, on average. Demanding significantly lower amounts are respondents with higher income per capita and those having self-interest in the power plant either because they work/worked in the plant or have family or friends who work/worked there. Based on the regression model we predict that the amount of compensation would be on average 17.3 Euros per month. By power plant predicted WTA is 31.2 Euros in Constância and 8.3 Euros in Mortágua, matching the size of the power plant. In sum, populations feel annoyed by the presence of the FBPP which influences their decisions; the amount of compensation demanded is location specific; and, finally, socio-demographic characteristics play some role in explaining the amount of compensation demanded.

V.6.2. General Population's Valuation

In these questionnaires, respondents were presented with a section of six choice sets, each consisting of a number of attributes (environmental impacts) with different levels and asked to choose between distinct forms of electricity production through forest biomass. Three non-monetary attributes were used, namely: (i) significant impacts on the landscape; (ii) significant impacts on fauna and flora; (iii) production of an unpleasant odour that significantly affects local population; for each attribute two levels were chosen. A cost attribute was also included, and it was described to respondents as an increase in the price of the monthly electricity bill with three different levels (4, 8 and 12 Euros). By choosing the preferred alternative presented in each choice set and making trade-offs between different prices and environmental impacts, individuals' responses allowed us to derive the marginal willingness to pay (WTP) estimate for each attribute.

In order to compute individuals' willingness to pay to avoid significant impacts on landscape, noise, odour, and fauna and flora, a binary logit panel model is estimated. Table V.13 reports the partial effects estimates, and the predicted mean WTP per attribute.

Table V.13: Binary Logit Model Estimates – Forest Biomass Power Plants

Variables	**Partial effects** (standard errors)	**WTP** (standard errors)
Landscape	-0.1712 (0.0231)	7.8349 (1.4371)
Fauna/Flora	-0.4134 (0.0278)	18.7221 (2.7729)
Odour	-0.3508 (0.0267)	18.2001 (2.8604)
Price	-0.0211 (0.0022)	--
Log likelihood function		-1662.6579

Note: all estimates and the overall regression are statistically significant at 1%.

Observation of the first column reveals that the attribute that affects respondents' utility level most strongly is fauna/flora, followed by odour. The probability of choosing an alternative with impacts on Odour or on fauna and flora is about 35 and 41 percentage points lower than the probability of choosing an alternative avoiding each of the impacts, respectively. Significant changes in the landscape decrease the probability of choosing that alternative by 17 percentage points, approximately, while an increase in 1 euro in the electricity bill decreases that probability by 2.1 percentage points. All effects are statistically significant. In the second column predicted average WTP is reported. The hierarchy of the WTP measures mimics that of the effect of the attributes on respondents' welfare. On average, respondents are willing to pay about 18 Euros monthly to avoid the effects on Fauna/Flora or on Odour. Their WTP to avoid effects on landscape is much smaller, 7.84 euros per month, approximately.

In sum, respondents distinguish between attributes, revealing statistically significant impacts of each attribute on their utility level. In addition, predicted average WTP is similar for two attributes but significantly different for one of the attributes considered.

V.7: Renewables: Do People Have Preferences Over Them?

Previous economic studies elicited respondents' WTP for green electricity leaving the specific source unspecified (e.g. Longo *et al.*, 2008; Yoo and Kwak, 2009; Aldy *et al.*, 2012; Zoric and Hrovatin, 2012) and/or elicited respondents' WTP for a particular type of RES, detailing or not its environmental impacts) (e.g. Foster *et al.*, 1998; Ladenburg,

J. and Dubgaard, A., 2007; Solino *et al*., 2009; Han, S-Y *et al*., 2008). However, the choice between each renewable energy source controlling for respondents' preferences regarding the environmental effects has not been performed yet in the literature. To fill this void, we proposed to estimate the respondents' preferences for the type of RES used and for their different environmental impacts. To accomplish this goal, we applied a DCE questionnaire (see appendix 2). Respondents were given a choice between a series of paired unlabelled alternatives of generating electricity through the use of RES. As previously explained, we excluded from this analysis the renewable biomass due to the lack of knowledge demonstrated by the majority of the population regarding this specific energy source. The selected attributes and levels presented in the questionnaires were: i) the source of renewable energy with three levels (hydropower, wind and solar photovoltaic); ii) significant impact of the glare effect on local population, with two levels (present, absent); iii) significant impact of noise on populations (present, absent); iv) significant destruction of heritage (present, absent); v) significant impact on fauna and flora (present, absent); vi) significant impact on landscape (present, absent); and vii) increase in the monthly electricity bill with three levels (4, 8, and 12 Euros). Some of the attributes considered are specific to the renewable energy source used: noise is specific to wind and hydropower; glare is specific to solar photovoltaic; and, destruction of heritage is specific to hydropower. Since the design was constrained to these conditions, the resulting data set is deemed unbalanced as each pair (attribute, level) is not observed the same number of times.

Concerning this issue, it is important to clarify some aspects on unbalanced designs. First, a factorial design is said to be orthogonal when every pair of levels occurs equally often across all pairs of factors. When each level occurs equally often within each factor, the design is balanced. A design that is both balanced and orthogonal is called an orthogonal array and ensures all estimable effects are uncorrelated. Orthogonal arrays come in specific number of runs for specific numbers of factors with specific number of levels. With these two properties, an orthogonal array is optimal. However, there are some situations in which even orthogonal arrays are not practical and the present analysis falls in one of those cases: due to the fact that some of the attributes considered are specific to the renewable energy source used, we had to use an orthogonal, but not balanced design, and hence "nonoptimal" from a statistical standpoint. A design can be orthogonal when the frequencies for level pairs are proportional instead of equal. For example, with two-level factors, an orthogonal design could have pair-wise frequencies proportional to 1, 2 2, 4. Such a design will not be balanced – one level will occur twice as often as the other. Unbalance, since it is a generalized form of nonorthogonality, increases the standard errors (Kuhfeld *et al.,* 1994) in statistical analyses, potentially rendering many effects statistically insignificant.

To estimate the welfare change that respondents experience with renewables' environmental impacts, we modelled respondents' choices as a binary logit model with a cluster correction and used the attributes as explanatory variables. Table V.14 reports the results.

Table V.14: Binary Logit Estimates – Global

Variables	**Partial effects** (standard errors)	**WTP** (standard errors)
Landscape	-0.0420*** (0.0104)	1.0673*** (0.2801)
Fauna/Flora	-0.4545*** (0.0131)	10.2099*** (0.5510)
Noise	-0.0582*** (0.0102)	1.4642*** (0.2799)
Heritage	-0.0385*** (0.0078)	0.9801*** (0.2067)
Hydropower	-0.0164*** (0.0095)	0.4179* (0.2454)
Wind	0.0626*** (0.0102)	-1.5942*** (0.2671)
Price	-0.0393*** (0.0021)	
Log-likelihood function		-7807.7624***

Note: Omitted category for RES is Photovoltaic farms; * 10% significance level;** 5 % significance level; ***1% significance level

The results show that all environmental and social attributes are statistically significant and have the expected negative sign. The most important attribute is by far the impact on fauna and flora. Considerably less important are the impacts of noise, landscape and heritage. Regarding the impact of the source of energy on respondents' probability of choosing an alternative, controlling for the environmental impacts, the results in Table V.14 show that the most preferred energy source is hydropower, followed by solar photovoltaic and then by wind power, which is the least preferred as respondents reveal a negative WTP to have wind power when compared with solar photovoltaic. On average, respondents would be willing to pay approximately 10 Euros more per month to avoid significant impacts on the fauna and flora. Concerning the other impacts, respondents are willing to pay on average a monthly bill increase of 1 Euro. Regarding the sources of electricity, predicted WTP of respondents for hydropower is 0.41 Euros more than for solar photovoltaic, while for wind power they are willing to accept compensation of 1.59 Euros per month, relative to solar photovoltaic. Thus, the results show that respondents value all attributes included and value them differently, which is often interpreted as evidence of the validity of the method used. Moreover, controlling for the environmental and social impacts of RES, respondents exhibit a preference for the source of energy. We may therefore conclude that not only the environmental effects of the exploration of RES for electricity production have an impact on population well-being, but also that the specific RES used impacts it differently. This last effect is particularly significant for wind energy, the least preferred RES by respondents.

V.8. Concluding Remarks

The application of the CV and DCE approaches for each renewable allowed the analysis of the welfare effects of two sets of stakeholders: local residents potentially affected by negative effects of the presence of the different power plants and the population in general that may potentially benefit of the advantages associated to the use of the RES for electricity generation, namely lower CO_2 emissions. The most relevant difference of the two samples concerns income, age, and education, with local residents being older, less educated and with less income.

Through the CV method we were able to predict that the compensation amount demanded by local residents would be on average, per month: 44,4 Euros for hydropower; 37,95 Euros for wind; 28,67 Euros for photovoltaic; and 17,27 Euros for forest biomass. On the other hand, the application of the DCE method among the general population allowed us to conclude that, on average, respondents are willing to pay different values depending on the impact considered, but included in the following ranges: [4,2 Euros; 15,1 Euros] for hydropower; [3,2 Euros; 7,8 Euros] for wind; [4,8 Euros; 8,1 Euros] for photovoltaic; and [7.8 Euros ; 18.7 Euros] for forest biomass. Thus, as the number of residents to be compensated are those living close to the installations, and those willing to pay are the entire population, it is safe to conclude that the welfare benefits more than compensates the costs and thus, pending equity considerations, the use of RES for electricity generation is potentially welfare improving.

Moreover, the results of the DCE questionnaire comparing all the renewables (but for forest biomass) allowed us to conclude that respondents perceive each renewable differently and have preferences over them: the most preferred energy source is hydropower, followed by solar photovoltaic and then by wind power, which is the least preferred. However the raking of attributes, controlling for the source of renewable energy, still positions the protection of fauna and flora in the first place.

CHAPTER VI: CONCLUSIONS

Portugal is a privileged country in terms of sun exposure, wind speed, river resources and forest area, and, as a consequence, the use of renewable energy sources for electricity generation seems to be a good decision for the country. Comparing to fossil fuel resources, the renewables present several economic advantages, namely: they are based on available domestic resources, they allow the diversification of energy supply, they decrease fossil fuel imports thereby contributing to a lower external energy dependence. Moreover, the renewables also present important environmental benefits, particularly by allowing a significant reduction of greenhouse gases emissions. Despite these strong reasons for using RES for electricity generation, it is important to point out that they are not free of negative impacts, and although the public`s attitude towards them is generally positive, when a specific new project is planned to be installed in a certain location, there are some negative reactions by the residents of the local communities. This local resistance towards renewable energy developments is often explained by the NIMBY syndrome, but this explanation is too simplistic, ignoring the main reasons for this opposition from the local residents. Policy makers in the energy area must consider and "listen" to all the agents involved, particularly the individuals living in the surroundings of the renewables facilities. Moreover, they must be aware that renewable energy sources are not totally environmental benign thereby negatively affecting people`s wellbeing.

Common effects of renewables are the impact on landscape; the occupation of land and its opportunity cost; and the effects on fauna and flora. More specific to each source is the noise effect in the case of wind power, and to a less extent hydropower; specific to photovoltaic solar energy is the glare effect and the rise in soil temperature. Hydropower dam installation implies, in most cases, the heritage destruction, which may represent a significant social impact. Aware of the reduced information regarding these key issues, the main aim of this research study was to propose a methodology to aid policy makers in deciding the presence of RES in the electricity production mix including the welfare impacts of all stakeholders in the decision. One difficulty in including all stakeholders' welfare change is the measurement of non-market benefits and costs. Specifically, given that negative effects from the installation and operation of RES power plants are local while the benefits are global it is important to devise instruments to assess both perspectives. To elicit the economic value of the main environmental impacts caused by the activity of the different facilities dedicated to electricity generation through the use of renewable energy sources, we applied the contingent valuation method and the discrete choice experiments method. These survey-based direct methods do not require individuals to make any behavioural change; they only ask individuals to attach an economic value to non-market goods or services. Despite their hypothetical nature, several reasons justify the use of these methodologies: they can be used to value any environmental good or service; they currently provide the only viable alternative for measuring non-use values; and they may be used to elicit values in cases in which the environmental quality change involves a large number of attribute changes.

This research also underlines the existence of a “lack of equity” problem: if a large majority of the Portuguese population benefits from the advantages of electricity generation through the use of renewable energy sources, the residents in the small communities near dams, wind farms, photovoltaic farms, and forest biomass power plants have a considerable welfare loss due to their proximity to the facilities. With our findings, we expect to contribute to a fairer, more efficient and sustainable decision-making process regarding the development of RES in Portugal.

The development of the survey instruments is crucial for the credibility of the results from this type of research. Chapter IV describes the designing process of the contingent valuation (CV) and discrete choice experiments (DCE) surveys. In these stated preference approaches, surveys represent a key tool for gathering good quality data on the individuals` preferences and perceptions about the renewables’ impacts. In order to design accurate and reliable questionnaires, we applied qualitative research methodologies, such as focus groups and “think aloud” techniques, which were essential to ensure that the language and the content of the questionnaires were considered realistic, relevant, credible and easily understood by respondents, in addition to reviewing the literature on the environmental impacts of RES power stations and performing expert consultation. This intensive process of questionnaires` design resulted in five discrete choice experiments questionnaires (in addition to the four individual questionnaires, an additional questionnaire was designed for all the renewable energies, excepting the biomass) and four contingent valuation questionnaires (each questionnaire concerning a single RES).

Through the application of the DCE survey among the general population, we presented individuals with a series of alternatives differing in terms of attributes and levels, and asked them to choose, for each pair of alternatives, their most preferred form of electricity generation through the use of a specific renewable energy source. This technique allowed us to estimate the respondents` maximum willingness to pay to avoid each environmental impact. In addition, we included in our study the individuals living in small villages near twelve selected power plants installed in different locations of continental Portugal. Among this population target, we conducted a contingent valuation survey to estimate the individuals' minimum willingness to accept money amount in order to be compensated for their welfare loss caused by the activity of the particular power plant installed in their vicinity (dams, photovoltaic farms, wind farms, or forest biomass power plants).

The surveys' summary results are presented in Chapter V. Three key results deserve emphasis. The first is the significance of location, annoyance and socio-demographic characteristics in explaining local residents' compensation decision, and the second is the statistical relevance of the welfare effects of the environmental attributes considered for each RES. Finally, the DCE results clearly show that the general population has preferences over the sources of renewable energy. The relevance of location in determining the amount of compensation coupled with the relevance of the attributes considered implies that local residents' are differently affected depending on the location decision within the same RES, and the general population is willing to pay different amounts to avoid specific environmental impacts which crucially depend on the type of RES and on their specific location. Moreover, methodologically it is very relevant that annoyance is a determining factor of the compensation decision as it links the environmental impacts, with annoyance and this to the amount of compensation. This result is in line with Botelho *et al.* (2015)'s finding that there is a direct and an indirect effect of wind turbines' sound pressure levels on respondents' decisions to take remediating measures on their homes, where the indirect effect occurs through the annoyance reported by subjects.

The implementation of the complex design here proposed constituted in itself a formidable task and implied some compromise regarding the richness of the data analysis' task. However some important conclusions emerged. First, welfare losses attributed to the presence of hydropower plants, photovoltaic plants, forest biomass plants and wind farms are significant; local residents feel negatively affected by their presence and demand compensation accordingly. Second, the environmental effects of RES power plants considered in this study negatively affect the general population utility level and this translates into significant money amounts which they are willing to pay to avoid each individual environmental effect considered. Third, location is relevant for the determination of the average amount of compensation, a finding suggesting that benefit transfer techniques should not be applied in these types of assessments. Fourth, the amount of compensation demanded is, in most cases, dependent on annoyance level and specific to energy source. Fifth, the general population has preferences over the source of renewable energy. Finally, socio-demographic variables play a role in the compensation decision and possibly they also play a role in the WTP amount decision.

A novel contribution of the design herein implemented is the possibility of analysing within the same framework respondents' preferences for the type of renewable energy source and their preferences for the environmental impacts. However, in future work we intend to extend the analysis incorporating some refinements. One dimension that is left out in the analysis is the estimation of the effect of each environmental attribute accounting for the energy source; in the present analysis we assumed that individuals' preferences over environmental impacts were independent of their preferences over energy source. Data collected with the *global* questionnaire allows the estimation of these effects. Moreover, the estimation of the binomial logit assumed that preferences are homogeneous, ie, environmental effects affect respondents' utility in the same fashion independently of the subjects' characteristics. The consideration of heterogeneous preferences could be accounted for by interacting socio-demographic characteristics with the environmental effects. Amongst others, these extensions are now left for future work. Finally, this dissertation demonstrates the feasibility of using non-market economic valuation methodologies to assess the welfare effects of the impacts produced by the operation of renewable energy source installations. It also shows how CV and DCE approaches can be complementarily applied for the analysis of the welfare effect of different stakeholder groups. Concerning policy implications, the results indicate that energy policies should be developed accounting for local and national welfare implications of the environmental impacts produced by the use of RES. In a nutshell, given the overall findings of the present work, not only efficiency but also equity considerations should make part of effective energy policies.

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APPENDICES

Appendix I:
I.1. English Translation of DCE Questionnaires
I.1.1. DCE Questionnaire on Forest Biomass Power

B

Dear respondent,

We need your collaboration in a research project conducted by researchers of the University of Minho. Its main objective is the valuation of environmental impacts associated with each of the various renewable energy sources. The following questionnaire is anonymous and confidential. Please respond with the greatest sincerity possible.

It is very important that you fill out the questionnaire until the end.

Section I: Introductory Section

In this section we intend to have an idea of your familiarity with renewable energy.

1. What are the most important environmental problems in Portugal currently? (Indicate only 3)

- ☐ Climate change
- ☐ Atmospheric pollution
- ☐ Water pollution (rivers and ocean)
- ☐ Over-exploitation of natural resources
- ☐ Biodiversity decline (variety of animal and plant species)
- ☐ Waste
- ☐ Other

2. Say in which way you agree with the following statements (mark with an x).

	Agree totally	**Agree partially**	**Do not agree nor disagree**	**Disagree partially**	**Disagree totally**	**Do not know**
The government should act to reduce pollution by specific laws.						
It is important electricity have a low price.						
We should reduce environmental pollution and other environmental impacts caused by the electricity generation.						
The government should help reduce the costs of electricity production financing new forms of production.						
The government should help reduce the costs of electricity production financing new energy sources more environmentally friendly and renewable.						
People in general can do much to improve the environment, for instance by lowering electricity consumption.						
I, personally, do not have financial availability to contribute more to a better environment than what I already contribute.						
I, personally, do not have availability to dedicate more of my time to keep a better environment than I already dedicate.						
I do not know in what way I may collaborate more than I already collaborate to maintain a better environment.						

3. Do you usually buy environmentally friendly products (or someone in your household does)?

☐ Yes ☐ No

4. Have you ever heard of the environmental problems that are associated with the use of energy from fossil fuels (such as oil)?

☐ Yes ☐ No

4.1. If yes which ones? (if you consider all please tick only the three most important in your opinion)

☐ Accumulation of carbon dioxide
☐ Climate change
☐ Water pollution
☐ Loss of species diversity (animals and vegetal)
☐ Other

5. What are the renewable energy sources that you know?

☐ Wind Power
☐ Photovoltaic Power (solar)
☐ Biomass (forest remains)
☐ Geothermal Energy (heat of the earth)
☐ Hydropower (dams)
☐ Wave Energy
☐ Other ____________

6. What is your opinion on how environmentally friendly are these energy sources? (Indicate with an X).

	Very friend	Somewhat friend	Indifferent	Somewhat not friend	Not friend	Do not know
Nuclear						
Hydropower (dams)						
Coal						
Natural gas						
Wind power						
Photovoltaic (solar)						
Geothermal (heat of the earth)						
Biomass (forest waste)						
Fuel oil (gas oil)						
Wave energy						

7. Have you ever visited one of the following technologies of production of renewable energy?

- ➔ Dam ☐ Yes ☐ No
- ➔ Wind farm ☐ Yes ☐ No
- ➔ Photovoltaic farm ☐ Yes ☐ No
- ➔ Biomass power plant ☐ Yes ☐ No

8. Do you work/worked in any technology of production of renewable energy?

- ▢ Yes
- ▢ No

8.1. If **yes,** specify in which one(s):

- ▢ Wind farm
- ▢ Photovoltaic farm (solar)
- ▢ Dam
- ▢ Biomass power plant

9. Do you know someone that works/worked in any technology of production of renewable energy??

- ▢ Yes
- ▢ No

9.1. If **yes,** specify in which one(s):

- ▢ Wind farm
- ▢ Photovoltaic farm (solar)
- ▢ Dam
- ▢ Biomass power plant

10. How important is for you to know the type of renewable energy that is being consumed in the production of electricity (wind, solar, hydro, biomass)? On a scale from 0 to 5**, wherein 0 means "without opinion", 1 means "not important", 3 means "important" and 5 means "very important".**

▢ 0 ▢ 1 ▢ 2 ▢ 3 ▢ 4 ▢ 5

11. What is your monthly amount (average/approximately) of your electricity bill?

Value_______________ do not know ______

12. Do you usually observe in detail your electricity bill?

▢ No, I limit myself to pay ▢ Just the value ▢ Yes, I observe every details

Section II: Choices

The production of electricity through the use of vegetal biomass (forest remains) is held in thermoelectric plants. The use of this energy source may cause some environmental effects which in turn may cause you some discomfort. The impacts may depend on its location, causing changes in the landscape and in fauna/flora or less pleasant odor. These impacts can be reduced by changing some characteristics of production or location, but this is has an additional charge.

Next we present 6 situations of choice between two alternative forms of electricity generation through the use of biomass (forest). The alternatives vary in their environmental impacts and in the price increase regarding your current monthly electricity bill. In each decision you should choose your preferred alternative, as you would do in a real situation. It is important that you choose based only on the presented alternatives. In the choice moment consider your average monthly income and the expenses of your household.

EXAMPLE: Consider the choice between the form A of electricity generation through biomass and the form B of electricity generation also through biomass. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	Yes
Significant impact on the Fauna/Flora	No	Yes
Produces odour affecting population	Yes	No
Increase in the monthly bill €	12	8
Your choice	☐	☐

In this case the respondent chose to have in his home electricity produced through biomass of form A which produces a significant effect on the landscape, produces odour, but has no impact on fauna and flora and costs 12 euros more per month. Instead of electricity produced through the form B, which is cheaper and produces no odour, but affects the fauna and flora. With the answer of this respondent we can conclude that he prefers to pay more 12 euros per month to avoid negative impacts on fauna and flora, accepting facility with significant effects on the landscape and odour production.

Taking into account your average monthly income and the expenses of your household, make now your choices indicating an x in your option.

Choice 1 - Consider the choice between the form A of electricity generation through biomass and the form B of electricity generation also through biomass. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	Yes	No
Produces odour affecting population	Yes	No
Increase in the monthly bill €	4	8
Your choice	☐	☐

13. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

14. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 2 - Consider the choice between the form A of electricity generation through biomass and the form B of electricity generation also through biomass. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	No	Yes
Significant impact on the Fauna/Flora	No	Yes
Produces odour affecting population	Yes	No
Increase in the monthly bill €	12	4
Your choice	☐	☐

15. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

16. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 3 - Consider the choice between the form A of electricity generation through biomass and the form B of electricity generation also through biomass. Tick your preferred option:

	Form A	**Form B**
Significant impact on the landscape	No	Yes
Significant impact on the Fauna/Flora	Yes	No
Produces odour affecting population	No	Yes
Increase in the monthly bill €	12	12
Your choice	☐	☐

17. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

18. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

Choice 4 - Consider the choice between the form A of electricity generation through biomass and the form B of electricity generation also through biomass. Tick your preferred option:

	Form A	**Form B**
Significant impact on the landscape	No	Yes
Significant impact on the Fauna/Flora	No	Yes
Produces odour affecting population	Yes	No
Increase in the monthly bill €	4	12
Your choice	☐	☐

19. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

20. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

Choice 5 - Consider the choice between the form A of electricity generation through biomass and the form B of electricity generation also through biomass. Tick your preferred option:

	Form A	**Form B**
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	Yes	No
Produces odour affecting population	No	Yes
Increase in the monthly bill €	8	4
Your choice	☐	☐

21. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

22. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

Choice 6 - Consider the choice between the form A of electricity generation through biomass and the form B of electricity generation also through biomass. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	No	Yes
Produces odour affecting population	No	Yes
Increase in the monthly bill €	8	8
Your choice	☐	☐

23. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

24. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

25. In the choices you made previously have you considered all the attributes?

☐ Yes ☐ No

25.1 If **not,** to which attributes you gave more importance? (Tick all that apply)

☐ *Preservation of fauna and flora.*
☐ *Preservation of the landscape*
☐ *Odour (smells)*
☐ *Price (increase in the monthly bill amount)*

26. Which of the following options best explain the reasons for your answers to the previous questions?

☐ *In my opinion the consumers should not have to pay more to have electricity friend of the environment.*
☐ *I chose the alternative that gave me more value for the price.*
☐ *It is important to know the destination of the additional payments that are made to the renewable energy sources.*
☐ *I would rather spend my money to buy electricity from other renewable sources.*
☐ *I do not have the financial capacity to pay more for electricity than what I already pay.*

27. How would you classify each of the impacts of electricity generation from thermoelectric plants (biomass), where 1 corresponds to "very negative" and 5 "very positive"? (Indicate with an X).

Impacts	**Effects of the Thermoelectric Plants (biomass)**					
	Very negative				**Very positive**	**Do not know**
	1	**2**	**3**	**4**	**5**	
Change of the landscape						
Changes in the fauna						
Changes in the flora						
Odour						
Production cost						

Section III: Opinion on renewable energy on general

28. Do you consider that Portugal has natural conditions to make a good use of the renewable energy?

☐ Yes ☐ No

29. Do you believe that renewable energy bring benefits to the population?

☐ Yes ☐ No

29.1. If **yes**, in your opinion, which of the following benefits you consider to be more important?

☐ It is inexhaustible on a human scale
☐ It does not produce harmful emissions or toxic solids
☐ It reduces the contribution to global climate change
☐ It is beneficial to employment and job creation
☐ It reduces external energy dependence of our economy

Section IV: Sociodemographic questions

30. Gender: ☐ Female ☐ Male

31. Marital Status**:**

☐ Married/ Facto Union
☐ Divorced
☐ Single
☐ Widower

32. Age: ____________

33. Situation in employment:

☐ Unemployed
☐ Domestic
☐ Student
☐ Retired
☐ Self employed
☐ Worker as an employed person

34. School qualifications:

☐ 1st, 2nd, 3rd or 4th year (former primary instruction)
☐ 5th or 6th year (former preparatory cycle)
☐ 7th, 8th or 9th year (former 3rd, 4th and 5th lyceum year)
☐ 10th, 11th or 12th (former 6th and 7th lyceum year/introductory year)
☐ Bachelor or Degree
☐ Master
☐ Doctoral Degree (PhD)
☐ Other

35. Monthly net household income (in euros):

- ▢ Less than 250€
- ▢ Between 251 and 500€
- ▢ Between 501 and 750€
- ▢ Between 751 and 1000€
- ▢ Between 1001 and 1250€
- ▢ Between 1251 and 1500€
- ▢ Between 1501 and 1750€
- ▢ Between 1751 and 2000€
- ▢ Between 2001 and 2250€
- ▢ Between 2251 and 2500€
- ▢ Between 2501 and 2750€
- ▢ Between 2751 and 3000€
- ▢ Between 3001 and 3250€
- ▢ Between 3251 and 3500€
- ▢ Between 3501 and 3750€
- ▢ Between 3751 and 4000€
- ▢ Between 4001 and 4250€
- ▢ Between 4251 and 4500€
- ▢ Between 4501 and 4750€
- ▢ Between 4751 and 5000€
- ▢ More than 5000€

36. Number of persons of the household:

Children (<12)________Young (12-18 years)________ Adults (>18) ________

37. From your residence, place of work or daily commuting do you see any facility of electricity generation through a renewable energy source?

▢ Yes ▢ No

37.1. If **yes**: which is the renewable energy source?

- Wind power ▢
- Hidro (dam) ▢
- Biomass (forest remains) ▢
- Photovoltaic (sun) ▢

37.2. If **yes**: in which place?

▢ Residence ▢ Work ▢ Daily commuting

38. What is your municipality of residence? ________________

39. Rate your behaviour towards risk, using a scale from 1 (absolutely nothing risky) to 9 (more than extremely risky). (Indicate with an X).

	Absolutely nothing risky (1)	**Nothing risky (2)**	**Little risky (3)**	**Somethin g risky (4)**	**Moderately risky (5)**	**Risky (6)**	**Very risky (7)**	**Extremel y risky (8)**	**More than extremely risky (9)**
In GENERAL, would you say that your behaviour and the decisions you make are:									
In your PROFESSIONAL ACTIVITY, would you say that your behaviour and the decisions you make are:									
With regard to your FINANCES, would you say that your behaviour and the decisions you make are:									
With regard to your HEALTH, would you say that your behaviour and the decisions you make are:									

40. Use the space below to leave your comment.

THANK YOU VERY MUCH FOR YOUR COOPERATION!

I.1.2. DCE Questionnaire on Wind Power

W

Dear respondent,

We need your collaboration in a research project conducted by researchers of the University of Minho. Its main objective is the valuation of environmental impacts associated with each of the various renewable energy sources. The following questionnaire is anonymous and confidential. Please respond with the greatest sincerity possible.

It is very important that you fill out the questionnaire until the end.

Section I: Introductory Section

In this section we intend to have an idea of your familiarity with renewable energy.

1. What are the most important environmental problems in Portugal currently? (Indicate only 3)

- ☐ Climate change
- ☐ Atmospheric pollution
- ☐ Water pollution (rivers and ocean)
- ☐ Over-exploitation of natural resources
- ☐ Biodiversity decline (variety of animal and plant species)
- ☐ Waste
- ☐ Other

2. Say in which way you agree with the following statements (mark with an x).

	Agree totally	**Agree partially**	**Do not agree nor disagree**	**Disagree partially**	**Disagree totally**	**Do not know**
The government should act to reduce pollution by specific laws.						
It is important electricity have a low price.						
We should reduce environmental pollution and other environmental impacts caused by the electricity generation.						
The government should help reduce the costs of electricity production financing new forms of production.						
The government should help reduce the costs of electricity production financing new energy sources more environmentally friendly and renewable.						
People in general can do much to improve the environment, for instance by lowering electricity consumption.						
I, personally, do not have financial availability to contribute more to a better environment than what I already contribute.						
I, personally, do not have availability to dedicate more of my time to keep a better environment than I already dedicate.						
I do not know in what way I may collaborate more than I already collaborate to maintain a better environment.						

3. Do you usually buy environmentally friendly products (or someone in your household does)?

☐ Yes ☐ No

4. Have you ever heard of the environmental problems that are associated with the use of energy from fossil fuels (such as oil)?

☐ Yes ☐ No

4.1. If yes which ones? (if you consider all please tick only the three most important in your opinion)

- ☐ Accumulation of carbon dioxide
- ☐ Climate change
- ☐ Water pollution
- ☐ Loss of species diversity (animals and vegetal)
- ☐ Other

5. What are the renewable energy sources that you know?

- ☐ Wind Power
- ☐ Photovoltaic Power (solar)
- ☐ Biomass (forest remains)
- ☐ Geothermal Energy (heat of the earth)
- ☐ Hydropower (dams)
- ☐ Wave Energy
- ☐ Other ____________

6. What is your opinion on how environmentally friendly are these energy sources? (Indicate with an X).

	Very friend	Somewhat friend	Indifferent	Somewhat not friend	Not friend	Do not know
Nuclear						
Hydropower (dams)						
Coal						
Natural gas						
Wind power						
Photovoltaic (solar)						
Geothermal (heat of the earth)						
Biomass (forest waste)						
Fuel oil (gas oil)						
Wave energy						

7. Have you ever visited one of the following technologies of production of renewable energy?

- ➔ Dam ☐ Yes ☐ No
- ➔ Wind farm ☐ Yes ☐ No
- ➔ Photovoltaic farm ☐ Yes ☐ No
- ➔ Biomass power plant ☐ Yes ☐ No

8. Do you work/worked in any technology of production of renewable energy?

☐ Yes ☐ No

8.1. If **yes,** specify in which one(s):

☐ Wind farm
☐ Photovoltaic farm (solar)
☐ Dam
☐ Biomass power plant

9. Do you know someone that works/worked in any technology of production of renewable energy??

☐ Yes ☐ No

9.1. If **yes,** specify in which one(s):

☐ Wind farm
☐ Photovoltaic farm (solar)
☐ Dam
☐ Biomass power plant

10. How important is for you to know the type of renewable energy that is being consumed in the production of electricity (wind, solar, hydro, biomass)? On a scale from 0 to 5**, wherein 0 means "without opinion", 1 means "not important", 3 means "important" and 5 means "very important".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. What is your monthly amount (average/approximately) of your electricity bill?

Value_______________ do not know ______

12. Do you usually observe in detail your electricity bill?

☐ No, I limit myself to pay ☐ Just the value ☐ Yes, I observe every details

Section II: Choices

The production of electricity through the use of wind power is held in wind farms. The use of this energy source may cause some environmental effects which in turn may cause you some discomfort. The impacts may depend on its location, causing changes in the landscape and in fauna/flora or the production of noise that may be annoying. These impacts can be reduced by changing some characteristics of production or location, but this is has an additional charge.

Next we present 6 situations of choice between two alternative forms of electricity generation through the use of wind power. The alternatives vary in their environmental impacts and in the price increase regarding your current monthly electricity bill. In each decision you should choose your preferred alternative, as you would do in a real situation. It is important that you choose based only on the presented alternatives. In the choice moment consider your average monthly income and the expenses of your household.

EXAMPLE: Consider the choice between the form A of electricity generation through wind power and the form B of electricity generation <u>also</u> through wind power. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	Yes
Significant impact on the Fauna/Flora	No	Yes
Produces noise affecting population	Yes	No
Increase in the monthly bill €	12	8
Your choice	☐	☐

In this case the respondent chose to have in his home electricity produced through wind power of form A which produces a significant effect on the landscape, produces noise, but has no impact on fauna and flora and costs 12 euros more per month. Instead of electricity produced through the form B, which is cheaper and produces no noise, but affects the fauna and flora. With the answer of this respondent we can conclude that he prefers to pay more 12 euros per month to avoid negative impacts on fauna and flora, accepting facility with significant effects on the landscape and noise production.

Taking into account your <u>average monthly income</u> and the <u>expenses of your household, make now your choices indicating an x in your option.</u>

Choice 1 - Consider the choice between the form A of electricity generation through wind power and the form B of electricity generation <u>also</u> through wind power. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	Yes	No
Produces noise affecting population	Yes	No
Increase in the monthly bill €	4	8
Your choice	☐	☐

13. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

14. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 2 - Consider the choice between the form A of electricity generation through wind power and the form B of electricity generation <u>also</u> through wind power. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	No	Yes
Significant impact on the Fauna/Flora	No	Yes
Produces noise affecting population	Yes	No
Increase in the monthly bill €	12	4
Your choice	☐	☐

15. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

16. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 3 - Consider the choice between the form A of electricity generation through wind power and the form B of electricity generation also through wind power. Tick your preferred option:

	Form A	**Form B**
Significant impact on the landscape	No	Yes
Significant impact on the Fauna/Flora	Yes	No
Produces noise affecting population	No	Yes
Increase in the monthly bill €	12	12
Your choice	☐	☐

17. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

18. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 4 - Consider the choice between the form A of electricity generation through wind power and the form B of electricity generation also through wind power. Tick your preferred option:

	Form A	**Form B**
Significant impact on the landscape	No	Yes
Significant impact on the Fauna/Flora	No	Yes
Produces noise affecting population	Yes	No
Increase in the monthly bill €	4	12
Your choice	☐	☐

19. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

20. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 5 - Consider the choice between the form A of electricity generation through wind power and the form B of electricity generation also through wind power. Tick your preferred option:

	Form A	**Form B**
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	Yes	No
Produces noise affecting population	No	Yes
Increase in the monthly bill €	8	4
Your choice	☐	☐

21. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

22. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 6 - Consider the choice between the form A of electricity generation through wind power and the form B of electricity generation also through wind power. Tick your preferred option:

	Form A	**Form B**
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	No	Yes
Produces noise affecting population	No	Yes
Increase in the monthly bill €	8	8
Your choice	▢	▢

23. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

▢ Yes ▢ No

24. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0▢ 1▢ 2▢ 3▢ 4▢ 5▢ 6▢ 7▢ 8▢ 9▢ 10▢

25. In the choices you made previously have you considered all the attributes?

▢ Yes ▢ No

25.1 If **not,** to which attributes you gave more importance? (Tick all that apply)

▢ *Preservation of fauna and flora.*
▢ *Preservation of the landscape*
▢ *Noise*
▢ *Price (increase in the monthly bill amount)*

26. Which of the following options best explain the reasons for your answers to the previous questions?

▢ *In my opinion the consumers should not have to pay more to have electricity friend of the environment.*
▢ *I chose the alternative that gave me more value for the price.*
▢ *It is important to know the destination of the additional payments that are made to the renewable energy sources.*
▢ *I would rather spend my money to buy electricity from other renewable sources.*
▢ *I do not have the financial capacity to pay more for electricity than what I already pay.*

27. How would you classify each of the impacts of electricity generation from wind power, where 1 corresponds to "very negative" and 5 "very positive"? (Indicate with an X).

Impacts	**Effects of the Wind Farms**					
	Very negative			**Very positive**		**Do not know**
	1	**2**	**3**	**4**	**5**	
Change of the landscape						
Changes in the fauna						
Changes in the flora						
Noise						
Production cost						

Section III: Opinion on renewable energy on general

28. Do you consider that Portugal has natural conditions to make a good use of the renewable energy?

☐ Yes ☐ No

29. Do you believe that renewable energy bring benefits to the population?

☐ Yes ☐ No

29.1. If **yes**, in your opinion, which of the following benefits you consider to be more important?

- ☐ It is inexhaustible on a human scale
- ☐ It does not produce harmful emissions or toxic solids
- ☐ It reduces the contribution to global climate change
- ☐ It is beneficial to employment and job creation
- ☐ It reduces external energy dependence of our economy

Section IV: Sociodemographic questions

30. Gender: ☐ Female ☐ Male

31. Marital Status**:**

- ☐ Married/ Facto Union
- ☐ Divorced
- ☐ Single
- ☐ Widower

32. Age: ____________

33. Situation in employment:

- ☐ Unemployed
- ☐ Domestic
- ☐ Student
- ☐ Retired
- ☐ Self employed
- ☐ Worker as an employed person

34. School qualifications:

- ☐ 1st, 2nd, 3rd or 4th year (former primary instruction)
- ☐ 5th or 6th year (former preparatory cycle)
- ☐ 7th, 8th or 9th year (former 3rd, 4th and 5th lyceum year)
- ☐ 10th, 11th or 12th (former 6th and 7th lyceum year/introductory year)
- ☐ Bachelor or Degree
- ☐ Master
- ☐ Doctoral Degree (PhD)
- ☐ Other

35. Monthly net household income (in euros):

- ☐ Less than 250€
- ☐ Between 251 and 500€
- ☐ Between 501 and 750€
- ☐ Between 751 and 1000€
- ☐ Between 1001 and 1250€
- ☐ Between 1251 and 1500€
- ☐ Between 1501 and 1750€
- ☐ Between 1751 and 2000€
- ☐ Between 2001 and 2250€
- ☐ Between 2251 and 2500€
- ☐ Between 2501 and 2750€
- ☐ Between 2751 and 3000€
- ☐ Between 3001 and 3250€
- ☐ Between 3251 and 3500€
- ☐ Between 3501 and 3750€
- ☐ Between 3751 and 4000€
- ☐ Between 4001 and 4250€
- ☐ Between 4251 and 4500€
- ☐ Between 4501 and 4750€
- ☐ Between 4751 and 5000€
- ☐ More than 5000€

36. Number of persons of the household:

Children (<12)________Young (12-18 years)________Adults (>18) ________

37. From your residence, place of work or daily commuting do you see any facility of electricity generation through a renewable energy source?

☐ Yes ☐ No

37.1. If **yes**: which is the renewable energy source?

Wind power ☐
Hidro (dam) ☐
Biomass (forest remains) ☐
Photovoltaic (sun) ☐

37.2. If **yes**: in which place?

☐ Residence ☐ Work ☐ Daily commuting

38. What is your municipality of residence? ________________________

39. Rate your behaviour towards risk, using a scale from 1 (absolutely nothing risky) to 9 (more than extremely risky). (Indicate with an X).

	Absolutely nothing risky (1)	**Nothing risky (2)**	**Little risky (3)**	**Somethin g risky (4)**	**Moderately risky (5)**	**Risky (6)**	**Very risky (7)**	**Extremel y risky (8)**	**More than extremely risky (9)**
In GENERAL, would you say that your behaviour and the decisions you make are:									
In your PROFESSIONAL ACTIVITY, would you say that your behaviour and the decisions you make are:									
With regard to your FINANCES, would you say that your behaviour and the decisions you make are:									
With regard to your HEALTH, would you say that your behaviour and the decisions you make are:									

40. Use the space below to leave your comment.

THANK YOU VERY MUCH FOR YOUR COOPERATION!

I.1.3. DCE Questionnaire on Photovoltaic Power

P

Dear respondent,

We need your collaboration in a research project conducted by researchers of the University of Minho. Its main objective is the valuation of environmental impacts associated with each of the various renewable energy sources. The following questionnaire is anonymous and confidential. Please respond with the greatest sincerity possible.

It is very important that you fill out the questionnaire until the end.

Section I: Introductory Section

In this section we intend to have an idea of your familiarity with renewable energy.

1. What are the most important environmental problems in Portugal currently? (Indicate only 3)

- ☐ Climate change
- ☐ Atmospheric pollution
- ☐ Water pollution (rivers and ocean)
- ☐ Over-exploitation of natural resources
- ☐ Biodiversity decline (variety of animal and plant species)
- ☐ Waste
- ☐ Other

2. Say in which way you agree with the following statements (mark with an x).

	Agree totally	**Agree partially**	**Do not agree nor disagree**	**Disagree partially**	**Disagree totally**	**Do not know**
The government should act to reduce pollution by specific laws.						
It is important electricity have a low price.						
We should reduce environmental pollution and other environmental impacts caused by the electricity generation.						
The government should help reduce the costs of electricity production financing new forms of production.						
The government should help reduce the costs of electricity production financing new energy sources more environmentally friendly and renewable.						
People in general can do much to improve the environment, for instance by lowering electricity consumption.						
I, personally, do not have financial availability to contribute more to a better environment than what I already contribute.						
I, personally, do not have availability to dedicate more of my time to keep a better environment than I already dedicate.						
I do not know in what way I may collaborate more than I already collaborate to maintain a better environment.						

3. Do you usually buy environmentally friendly products (or someone in your household does)?

☐ Yes ☐ No

4. Have you ever heard of the environmental problems that are associated with the use of energy from fossil fuels (such as oil)?

☐ Yes ☐ No

4.1. If yes which ones? (if you consider all please tick only the three most important in your opinion)

☐ Accumulation of carbon dioxide
☐ Climate change
☐ Water pollution
☐ Loss of species diversity (animals and vegetal)
☐ Other

5. What are the renewable energy sources that you know?

☐ Wind Power
☐ Photovoltaic Power (solar)
☐ Biomass (forest remains)
☐ Geothermal Energy (heat of the earth)
☐ Hydropower (dams)
☐ Wave Energy
☐ Other ___________

6. What is your opinion on how environmentally friendly are these energy sources? (Indicate with an X).

	Very friend	**Somewhat friend**	**Indifferent**	**Somewhat not friend**	**Not friend**	**Do not know**
Nuclear						
Hydropower (dams)						
Coal						
Natural gas						
Wind power						
Photovoltaic (solar)						
Geothermal (heat of the earth)						
Biomass (forest waste)						
Fuel oil (gas oil)						
Wave energy						

7. Have you ever visited one of the following technologies of production of renewable energy?

➔ Dam ☐ Yes ☐ No
➔ Wind farm ☐ Yes ☐ No
➔ Photovoltaic farm ☐ Yes ☐ No
➔ Biomass power plant ☐ Yes ☐ No

8. Do you work/worked in any technology of production of renewable energy?

☐ Yes ☐ No

8.1. If **yes,** specify in which one(s):

☐ Wind farm
☐ Photovoltaic farm (solar)
☐ Dam
☐ Biomass power plant

9. Do you know someone that works/worked in any technology of production of renewable energy??

☐ Yes ☐ No

9.1. If **yes,** specify in which one(s):

☐ Wind farm
☐ Photovoltaic farm (solar)
☐ Dam
☐ Biomass power plant

10. How important is for you to know the type of renewable energy that is being consumed in the production of electricity (wind, solar, hydro, biomass)? On a scale from 0 to 5**, wherein 0 means "without opinion", 1 means "not important", 3 means "important" and 5 means "very important".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. What is your monthly amount (average/approximately) of your electricity bill?

Value_______________ do not know ______

12. Do you usually observe in detail your electricity bill?

☐ No, I limit myself to pay ☐ Just the value ☐ Yes, I observe every details

Section II: Choices

The production of electricity through the use of photovoltaic power (solar) is held in photovoltaic farms. The use of this energy source may cause some environmental effects which in turn may cause you some discomfort. The impacts may depend on its location, causing changes in the landscape and in fauna/flora or the production of glare that may be annoying. These impacts can be reduced by changing some characteristics of production or location, but this is has an additional charge.

Next we present 6 situations of choice between two alternative forms of electricity generation through the use of photovoltaic power (solar). The alternatives vary in their environmental impacts and in the price increase regarding your current monthly electricity bill. In each decision you should choose your preferred alternative, as you would do in a real situation. It is important that you choose based only on the presented alternatives. In the choice moment consider your average monthly income and the expenses of your household.

EXAMPLE: Consider the choice between the form A of electricity generation through photovoltaic power and the form B of electricity generation also through photovoltaic power. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	Yes
Significant impact on the Fauna/Flora	No	Yes
Produces glare affecting population	Yes	No
Increase in the monthly bill €	12	8
Your choice	☐	☐

In this case the respondent chose to have in his home electricity produced through photovoltaic power of form A which produces a significant effect on the landscape, produces glare, but has no impact on fauna and flora and costs 12 euros more per month. Instead of electricity produced through the form B, which is cheaper and produces no glare, but affects the fauna and flora. With the answer of this respondent we can conclude that he prefers to pay more 12 euros per month to avoid negative impacts on fauna and flora, accepting facility with significant effects on the landscape and production of glare.

Taking into account your average monthly income and the expenses of your household, make now your choices indicating an x in your option.

Choice 1 - Consider the choice between the form A of electricity generation through photovoltaic power and the form B of electricity generation also through photovoltaic power. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	Yes	No
Produces glare affecting population	Yes	No
Increase in the monthly bill €	4	8
Your choice	☐	☐

13. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

14. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 2 - Consider the choice between the form A of electricity generation through photovoltaic power and the form B of electricity generation also through photovoltaic power. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	No	Yes
Significant impact on the Fauna/Flora	No	Yes
Produces glare affecting population	Yes	No
Increase in the monthly bill €	12	4
Your choice	☐	☐

15. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

16. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 3 - Consider the choice between the form A of electricity generation through photovoltaic power and the form B of electricity generation also through photovoltaic power. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	No	Yes
Significant impact on the Fauna/Flora	Yes	No
Produces glare affecting population	No	Yes
Increase in the monthly bill €	12	12
Your choice	☐	☐

17. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

18. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 4 - Consider the choice between the form A of electricity generation through photovoltaic power and the form B of electricity generation also through photovoltaic power. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	No	Yes
Significant impact on the Fauna/Flora	No	Yes
Produces glare affecting population	Yes	No
Increase in the monthly bill €	4	12
Your choice	☐	☐

19. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

20. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 5 - Consider the choice between the form A of electricity generation through photovoltaic power and the form B of electricity generation also through photovoltaic power. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	Yes	No
Produces glare affecting population	No	Yes
Increase in the monthly bill €	8	4
Your choice	☐	☐

21. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

22. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 6 - Consider the choice between the form A of electricity generation through photovoltaic power and the form B of electricity generation also through photovoltaic power. Tick your preferred option:

	Form A	**Form B**
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	No	Yes
Produces glare affecting population	No	Yes
Increase in the monthly bill €	8	8
Your choice	☐	☐

23. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

24. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

25. In the choices you made previously have you considered all the attributes?

☐ Yes ☐ No

25.1 If **not,** to which attributes you gave more importance? (Tick all that apply)

☐ *Preservation of fauna and flora.*
☐ *Preservation of the landscape*
☐ *Glare*
☐ *Price (increase in the monthly bill amount)*

26. Which of the following options best explain the reasons for your answers to the previous questions?

☐ *In my opinion the consumers should not have to pay more to have electricity friend of the environment.*
☐ *I chose the alternative that gave me more value for the price.*
☐ *It is important to know the destination of the additional payments that are made to the renewable energy sources.*
☐ *I would rather spend my money to buy electricity from other renewable sources.*
☐ *I do not have the financial capacity to pay more for electricity than what I already pay.*

27. How would you classify each of the impacts of electricity generation from photovoltaic power (solar), where 1 corresponds to "very negative" and 5 "very positive"? (Indicate with an X).

Impacts	**Effects of the Photovoltaic Farms**					
	Very negative			**Very positive**		**Do not know**
	1	**2**	**3**	**4**	**5**	
Change of the landscape						
Changes in the fauna						
Changes in the flora						
Glare						
Production cost						

Section III: Opinion on renewable energy on general

28. Do you consider that Portugal has natural conditions to make a good use of the renewable energy?

☐ Yes ☐ No

29. Do you believe that renewable energy bring benefits to the population?

☐ Yes ☐ No

29.1. If **yes**, in your opinion, which of the following benefits you consider to be more important?

- ☐ It is inexhaustible on a human scale
- ☐ It does not produce harmful emissions or toxic solids
- ☐ It reduces the contribution to global climate change
- ☐ It is beneficial to employment and job creation
- ☐ It reduces external energy dependence of our economy

Section IV: Sociodemographic questions

30. Gender: ☐ Female ☐ Male

31. Marital Status**:**

- ☐ Married/ Facto Union
- ☐ Divorced
- ☐ Single
- ☐ Widower

32. Age: ____________

33. Situation in employment:

- ☐ Unemployed
- ☐ Domestic
- ☐ Student
- ☐ Retired
- ☐ Self employed
- ☐ Worker as an employed person

34. School qualifications:

- ☐ 1st, 2nd, 3rd or 4th year (former primary instruction)
- ☐ 5th or 6th year (former preparatory cycle)
- ☐ 7th, 8th or 9th year (former 3rd, 4th and 5th lyceum year)
- ☐ 10th, 11th or 12th (former 6th and 7th lyceum year/introductory year)
- ☐ Bachelor or Degree
- ☐ Master
- ☐ Doctoral Degree (PhD)
- ☐ Other

35. Monthly net household income (in euros):

- ☐ Less than 250€
- ☐ Between 251 and 500€
- ☐ Between 501 and 750€
- ☐ Between 751 and 1000€
- ☐ Between 1001 and 1250€
- ☐ Between 1251 and 1500€
- ☐ Between 1501 and 1750€
- ☐ Between 1751 and 2000€
- ☐ Between 2001 and 2250€
- ☐ Between 2251 and 2500€
- ☐ Between 2501 and 2750€
- ☐ Between 2751 and 3000€
- ☐ Between 3001 and 3250€
- ☐ Between 3251 and 3500€
- ☐ Between 3501 and 3750€
- ☐ Between 3751 and 4000€
- ☐ Between 4001 and 4250€
- ☐ Between 4251 and 4500€
- ☐ Between 4501 and 4750€
- ☐ Between 4751 and 5000€
- ☐ More than 5000€

36. Number of persons of the household:

Children (<12)________ Young (12-18 years)________ Adults (>18) ________

37. From your residence, place of work or daily commuting do you see any facility of electricity generation through a renewable energy source?

☐ Yes ☐ No

37.1. If **yes**: which is the renewable energy source?

Wind power ☐
Hidro (dam) ☐
Biomass (forest remains) ☐
Photovoltaic (sun) ☐

37.2. If **yes**: in which place?

☐ Residence ☐ Work ☐ Daily commuting

38. What is your municipality of residence? _________________________

39. Rate your behaviour towards risk, using a scale from 1 (absolutely nothing risky) to 9 (more than extremely risky). (Indicate with an X).

	Absolutely nothing risky (1)	**Nothing risky (2)**	**Little risky (3)**	**Somethin g risky (4)**	**Moderately risky (5)**	**Risky (6)**	**Very risky (7)**	**Extremel y risky (8)**	**More than extremely risky (9)**
<u>In GENERAL</u>, would you say that your behaviour and the decisions you make are:									
<u>In your PROFESSIONAL ACTIVITY</u>, would you say that your behaviour and the decisions you make are:									
<u>With regard to your FINANCES</u>, would you say that your behaviour and the decisions you make are:									
<u>With regard to your HEALTH</u>, would you say that your behaviour and the decisions you make are:									

40. Use the space below to leave your comment.

THANK YOU VERY MUCH FOR YOUR COOPERATION!

I.1.4. DCE Questionnaire on Hydropower

H

Dear respondent,

We need your collaboration in a research project conducted by researchers of the University of Minho. Its main objective is the valuation of environmental impacts associated with each of the various renewable energy sources. The following questionnaire is anonymous and confidential. Please respond with the greatest sincerity possible.

It is very important that you fill out the questionnaire until the end.

Section I: Introductory Section

In this section we intend to have an idea of your familiarity with renewable energy.

1. What are the most important environmental problems in Portugal currently? (Indicate only 3)

- ☐ Climate change
- ☐ Atmospheric pollution
- ☐ Water pollution (rivers and ocean)
- ☐ Over-exploitation of natural resources
- ☐ Biodiversity decline (variety of animal and plant species)
- ☐ Waste
- ☐ Other

2. Say in which way you agree with the following statements (mark with an x).

	Agree totally	**Agree partially**	**Do not agree nor disagree**	**Disagree partially**	**Disagree totally**	**Do not know**
The government should act to reduce pollution by specific laws.						
It is important electricity have a low price.						
We should reduce environmental pollution and other environmental impacts caused by the electricity generation.						
The government should help reduce the costs of electricity production financing new forms of production.						
The government should help reduce the costs of electricity production financing new energy sources more environmentally friendly and renewable.						
People in general can do much to improve the environment, for instance by lowering electricity consumption.						
I, personally, do not have financial availability to contribute more to a better environment than what I already contribute.						
I, personally, do not have availability to dedicate more of my time to keep a better environment than I already dedicate.						
I do not know in what way I may collaborate more than I already collaborate to maintain a better environment.						

3. Do you usually buy environmentally friendly products (or someone in your household does)?

☐ Yes ☐ No

4. Have you ever heard of the environmental problems that are associated with the use of energy from fossil fuels (such as oil)?

☐ Yes ☐ No

4.1. If yes which ones? (if you consider all please tick only the three most important in your opinion)

- ☐ Accumulation of carbon dioxide
- ☐ Climate change
- ☐ Water pollution
- ☐ Loss of species diversity (animals and vegetal)
- ☐ Other

5. What are the renewable energy sources that you know?

- ☐ Wind Power
- ☐ Photovoltaic Power (solar)
- ☐ Biomass (forest remains)
- ☐ Geothermal Energy (heat of the earth)
- ☐ Hydropower (dams)
- ☐ Wave Energy
- ☐ Other ____________

6. What is your opinion on how environmentally friendly are these energy sources? (Indicate with an X).

	Very friend	**Somewhat friend**	**Indifferent**	**Somewhat not friend**	**Not friend**	**Do not know**
Nuclear						
Hydropower (dams)						
Coal						
Natural gas						
Wind power						
Photovoltaic (solar)						
Geothermal (heat of the earth)						
Biomass (forest waste)						
Fuel oil (gas oil)						
Wave energy						

7. Have you ever visited one of the following technologies of production of renewable energy?

- ➔ Dam ☐ Yes ☐ No
- ➔ Wind farm ☐ Yes ☐ No
- ➔ Photovoltaic farm ☐ Yes ☐ No
- ➔ Biomass power plant ☐ Yes ☐ No

8. Do you work/worked in any technology of production of renewable energy?

☐ Yes ☐ No

8.1. If **yes,** specify in which one(s):

☐ Wind farm
☐ Photovoltaic farm (solar)
☐ Dam
☐ Biomass power plant

9. Do you know someone that works/worked in any technology of production of renewable energy??

☐ Yes ☐ No

9.1. If **yes,** specify in which one(s):

☐ Wind farm
☐ Photovoltaic farm (solar)
☐ Dam
☐ Biomass power plant

10. How important is for you to know the type of renewable energy that is being consumed in the production of electricity (wind, solar, hydro, biomass)? On a scale from 0 to 5**, wherein 0 means "without opinion", 1 means "not important", 3 means "important" and 5 means "very important".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. What is your monthly amount (average/approximately) of your electricity bill?

Value_______________ do not know ______

12. Do you usually observe in detail your electricity bill?

☐ No, I limit myself to pay ☐ Just the value ☐ Yes, I observe every details

Section II: Choices

The production of electricity through the use of hydropower is held in dams. The use of this energy source may cause some environmental effects which in turn may cause you some discomfort. The impacts may depend on its location, causing changes in the landscape and in fauna/flora, destruction of heritage (including houses, chapels and traces of ancient buildings or works) or the production of noise that may be annoying. These impacts can be reduced by changing some characteristics of production or location, but this is has an additional charge.

Next we present 8 situations of choice between two alternative forms of electricity generation through the use of hydropower (dams). The alternatives vary in their environmental impacts and in the price increase regarding your current monthly electricity bill. In each decision you should choose your preferred alternative, as you would do in a real situation. It is important that you choose based only on the presented alternatives. In the choice moment consider your average monthly income and the expenses of your household.

EXAMPLE: Consider the choice between the form A of electricity generation through hydropower and the form B of electricity generation also through hydropower. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	Yes
Significant impact on the Fauna/Flora	No	Yes
Produces noise affecting population	No	Yes
Destroys heritage	Yes	No
Increase in the monthly bill €	12	8
Your choice	☐	☐

In this case the respondent chose to have in his home electricity produced through hydropower of form A which produces a significant effect on the landscape and destroys heritage, but has no impact on fauna and flora nor produces noise and costs 12 euros more per month. Instead of electricity produced through the form B, which is cheaper and do not destroys heritage, but produces noise and affects the fauna and flora. With the answer of this respondent we can conclude that he prefers to pay more 12 euros per month to avoid negative impacts on fauna and flora and the production of noise, accepting facility with significant effects on the landscape and destruction of heritage.

Taking into account your average monthly income and the expenses of your household, make now your choices indicating an x in your option.

Choice 1 - Consider the choice between the form A of electricity generation through hydropower and the form B of electricity generation also through hydropower. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	No	Yes
Significant impact on the Fauna/Flora	Yes	No
Produces noise affecting population	Yes	No
Destroys heritage	Yes	No
Increase in the monthly bill €	4	8
Your choice	☐	☐

13. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

14. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 2 - Consider the choice between the form A of electricity generation through hydropower and the form B of electricity generation also through hydropower. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	No	Yes
Significant impact on the Fauna/Flora	No	Yes
Produces noise affecting population	No	No
Destroys heritage	No	Yes
Increase in the monthly bill €	4	12
Your choice	☐	☐

15. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

16. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 3 - Consider the choice between the form A of electricity generation through hydropower and the form B of electricity generation also through hydropower. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	No	Yes
Significant impact on the Fauna/Flora	No	Yes
Produces noise affecting population	Yes	No
Destroys heritage	Yes	No
Increase in the monthly bill €	12	8
Your choice	☐	☐

17. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

18. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 4 - Consider the choice between the form A of electricity generation through hydropower and the form B of electricity generation also through hydropower. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	Yes	No
Produces noise affecting population	No	Yes
Destroys heritage	Yes	No
Increase in the monthly bill €	8	12
Your choice	☐	☐

19. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

20. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 5 - Consider the choice between the form A of electricity generation through hydropower and the form B of electricity generation also through hydropower. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	Yes	No
Produces noise affecting population	Yes	No
Destroys heritage	No	Yes
Increase in the monthly bill €	8	4
Your choice	☐	☐

21. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

22. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 6 - Consider the choice between the form A of electricity generation through hydropower and the form B of electricity generation also through hydropower. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	No	Yes
Significant impact on the Fauna/Flora	Yes	No
Produces noise affecting population	No	Yes
Destroys heritage	No	Yes
Increase in the monthly bill €	8	4
Your choice	☐	☐

23. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

24. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 7 - Consider the choice between the form A of electricity generation through hydropower and the form B of electricity generation also through hydropower. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	No	Yes
Produces noise affecting population	No	Yes
Destroys heritage	Yes	No
Increase in the monthly bill €	12	4
Your choice	☐	☐

25. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

26. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 8 - Consider the choice between the form A of electricity generation through hydropower and the form B of electricity generation also through hydropower. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	No	Yes
Produces noise affecting population	Yes	Yes
Destroys heritage	No	Yes
Increase in the monthly bill €	4	8
Your choice	☐	☐

27. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

28. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

29. In the choices you made previously have you considered all the attributes?

☐ Yes ☐ No

29.1 If **not,** to which attributes you gave more importance? (Tick all that apply)

☐ *Preservation of fauna and flora.*
☐ *Preservation of the landscape*
☐ *Preservation of heritage (buildings and settlements)*
☐ *Noise*
☐ *Price (increase in the monthly bill amount)*

30. Which of the following options best explain the reasons for your answers to the previous questions?

☐ *In my opinion the consumers should not have to pay more to have electricity friend of the environment.*
☐ *I chose the alternative that gave me more value for the price.*
☐ *It is important to know the destination of the additional payments that are made to the renewable energy sources.*
☐ *I would rather spend my money to buy electricity from other renewable sources.*
☐ *I do not have the financial capacity to pay more for electricity than what I already pay.*

31. How would you classify each of the impacts of electricity generation from dams, where 1 corresponds to "very negative" and 5 "very positive"? (Indicate with an X).

Impacts	**Effects of the Dams**					
	Very negative				**Very positive**	**Do not know**
	1	**2**	**3**	**4**	**5**	
Change of the landscape						
Changes in the fauna						
Changes in the flora						
Destruction of heritage						
Noise						
Production cost						

Section III: Opinion on renewable energy on general

32. Do you consider that Portugal has natural conditions to make a good use of the renewable energy?

☐ Yes ☐ No

33. Do you believe that renewable energy bring benefits to the population?

☐ Yes ☐ No

33.1. If **yes**, in your opinion, which of the following benefits you consider to be more important?

☐ It is inexhaustible on a human scale
☐ It does not produce harmful emissions or toxic solids
☐ It reduces the contribution to global climate change
☐ It is beneficial to employment and job creation
☐ It reduces external energy dependence of our economy

Section IV: Sociodemographic questions

34. Gender: ☐ Female ☐ Male

35. Marital Status**:**

- ☐ Married/ Facto Union
- ☐ Divorced
- ☐ Single
- ☐ Widower

36. Age: ____________

37. Situation in employment:

- ☐ Unemployed
- ☐ Domestic
- ☐ Student
- ☐ Retired
- ☐ Self employed
- ☐ Worker as an employed person

38. School qualifications:

- ☐ 1st, 2nd, 3rd or 4th year (former primary instruction)
- ☐ 5th or 6th year (former preparatory cycle)
- ☐ 7th, 8th or 9th year (former 3rd, 4th and 5th lyceum year)
- ☐ 10th, 11th or 12th (former 6th and 7th lyceum year/introductory year)
- ☐ Bachelor or Degree
- ☐ Master
- ☐ Doctoral Degree (PhD)
- ☐ Other

39. Monthly net household income (in euros):

- ☐ Less than 250€
- ☐ Between 251 and 500€
- ☐ Between 501 and 750€
- ☐ Between 751 and 1000€
- ☐ Between 1001 and 1250€
- ☐ Between 1251 and 1500€
- ☐ Between 1501 and 1750€
- ☐ Between 1751 and 2000€
- ☐ Between 2001 and 2250€
- ☐ Between 2251 and 2500€
- ☐ Between 2501 and 2750€
- ☐ Between 2751 and 3000€
- ☐ Between 3001 and 3250€
- ☐ Between 3251 and 3500€
- ☐ Between 3501 and 3750€
- ☐ Between 3751 and 4000€
- ☐ Between 4001 and 4250€
- ☐ Between 4251 and 4500€
- ☐ Between 4501 and 4750€
- ☐ Between 4751 and 5000€
- ☐ More than 5000€

40. Number of persons of the household:

Children (<12)________ Young (12-18 years) ________Adults (>18) __________

41. From your residence, place of work or daily commuting do you see any facility of electricity generation through a renewable energy source?

☐ Yes ☐ No

41.1. If **yes**: which is the renewable energy source?

Wind power ☐
Hidro (dam) ☐
Biomass (forest remains) ☐
Photovoltaic (sun) ☐

41.2. If **yes**: in which place?

☐ Residence ☐ Work ☐ Daily commuting

42. What is your municipality of residence? ________________________

43. Rate your behaviour towards risk, using a scale from 1 (absolutely nothing risky) to 9 (more than extremely risky). (Indicate with an X).

	Absolutely nothing risky (1)	**Nothing risky (2)**	**Little risky (3)**	**Somethin g risky (4)**	**Moderately risky (5)**	**Risky (6)**	**Very risky (7)**	**Extremel y risky (8)**	**More than extremely risky (9)**
In GENERAL, would you say that your behaviour and the decisions you make are:									
In your PROFESSIONAL ACTIVITY, would you say that your behaviour and the decisions you make are:									
With regard to your FINANCES, would you say that your behaviour and the decisions you make are:									
With regard to your HEALTH, would you say that your behaviour and the decisions you make are:									

44. Use the space below to leave your comment.

THANK YOU VERY MUCH FOR YOUR COOPERATION!

I.1.5. DCE Questionnaire on the Renewables: Wind, Photovoltaic and Hydropower

W, P, H

Dear respondent,

We need your collaboration in a research project conducted by researchers of the University of Minho. Its main objective is the valuation of environmental impacts associated with each of the various renewable energy sources. The following questionnaire is anonymous and confidential. Please respond with the greatest sincerity possible.

It is very important that you fill out the questionnaire until the end.

Section I: Introductory Section

In this section we intend to have an idea of your familiarity with renewable energy.

1. What are the most important environmental problems in Portugal currently? (Indicate only 3)

- ☐ Climate change
- ☐ Atmospheric pollution
- ☐ Water pollution (rivers and ocean)
- ☐ Over-exploitation of natural resources
- ☐ Biodiversity decline (variety of animal and plant species)
- ☐ Waste
- ☐ Other

2. Say in which way you agree with the following statements (mark with an x).

	Agree totally	**Agree partially**	**Do not agree nor disagree**	**Disagree partially**	**Disagree totally**	**Do not know**
The government should act to reduce pollution by specific laws.						
It is important electricity have a low price.						
We should reduce environmental pollution and other environmental impacts caused by the electricity generation.						
The government should help reduce the costs of electricity production financing new forms of production.						
The government should help reduce the costs of electricity production financing new energy sources more environmentally friendly and renewable.						
People in general can do much to improve the environment, for instance by lowering electricity consumption.						
I, personally, do not have financial availability to contribute more to a better environment than what I already contribute.						
I, personally, do not have availability to dedicate more of my time to keep a better environment than I already dedicate.						
I do not know in what way I may collaborate more than I already collaborate to maintain a better environment.						

3. Do you usually buy environmentally friendly products (or someone in your household does)?

☐ Yes ☐ No

4. Have you ever heard of the environmental problems that are associated with the use of energy from fossil fuels (such as oil)?

☐ Yes ☐ No

4.1. If yes which ones? (if you consider all please tick only the three most important in your opinion)

☐ Accumulation of carbon dioxide
☐ Climate change
☐ Water pollution
☐ Loss of species diversity (animals and vegetal)
☐ Other

5. What are the renewable energy sources that you know?

☐ Wind Power
☐ Photovoltaic Power (solar)
☐ Biomass (forest remains)
☐ Geothermal Energy (heat of the earth)
☐ Hydropower (dams)
☐ Wave Energy
☐ Other ____________

6. What is your opinion on how environmentally friendly are these energy sources? (Indicate with an X).

	Very friend	**Somewhat friend**	**Indifferent**	**Somewhat not friend**	**Not friend**	**Do not know**
Nuclear						
Hydropower (dams)						
Coal						
Natural gas						
Wind power						
Photovoltaic (solar)						
Geothermal (heat of the earth)						
Biomass (forest waste)						
Fuel oil (gas oil)						
Wave energy						

7. Have you ever visited one of the following technologies of production of renewable energy?

- ➔ Dam ☐ Yes ☐ No
- ➔ Wind farm ☐ Yes ☐ No
- ➔ Photovoltaic farm ☐ Yes ☐ No
- ➔ Biomass power plant ☐ Yes ☐ No

8. Do you work/worked in any technology of production of renewable energy?

☐ Yes ☐ No

8.1. If **yes,** specify in which one(s):

☐ Wind farm
☐ Photovoltaic farm (solar)
☐ Dam
☐ Biomass power plant

9. Do you know someone that works/worked in any technology of production of renewable energy??

☐ Yes ☐ No

9.1. If **yes,** specify in which one(s):

☐ Wind farm
☐ Photovoltaic farm (solar)
☐ Dam
☐ Biomass power plant

10. How important is for you to know the type of renewable energy that is being consumed in the production of electricity (wind, solar, hydro, biomass)? On a scale from 0 to 5**, wherein 0 means "without opinion", 1 means "not important", 3 means "important" and 5 means "very important".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. What is your monthly amount (average/approximately) of your electricity bill?

Value_______________ do not know ______

12. Do you usually observe in detail your electricity bill?

☐ No, I limit myself to pay ☐ Just the value ☐ Yes, I observe every details

Section II: Choices

The production of electricity through renewable energy sources, such as wind power, hydropower (dams) and photovoltaic power (solar), may cause some environmental effects which in turn may cause you some discomfort. The impacts may depend on its location, causing changes in the landscape and in fauna/flora, the production of noise that may be annoying and affect the population in the surrounding area and the destruction of heritage (including houses, chapels and traces of ancient buildings or works). These impacts can be reduced by changing some characteristics of production or location, but this is has an additional charge.

Next we present 9 situations of choice between two alternative forms of electricity generation (Form A and Form B). The alternatives vary in the type of the used energy source, in its environmental impacts and in the price increase regarding your current monthly electricity bill. In each decision you should choose your preferred alternative, as you would do in a real situation. It is important that you choose based only on the presented alternatives. In the choice moment consider your average monthly income and the expenses of your household.

EXAMPLE: Consider the choice between the form A and the form B of electricity generation. Tick your preferred option:

	Form A	Forma B
Significant impact on the landscape	No	No
Significant impact on the Fauna/Flora	No	Yes
Destroys heritage	Yes	No
Produces noise affecting population	No	No
Energy source	Hidro	Photovoltaic
Increase in the monthly bill €	8	12
Your choice	▢	▢

In this case the respondent chose to have in his home electricity produced in a photovoltaic farm that do not produces a significant effect on the landscape, do not destroys heritage nor produces noise, but has a significant impact on the fauna and flora and costs more 12 euros per month. Instead of electricity produced in a dam, which is cheaper and do not affect the fauna and flora, but destroys heritage. With the answer of this respondent we can conclude that he prefers to pay more 12 euros per month to avoid the destruction of heritage, accepting facility with significant effects on fauna and flora.

Taking into account your <u>average monthly income</u> and the <u>expenses of your household, make now your choices indicating an x in your option.</u>

Choice 1 – Consider the choice between the form A and form B of electricity generation. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	No	Yes
Destroys heritage	No	No
Produces noise affecting population	No	No
Energy source	Wind	Photovoltaic
Increase in the monthly bill €	4	8
Your choice	▢	▢

13. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

▢ Yes ▢ No

14. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0▢ 1▢ 2▢ 3▢ 4▢ 5▢ 6▢ 7▢ 8▢ 9▢ 10▢

Choice 2 – Consider the choice between the form A and the form B of electricity generation. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	No	Yes
Destroys heritage	No	Yes
Produces noise affecting population	No	Yes
Energy source	Photovoltaic	Hidro
Increase in the monthly bill €	4	8
Your choice	▢	▢

15. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

▢ Yes ▢ No

16. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0▢ 1▢ 2▢ 3▢ 4▢ 5▢ 6▢ 7▢ 8▢ 9▢ 10▢

Choice 3 - Consider the choice between the form A and the form B of electricity generation. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	No	Yes
Significant impact on the Fauna/Flora	No	Yes
Destroys heritage	No	No
Produces noise affecting population	Yes	No
Energy source	Wind	Hidro
Increase in the monthly bill €	8	12
Your choice	☐	☐

17. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

18. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 4 - Consider the choice between the form A and the form B of electricity generation. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	No	Yes
Significant impact on the Fauna/Flora	No	Yes
Destroys heritage	No	Yes
Produces noise affecting population	No	Yes
Energy source	Hidro	Hidro
Increase in the monthly bill €	8	4
Your choice	☐	☐

19. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

20. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 5 - Consider the choice between the form A and the form B of electricity generation. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	Yes	No
Destroys heritage	No	No
Produces noise affecting population	No	Yes
Energy source	Wind	Hidro
Increase in the monthly bill €	8	4
Your choice	☐	☐

21. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

22. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 6 - Consider the choice between the form A and the form B of electricity generation. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	Yes	No
Destroys heritage	No	Yes
Produces noise affecting population	Yes	No
Energy source	Hidro	Hidro
Increase in the monthly bill €	8	12
Your choice	☐	☐

23. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

24. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 7 - Consider the choice between the form A and the form B of electricity generation. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	No	Yes
Destroys heritage	No	No
Produces noise affecting population	Yes	No
Energy source	Hidro	Photovoltaic
Increase in the monthly bill €	12	4
Your choice	☐	☐

25. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

26. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 8 - Consider the choice between the form A and the form B of electricity generation. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	No	Yes
Destroys heritage	Yes	No
Produces noise affecting population	No	Yes
Energy source	Hidro	Wind
Increase in the monthly bill €	8	12
Your choice	☐	☐

27. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

28. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Choice 9 - Consider the choice between the form A and the form B of electricity generation. Tick your preferred option:

	Form A	Form B
Significant impact on the landscape	Yes	No
Significant impact on the Fauna/Flora	No	Yes
Destroys heritage	No	No
Produces noise affecting population	No	No
Energy source	Photovoltaic	Hidro
Increase in the monthly bill €	12	4
Your choice	☐	☐

29. Would you be willing to buy electricity produced in the form that you chose with the specified price increase?

☐ Yes ☐ No

30. On a scale from 0 to 10, where 0 corresponds to "Very little certainty" and 10 "Absolute Certainty," say with which certainty degree you would pay the amount indicated in your choice.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

31. In the choices you made previously have you considered all the attributes?

☐ Yes ☐ No

31.1 If **not,** to which attributes you gave more importance? (Tick all that apply)

☐ *Preservation of fauna and flora.*
☐ *Preservation of the landscape*
☐ *Preservation of heritage (buildings and settlements)*
☐ *Noise*
☐ *Type of energy source*
☐ *Price (increase in the monthly bill amount)*

32. Which of the following options best explain the reasons for your answers to the previous questions?

☐ *In my opinion the consumers should not have to pay more to have electricity friend of the environment.*
☐ *I chose the alternative that gave me more value for the price.*
☐ *It is important to know the destination of the additional payments that are made to the renewable energy sources.*
☐ *I would rather spend my money to buy electricity from other renewable sources.*
☐ *I do not have the financial capacity to pay more for electricity than what I already pay.*

33. How would you classify each of the impacts of electricity generation from dams, where 1 corresponds to "very negative" and 5 "very positive"? (Indicate with an X).

Impacts	**Effects of the Dams**					
	Very negative			**Very positive**		**Do not know**
	1	**2**	**3**	**4**	**5**	
Change of the landscape						
Changes in the fauna						
Changes in the flora						
Noise						
Destruction of heritage						
Production cost						

34. How would you classify each of the impacts of electricity generation from photovoltaic power (photovoltaic farms), where 1 corresponds to "very negative" and 5 "very positive"? (Indicate with an X).

Impacts	Effects of the Photovoltaic Farms					
	Very negative			Very positive		Do not know
	1	2	3	4	5	
Change of the landscape						
Changes in the fauna						
Changes in the flora						
Glare						
Production cost						

35. How would you classify each of the impacts of electricity generation from wind power (wind farms), where 1 corresponds to "very negative" and 5 "very positive"? (Indicate with an X).

Impacts	Effects of the Wind Farms					
	Very negative			Very positive		Do not know
	1	2	3	4	5	
Change of the landscape						
Changes in the fauna						
Changes in the flora						
Noise						
Production cost						

Section III: Opinion on renewable energy on general

36. Do you consider that Portugal has natural conditions to make a good use of the renewable energy?

☐ Yes ☐ No

37. Do you believe that renewable energy bring benefits to the population?

☐ Yes ☐ No

37.1. If **yes**, in your opinion, which of the following benefits you consider to be more important?

☐ It is inexhaustible on a human scale
☐ It does not produce harmful emissions or toxic solids
☐ It reduces the contribution to global climate change
☐ It is beneficial to employment and job creation
☐ It reduces external energy dependence of our economy

Section IV: Sociodemographic questions

38. Gender: ☐ Female ☐ Male

39. Marital Status**:**

☐ Married/ Facto Union
☐ Divorced
☐ Single
☐ Widower

40. Age: ____________

41. Situation in employment:

- ☐ Unemployed
- ☐ Domestic
- ☐ Student
- ☐ Retired
- ☐ Self employed
- ☐ Worker as an employed person

42. School qualifications:

- ☐ 1st, 2nd, 3rd or 4th year (former primary instruction)
- ☐ 5th or 6th year (former preparatory cycle)
- ☐ 7th, 8th or 9th year (former 3rd, 4th and 5th lyceum year)
- ☐ 10th, 11th or 12th (former 6th and 7th lyceum year/introductory year)
- ☐ Bachelor or Degree
- ☐ Master
- ☐ Doctoral Degree (PhD)
- ☐ Other

43. Monthly net household income (in euros):

- ☐ Less than 250€
- ☐ Between 251 and 500€
- ☐ Between 501 and 750€
- ☐ Between 751 and 1000€
- ☐ Between 1001 and 1250€
- ☐ Between 1251 and 1500€
- ☐ Between 1501 and 1750€
- ☐ Between 1751 and 2000€
- ☐ Between 2001 and 2250€
- ☐ Between 2251 and 2500€
- ☐ Between 2501 and 2750€
- ☐ Between 2751 and 3000€
- ☐ Between 3001 and 3250€
- ☐ Between 3251 and 3500€
- ☐ Between 3501 and 3750€
- ☐ Between 3751 and 4000€
- ☐ Between 4001 and 4250€
- ☐ Between 4251 and 4500€
- ☐ Between 4501 and 4750€
- ☐ Between 4751 and 5000€
- ☐ More than 5000€

44. Number of persons of the household:

Children (<12)________ Young (12-18 years) ________ Adults (>18) ________

45. From your residence, place of work or daily commuting do you see any facility of electricity generation through a renewable energy source?

☐ Yes ☐ No

45.1. If **yes**: which is the renewable energy source?

- Wind power ☐
- Hidro (dam) ☐
- Biomass (forest remains) ☐
- Photovoltaic (sun) ☐

45.2. If **yes**: in which place?

☐ Residence ☐ Work ☐ Daily commuting

46. What is your municipality of residence? _________________________

47. Rate your behaviour towards risk, using a scale from 1 (absolutely nothing risky) to 9 (more than extremely risky). (Indicate with an X).

	Absolutely nothing risky (1)	**Nothing risky (2)**	**Little risky (3)**	**Somethin g risky (4)**	**Moderately risky (5)**	**Risky (6)**	**Very risky (7)**	**Extremel y risky (8)**	**More than extremely risky (9)**
In GENERAL, would you say that your behaviour and the decisions you make are:									
In your PROFESSIONAL ACTIVITY, would you say that your behaviour and the decisions you make are:									
With regard to your FINANCES, would you say that your behaviour and the decisions you make are:									
With regard to your HEALTH, would you say that your behaviour and the decisions you make are:									

48. Use the space below to leave your comment.

THANK YOU VERY MUCH FOR YOUR COOPERATION!

I.2. Portuguese Original DCE Questionnaires
I.2.1. DCE Questionnaire on Forest Biomass Power

B

Caro(a) respondente,

Precisamos da sua colaboração num projeto de investigação conduzido por investigadores da Universidade do Minho. O seu principal objetivo é a valoração dos impactos ambientais associados a cada uma das diversas fontes de energia renováveis. O questionário que se segue é anónimo e confidencial. Agradecemos que responda com a maior sinceridade possível.

É muito importante que preencha o questionário até ao fim.

Secção I: Secção Introdutória

Nesta secção pretende-se ter uma ideia da sua familiaridade com as energias renováveis.

1. Quais são os problemas ambientais mais importantes em Portugal actualmente? (Indique apenas 3)

- ☐ Alterações Climáticas
- ☐ Poluição atmosférica
- ☐ Poluição das águas (rios e oceano)
- ☐ Sobre-exploração dos recursos naturais
- ☐ Diminuição da biodiversidade (variedade de espécies animais e vegetais)
- ☐ Lixo
- ☐ Outros

2. Diga de que forma concorda com as seguintes afirmações (assinale com um x).

	Concorda totalmente	**Concorda parcialmente**	**Não concorda nem discorda**	**Discorda parcialmente**	**Discorda totalmente**	**Não sabe**
O governo deve atuar para diminuir a poluição através de leis específicas.						
É importante a electricidade ter um preço baixo.						
Devemos reduzir a poluição ambiental e outros impactos ambientais causados pela produção de electricidade.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas formas de produção.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas fontes de energia mais amigas do ambiente e renováveis.						
As pessoas em geral podem fazer muito para melhorar o meio ambiente, por exemplo diminuindo o consumo de electricidade.						
Eu, pessoalmente, não tenho disponibilidade financeira para contribuir mais para um melhor ambiente do que aquilo que já contribuo.						
Eu, pessoalmente, não tenho disponibilidade para dedicar mais do meu tempo para manter um ambiente melhor do que já dedico.						
Eu não sei de que forma posso colaborar mais do que já colaboro para manter um ambiente melhor.						

3. Compra habitualmente produtos amigos do ambiente (ou alguém no seu agregado o faz)?

☐ Sim ☐ Não

4. Já ouviu falar dos problemas ambientais que se encontram associados à utilização das energias provenientes dos combustíveis fósseis (como seja por exemplo o petróleo)?

☐ Sim ☐ Não

4.1. Se sim quais? (se considerar todos, por favor assinale apenas os três mais importantes na sua opinião)

☐ Acumulação de dióxido de carbono
☐ Alterações climáticas
☐ Poluição da água
☐ Perda de diversidade de espécies (animais e vegetais)
☐ Outros

5. Quais são as fontes de energia renováveis que conhece?

☐ Energia Eólica (do vento)
☐ Energia Fotovoltaica (solar)
☐ Biomassa (restos florestais)
☐ Energia Geotérmica (calor da terra)
☐ Energia Hídrica (barragens)
☐ Energia das Ondas
☐ Outras ____________

6. Qual a sua opinião relativamente a quão amigas do ambiente são estas fontes de energia? (Assinale com um X).

	Muito amiga	**Algo amiga**	**Indiferente**	**Algo não amiga**	**Não amiga**	**Não sabe**
Nuclear						
Hídrica (barragens)						
Carvão						
Gás natural						
Eólica (vento)						
Fotovoltaica (solar)						
Geotérmica (calor da terra)						
Biomassa (restos florestais)						
Fuel óleo (gasóleo)						
Energia das Ondas						

7. Alguma vez visitou uma das seguintes tecnologias de produção de energia renovável?

➔ Barragem ☐ Sim ☐ Não
➔ Parque eólico ☐ Sim ☐ Não
➔ Parque fotovoltaico ☐ Sim ☐ Não
➔ Central termoelétrica a biomassa ☐ Sim ☐ Não

8. Trabalha/trabalhou em alguma tecnologia de produção de energia renovável?

☐ Sim ☐ Não

8.1. Se **sim** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

9. Conhece alguém que trabalha/trabalhou em alguma tecnologia de produção de energia renovável?

☐ Sim ☐ Não

9.1. Se **sim** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

10. Quão importante é para si conhecer o tipo de energia renovável que se está a consumir (do vento, solar, hídrica, biomassa)? Numa escala de 0 a 5 em que, **0 significa "sem opinião", 1 significa "não importante", 3 significa "importante" e 5 significa "muito importante".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. Qual o valor mensal (em média/aproximado) da sua conta de electricidade?

Valor_______________ não sei ______

12. Costuma observar pormenorizadamente a sua factura da electricidade?

☐ Não, limito-me a pagar ☐ Apenas o valor ☐ Sim, observo todos os detalhes

Secção II: Escolhas

A produção de electricidade através do aproveitamento de biomassa vegetal (restos florestais) realiza-se em centrais termoelétricas. O uso desta fonte de energia pode provocar alguns efeitos ambientais que podem por sua vez causar-lhe algum incómodo. Os impactos podem depender da sua localização reflectindo-se na paisagem, em alterações na fauna/flora ou em odor menos agradável. Estes impactos podem ser reduzidos alterando algumas características da produção ou da localização, mas tal acarreta um custo adicional.

Seguidamente apresentamos 6 situações de escolha de entre duas formas alternativas de produção de electricidade através do aproveitamento da biomassa (florestal). As alternativas variam nos seus impactos ambientais e no acréscimo de preço relativamente à sua conta mensal de electricidade actual. Em cada decisão deverá escolher a sua alternativa preferida, tal como o faria numa situação real. É importante que escolha com base unicamente nas alternativas apresentadas. No momento de escolha considere o seu rendimento mensal médio e as despesas do seu agregado familiar.

EXEMPLO: Considere a escolha entre a forma A de produção de electricidade através de biomassa e a forma B de produção de electricidade <u>também</u> através de biomassa. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Sim
Impacto significativo sobre a Fauna/Flora	Não	Sim
Produz cheiro que afecta população	Sim	Não
Acréscimo no valor da factura mensal €	12	8
A sua escolha	☐	☐

Neste caso o respondente escolheu ter em sua casa electricidade produzida através de biomassa da forma A que produz um efeito significativo na paisagem, produz cheiro, mas não tem impacto sobre a fauna e a flora e custa mais 12 euros por mês. Em vez de eletricidade produzida através da forma B, que sendo mais barata e não produz cheiro, afecta a fauna e a flora. Pela resposta deste respondente podemos concluir que ele prefere pagar mais 12 euros mensais para evitar impactos negativos sobre a fauna e a flora, aceitando instalações com efeitos significativos sobre a paisagem e produção de cheiro.

Tendo em conta o seu <u>rendimento mensal médio</u> e as <u>despesas do seu agregado familiar, faça agora as suas escolhas assinalando com um x a sua opção.</u>

Escolha 1 - Considere a escolha entre a forma A de produção de electricidade através de biomassa e a forma B de produção de electricidade <u>também</u> através de biomassa. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Sim	Não
Produz cheiro que afecta população	Sim	Não
Acréscimo no valor da factura mensal €	4	8
A sua escolha	☐	☐

13. Estaria disposto a comprar electricidade produzida da forma que escolheu com o acréscimo de preço especificado?

☐ Sim ☐ Não

14. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 2- Considere a escolha entre a forma A de produção de electricidade através de biomassa e a forma B de produção de electricidade <u>também</u> através de biomassa. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Não	Sim
Impacto significativo sobre a Fauna/Flora	Não	Sim
Produz cheiro que afecta população	Sim	Não
Acréscimo no valor da factura mensal €	12	4
A sua escolha	☐	☐

15. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

16. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 3- Considere a escolha entre a forma A de produção de electricidade através de biomassa e a forma B de produção de electricidade <u>também</u> através de biomassa. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a Paisagem	Não	Sim
Impacto significativo sobre a Fauna/Flora	Sim	Não
Produz cheiro que afecta população	Não	Sim
Acréscimo no valor da factura mensal €	12	12
A sua escolha	☐	☐

17. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

18. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 4- Considere a escolha entre a forma A de produção de electricidade através de biomassa e a forma B de produção de electricidade <u>também</u> através de biomassa. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Não	Sim
Impacto significativo sobre a Fauna/Flora	Não	Sim
Produz cheiro que afecta população	Sim	Não
Acréscimo no valor da factura mensal €	4	12
A sua escolha	☐	☐

19. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

20. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 5- Considere a escolha entre a forma A de produção de electricidade através de biomassa e a forma B de produção de electricidade <u>também</u> através de biomassa. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Sim	Não
Produz cheiro que afecta população	Não	Sim
Acréscimo no valor da factura mensal €	8	4
A sua escolha	☐	☐

21. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

22. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 6- Considere a escolha entre a forma A de produção de electricidade através de biomassa e a forma B de produção de electricidade também através de biomassa. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Não	Sim
Produz cheiro que afecta população	Não	Sim
Acréscimo no valor da factura mensal €	8	8
A sua escolha	☐	☐

23. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

24. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

25. Nas escolhas que fez anteriormente considerou todos os atributos?

☐ Sim ☐ Não

25.1 Se **não,** quais os atributos a que deu mais importância? (Assinale todos os que se aplicam)

☐ *Preservação de fauna e flora.*
☐ *Preservação da paisagem*
☐ *Odor (cheiros)*
☐ *Preço (acréscimo no valor da factura mensal)*

26. Quais das seguintes opções melhor explicam as razões das suas respostas às questões anteriores?

☐ *Na minha opinião os consumidores não deveriam ter de pagar mais para ter electricidade amiga do ambiente.*
☐ *Escolhi a alternativa que me dava mais valor pelo preço.*
☐ *É importante saber a que se destinam os pagamentos adicionais que se fazem às fontes de energia renovável.*
☐ *Preferia gastar o meu dinheiro para comprar electricidade produzida por outras fontes renováveis.*
☐ *Não tenho capacidade financeira para pagar mais por electricidade do que o que já pago.*

27. Como classificaria cada um dos impactos da produção de electricidade a partir de centrais termoelétricas (biomassa), sendo que 1 corresponde a "muito negativo" e 5 a "muito positivo"? (Assinale com um X).

Impactos	**Efeitos da Centrais Termoelétricas (biomassa)**					
	Muito negativo			**Muito positivo**		**Não sei**
	1	**2**	**3**	**4**	**5**	
Alteração da paisagem						
Alterações na fauna						
Alterações na flora						
Odor						
Custo de produção						

Secção III: Opinião sobre energias renováveis em geral

28. Considera que Portugal tem condições naturais para fazer um bom aproveitamento das energias renováveis?

☐ Sim ☐ Não

29. Acredita que as energias renováveis trazem benefícios para a população?

☐ Sim ☐ Não

29.1. Se **sim**, na sua opinião, quais dos seguintes benefícios considera serem mais importantes?

☐ É inesgotável à escala humana
☐ Não produz emissões perigosas ou de sólidos tóxicos
☐ Reduz a contribuição para as alterações climáticas globais
☐ Favorável ao emprego e criação de postos de trabalho
☐ Reduz a dependência energética externa da nossa economia

Secção IV: Questões sociodemográficas

30. Sexo: ☐ Feminino ☐ Masculino

31. Estado Civil**:**

☐ Casado(a)/União de facto
☐ Divorciado(a)
☐ Solteiro(a)
☐ Viúvo(a)

32. Idade: ____________

33. Situação perante o emprego:

☐ Desempregado(a)
☐ Doméstico(a)
☐ Estudante
☐ Reformado(a)
☐ Trabalhador(a) por conta própria
☐ Trabalhador(a) por conta de outrém

34. Habilitações escolares:

☐ 1.º, 2.º, 3.º ou 4.º ano (antiga instrução primária)
☐ 5.º ou 6.º ano (antigo ciclo preparatório)
☐ 7.º, 8.º ou 9.º ano (antigo 3.º, 4.º e 5.º ano liceal)
☐ 10.º, 11.º ou 12.º (antigo 6.º e 7.º ano liceal / ano propedêutico)
☐ Bacharelato ou Licenciatura
☐ Mestrado
☐ Doutoramento
☐ Outro

35. Rendimento mensal líquido do agregado familiar (em euros):

- ☐ Inferior a 250€
- ☐ Entre 251 e 500€
- ☐ Entre 501 e 750€
- ☐ Entre 751 e 1000€
- ☐ Entre 1001 e 1250€
- ☐ Entre 1251 e 1500€
- ☐ Entre 1501 e 1750€
- ☐ Entre 1751 e 2000€
- ☐ Entre 2001 e 2250€
- ☐ Entre 2251 e 2500€
- ☐ Entre 2501 e 2750€
- ☐ Entre 2751 e 3000€
- ☐ Entre 3001 e 3250€
- ☐ Entre 3251 e 3500€
- ☐ Entre 3501 e 3750€
- ☐ Entre 3751 e 4000€
- ☐ Entre 4001 e 4250€
- ☐ Entre 4251 e 4500€
- ☐ Entre 4501 e 4750€
- ☐ Entre 4751 e 5000€
- ☐ Mais de 5000€

36. Número de pessoas do agregado familiar?

Crianças (<12)________ Jovens (12-18 anos) ________ Adultos (>18) __________

37. Da sua residência, local de trabalho ou deslocações diárias avista alguma instalação de produção de electricidade através de uma fonte de energia renovável?

☐ Sim ☐ Não

37.1. Se **sim**: qual a fonte de energia renovável?

- Eólica (vento) ☐
- Hídrica (barragem) ☐
- Biomassa (restos florestais) ☐
- Fotovoltaica (sol) ☐

37.2. Se **sim**: em que local?

☐ Residência ☐ Trabalho ☐ Deslocações

38. Qual o seu concelho de residência? _________________________

39. Classifique o seu comportamento face ao risco, usando uma escala de 1 (absolutamente nada arriscados) a 9 (mais do que extremamente arriscados). (Assinale com um X).

	Absolutamente nada arriscados (1)	Nada arriscados (2)	Pouco arriscados (3)	Algo arriscados (4)	Moderadamente arriscados (5)	Arriscados (6)	Muito arriscados (7)	Extremamente arriscados (8)	Mais do que extremamente arriscados (9)
<u>Em GERAL</u>, diria que o seu comportamento e as decisões que toma são:									
<u>Na sua ATIVIDADE PROFISSIONAL</u>, diria que o seu comportamento e as decisões que toma são:									
<u>Relativamente às suas FINANÇAS</u>, diria que o seu comportamento e as decisões que toma são:									
<u>Relativamente à sua SAÚDE</u>, diria que o seu comportamento e as decisões que toma são:									

40. Use o espaço abaixo para deixar o seu comentário.

MUITO OBRIGADA PELA SUA COLABORAÇÃO!

I.2.2. DCE Questionnaire on Wind Power

E

Caro(a) respondente,

Precisamos da sua colaboração num projeto de investigação conduzido por investigadores da Universidade do Minho. O seu principal objetivo é a valoração dos impactos ambientais associados a cada uma das diversas fontes de energia renováveis. O questionário que se segue é anónimo e confidencial. Agradecemos que responda com a maior sinceridade possível.

É muito importante que preencha o questionário até ao fim.

Secção I: Secção Introdutória

Nesta secção pretende-se ter uma ideia da sua familiaridade com as energias renováveis.

1. Quais são os problemas ambientais mais importantes em Portugal actualmente? (Indique apenas 3)

- ☐ Alterações Climáticas
- ☐ Poluição atmosférica
- ☐ Poluição das águas (rios e oceano)
- ☐ Sobre-exploração dos recursos naturais
- ☐ Diminuição da biodiversidade (variedade de espécies animais e vegetais)
- ☐ Lixo
- ☐ Outros

2. Diga de que forma concorda com as seguintes afirmações (assinale com um x).

	Concorda totalmente	**Concorda parcialmente**	**Não concorda nem discorda**	**Discorda parcialmente**	**Discorda totalmente**	**Não sabe**
O governo deve atuar para diminuir a poluição através de leis específicas.						
É importante a electricidade ter um preço baixo.						
Devemos reduzir a poluição ambiental e outros impactos ambientais causados pela produção de electricidade.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas formas de produção.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas fontes de energia mais amigas do ambiente e renováveis.						
As pessoas em geral podem fazer muito para melhorar o meio ambiente, por exemplo diminuindo o consumo de electricidade.						
Eu, pessoalmente, não tenho disponibilidade financeira para contribuir mais para um melhor ambiente do que aquilo que já contribuo.						
Eu, pessoalmente, não tenho disponibilidade para dedicar mais do meu tempo para manter um ambiente melhor do que já dedico.						
Eu não sei de que forma posso colaborar mais do que já colaboro para manter um ambiente melhor.						

3. Compra habitualmente produtos amigos do ambiente (ou alguém no seu agregado o faz)?

☐ Sim ☐ Não

4. Já ouviu falar dos problemas ambientais que se encontram associados à utilização das energias provenientes dos combustíveis fósseis (como seja por exemplo o petróleo)?

☐ Sim ☐ Não

4.1. Se sim quais? (se considerar todos, por favor assinale apenas os três mais importantes na sua opinião)

☐ Acumulação de dióxido de carbono
☐ Alterações climáticas
☐ Poluição da água
☐ Perda de diversidade de espécies (animais e vegetais)
☐ Outros

5. Quais são as fontes de energia renováveis que conhece?

☐ Energia Eólica (do vento)
☐ Energia Fotovoltaica (solar)
☐ Biomassa (restos florestais)
☐ Energia Geotérmica (calor da terra)
☐ Energia Hídrica (barragens)
☐ Energia das Ondas
☐ Outras ____________

6. Qual a sua opinião relativamente a quão amigas do ambiente são estas fontes de energia? (Assinale com um X).

	Muito amiga	**Algo amiga**	**Indiferente**	**Algo não amiga**	**Não amiga**	**Não sabe**
Nuclear						
Hídrica (barragens)						
Carvão						
Gás natural						
Eólica (vento)						
Fotovoltaica (solar)						
Geotérmica (calor da terra)						
Biomassa (restos florestais)						
Fuel óleo (gasóleo)						
Energia das Ondas						

7. Alguma vez visitou uma das seguintes tecnologias de produção de energia renovável?

- ➔ Barragem ☐ Sim ☐ Não
- ➔ Parque eólico ☐ Sim ☐ Não
- ➔ Parque fotovoltaico ☐ Sim ☐ Não
- ➔ Central termoelétrica a biomassa ☐ Sim ☐ Não

8. Trabalha/trabalhou em alguma tecnologia de produção de energia renovável?

☐ Sim ☐ Não

8.1. Se **sim** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

9. Conhece alguém que trabalha/trabalhou em alguma tecnologia de produção de energia renovável?

☐ Sim ☐ Não

9.1. Se **sim** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

10. Quão importante é para si conhecer o tipo de energia renovável que se está a consumir (do vento, solar, hídrica, biomassa)? Numa escala de 0 a 5 em que, **0 significa "sem opinião", 1 significa "não importante", 3 significa "importante" e 5 significa "muito importante".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. Qual o valor mensal (em média/aproximado) da sua conta de electricidade?

Valor_______________ não sei ______

12. Costuma observar pormenorizadamente a sua factura da electricidade?

☐ Não, limito-me a pagar ☐ Apenas o valor ☐ Sim, observo todos os detalhes

Secção II: Escolhas

A produção de electricidade através do aproveitamento da energia eólica (do vento) realiza-se em parques eólicos. O uso desta fonte de energia pode provocar alguns efeitos ambientais que podem por sua vez causar-lhe algum incómodo. Os impactos podem depender da sua localização reflectindo-se na paisagem, em alterações na fauna/flora ou na produção de um ruído que pode ser incomodativo. Estes impactos podem ser reduzidos alterando algumas características da produção ou da localização, mas tal acarreta um custo adicional.

Seguidamente apresentamos 6 situações de escolha de entre duas formas alternativas de produção de electricidade através da energia eólica (vento). As alternativas variam nos seus impactos ambientais e no acréscimo de preço relativamente à sua conta mensal de electricidade actual. Em cada decisão deverá escolher a sua alternativa preferida, tal como o faria numa situação real. É importante que escolha com base unicamente nas alternativas apresentadas. No momento de escolha considere o seu rendimento mensal médio e as despesas do seu agregado familiar.

EXEMPLO: Considere a escolha entre a forma A de produção de electricidade através de energia eólica e a forma B de produção de electricidade <u>também</u> através de energia eólica. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Sim
Impacto significativo sobre a Fauna/Flora	Não	Sim
Produz ruído que afecta população	Sim	Não
Acréscimo no valor da factura mensal €	12	8
A sua escolha	☐	☐

Neste caso o respondente escolheu ter em sua casa electricidade produzida por energia eólica da forma A que produz um efeito significativo na paisagem, produz ruído, mas não tem impacto sobre a fauna e a flora e custa mais 12 euros por mês. Em vez de eletricidade produzida através da forma B, que sendo mais barata e não produz ruído, afecta a fauna e a flora. Pela resposta deste respondente podemos concluir que ele prefere pagar mais 12 euros mensais para evitar impactos negativos sobre a fauna e a flora, aceitando instalações com efeitos significativos sobre a paisagem e produção de ruído.

Tendo em conta o seu <u>rendimento mensal médio</u> e as <u>despesas do seu agregado familiar, faça agora as suas escolhas assinalando com um x a sua opção.</u>

Escolha 1 - Considere a escolha entre a forma A de produção de electricidade através de energia eólica e a forma B de produção de electricidade <u>também</u> através de energia eólica. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Sim	Não
Produz ruído que afecta população	Sim	Não
Acréscimo no valor da factura mensal €	4	8
A sua escolha	☐	☐

13. Estaria disposto a comprar electricidade produzida da forma que escolheu com o acréscimo de preço especificado?

☐ Sim ☐ Não

14. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 2- Considere a escolha entre a forma A de produção de electricidade através de energia eólica e a forma B de produção de electricidade <u>também</u> através de energia eólica. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Não	Sim
Impacto significativo sobre a Fauna/Flora	Não	Sim
Produz ruído que afecta população	Sim	Não
Acréscimo no valor da factura mensal €	12	4
A sua escolha	☐	☐

15. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

16. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 3- Considere a escolha entre a forma A de produção de electricidade através de energia eólica e a forma B de produção de electricidade <u>também</u> através de energia eólica. Assinale a sua opção preferida:

	Forma A	**Forma B**
Impacto significativo sobre a Paisagem	Não	Sim
Impacto significativo sobre a Fauna/Flora	Sim	Não
Produz ruído que afecta população	Não	Sim
Acréscimo no valor da factura mensal €	12	12
A sua escolha	☐	☐

17. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

18. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 4- Considere a escolha entre a forma A de produção de electricidade através de energia eólica e a forma B de produção de electricidade <u>também</u> através de energia eólica. Assinale a sua opção preferida:

	Forma A	**Forma B**
Impacto significativo sobre a paisagem	Não	Sim
Impacto significativo sobre a Fauna/Flora	Não	Sim
Produz ruído que afecta população	Sim	Não
Acréscimo no valor da factura mensal €	4	12
A sua escolha	☐	☐

19. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

20. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 5- Considere a escolha entre a forma A de produção de electricidade através de energia eólica e a forma B de produção de electricidade <u>também</u> através de energia eólica. Assinale a sua opção preferida:

	Forma A	**Forma B**
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Sim	Não
Produz ruído que afecta população	Não	Sim
Acréscimo no valor da factura mensal €	8	4
A sua escolha	☐	☐

21. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

22. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 6- Considere a escolha entre a forma A de produção de electricidade através de energia eólica e a forma B de produção de electricidade também através de energia eólica. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Não	Sim
Produz ruído que afecta população	Não	Sim
Acréscimo no valor da factura mensal €	8	8
A sua escolha	☐	☐

23. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

24. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

25. Nas escolhas que fez anteriormente considerou todos os atributos?

☐ Sim ☐ Não

25.1 Se **não,** quais os atributos a que deu mais importância? (Assinale todos os que se aplicam)

☐ *Preservação de fauna e flora.*
☐ *Preservação da paisagem*
☐ *Ruído*
☐ *Preço (acréscimo no valor da factura mensal)*

26. Quais das seguintes opções melhor explicam as razões das suas respostas às questões anteriores?

☐ *Na minha opinião os consumidores não deveriam ter de pagar mais para ter electricidade amiga do ambiente.*
☐ *Escolhi a alternativa que me dava mais valor pelo preço.*
☐ *É importante saber a que se destinam os pagamentos adicionais que se fazem às fontes de energia renovável.*
☐ *Preferia gastar o meu dinheiro para comprar electricidade produzida por outras fontes renováveis.*
☐ *Não tenho capacidade financeira para pagar mais por electricidade do que o que já pago.*

27. Como classificaria cada um dos impactos da produção de electricidade a partir de energia eólica (vento), sendo que 1 corresponde a "muito negativo" e 5 a "muito positivo"? (Assinale com um X).

Impactos	**Efeitos dos Parques Eólicos**					
	Muito negativo			**Muito positivo**		**Não sei**
	1	**2**	**3**	**4**	**5**	
Alteração da paisagem						
Alterações na fauna						
Alterações na flora						
Ruído						
Custo de produção						

Secção III: Opinião sobre energias renováveis em geral

28. Considera que Portugal tem condições naturais para fazer um bom aproveitamento das energias renováveis?

☐ Sim ☐ Não

29. Acredita que as energias renováveis trazem benefícios para a população?

☐ Sim ☐ Não

29.1. Se **sim**, na sua opinião, quais dos seguintes benefícios considera serem mais importantes?

☐ É inesgotável à escala humana
☐ Não produz emissões perigosas ou de sólidos tóxicos
☐ Reduz a contribuição para as alterações climáticas globais
☐ Favorável ao emprego e criação de postos de trabalho
☐ Reduz a dependência energética externa da nossa economia

Secção IV: Questões sociodemográficas

30. Sexo: ☐ Feminino ☐ Masculino

31. Estado Civil**:**

☐ Casado(a)/União de facto
☐ Divorciado(a)
☐ Solteiro(a)
☐ Viúvo(a)

32. Idade: ____________

33. Situação perante o emprego:

☐ Desempregado(a)
☐ Doméstico(a)
☐ Estudante
☐ Reformado(a)
☐ Trabalhador(a) por conta própria
☐ Trabalhador(a) por conta de outrém

34. Habilitações escolares:

☐ 1.º, 2.º, 3.º ou 4.º ano (antiga instrução primária)
☐ 5.º ou 6.º ano (antigo ciclo preparatório)
☐ 7.º, 8.º ou 9.º ano (antigo 3.º, 4.º e 5.º ano liceal)
☐ 10.º, 11.º ou 12.º (antigo 6.º e 7.º ano liceal / ano propedêutico)
☐ Bacharelato ou Licenciatura
☐ Mestrado
☐ Doutoramento
☐ Outro

35. Rendimento mensal líquido do agregado familiar (em euros):

- ▢ Inferior a 250€
- ▢ Entre 251 e 500€
- ▢ Entre 501 e 750€
- ▢ Entre 751 e 1000€
- ▢ Entre 1001 e 1250€
- ▢ Entre 1251 e 1500€
- ▢ Entre 1501 e 1750€
- ▢ Entre 1751 e 2000€
- ▢ Entre 2001 e 2250€
- ▢ Entre 2251 e 2500€
- ▢ Entre 2501 e 2750€
- ▢ Entre 2751 e 3000€
- ▢ Entre 3001 e 3250€
- ▢ Entre 3251 e 3500€
- ▢ Entre 3501 e 3750€
- ▢ Entre 3751 e 4000€
- ▢ Entre 4001 e 4250€
- ▢ Entre 4251 e 4500€
- ▢ Entre 4501 e 4750€
- ▢ Entre 4751 e 5000€
- ▢ Mais de 5000€

36. Número de pessoas do agregado familiar?

Crianças (<12) ________ Jovens (12-18 anos) ________ Adultos (>18) ________

37. Da sua residência, local de trabalho ou deslocações diárias avista alguma instalação de produção de electricidade através de uma fonte de energia renovável?

▢ Sim ▢ Não

37.1. Se **sim**: qual a fonte de energia renovável?

- Eólica (vento) ▢
- Hídrica (barragem) ▢
- Biomassa (restos florestais) ▢
- Fotovoltaica (sol) ▢

37.2. Se **sim**: em que local?

▢ Residência ▢ Trabalho ▢ Deslocações

38. Qual o seu concelho de residência? ________________________

39. Classifique o seu comportamento face ao risco, usando uma escala de 1 (absolutamente nada arriscados) a 9 (mais do que extremamente arriscados). (Assinale com um X).

	Absolutamente nada arriscados (1)	Nada arriscados (2)	Pouco arriscados (3)	Algo arriscados (4)	Moderadamente arriscados (5)	Arriscados (6)	Muito arriscados (7)	Extremamente arriscados (8)	Mais do que extremamente arriscados (9)
Em GERAL, diria que o seu comportamento e as decisões que toma são:									
Na sua ATIVIDADE PROFISSIONAL, diria que o seu comportamento e as decisões que toma são:									
Relativamente às suas FINANÇAS, diria que o seu comportamento e as decisões que toma são:									
Relativamente à sua SAÚDE, diria que o seu comportamento e as decisões que toma são:									

40. Use o espaço abaixo para deixar o seu comentário.

MUITO OBRIGADA PELA SUA COLABORAÇÃO!

I.2.3. DCE Questionnaire on Photovoltaic Power

F

Caro(a) respondente,

Precisamos da sua colaboração num projeto de investigação conduzido por investigadores da Universidade do Minho. O seu principal objetivo é a valoração dos impactos ambientais associados a cada uma das diversas fontes de energia renováveis. O questionário que se segue é anónimo e confidencial. Agradecemos que responda com a maior sinceridade possível.

É muito importante que preencha o questionário até ao fim.

Secção I: Secção Introdutória

Nesta secção pretende-se ter uma ideia da sua familiaridade com as energias renováveis.

1. Quais são os problemas ambientais mais importantes em Portugal actualmente? (Indique apenas 3)

- ☐ Alterações Climáticas
- ☐ Poluição atmosférica
- ☐ Poluição das águas (rios e oceano)
- ☐ Sobre-exploração dos recursos naturais
- ☐ Diminuição da biodiversidade (variedade de espécies animais e vegetais)
- ☐ Lixo
- ☐ Outros

2. Diga de que forma concorda com as seguintes afirmações (assinale com um x).

	Concorda totalmente	**Concorda parcialmente**	**Não concorda nem discorda**	**Discorda parcialmente**	**Discorda totalmente**	**Não sabe**
O governo deve atuar para diminuir a poluição através de leis específicas.						
É importante a electricidade ter um preço baixo.						
Devemos reduzir a poluição ambiental e outros impactos ambientais causados pela produção de electricidade.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas formas de produção.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas fontes de energia mais amigas do ambiente e renováveis.						
As pessoas em geral podem fazer muito para melhorar o meio ambiente, por exemplo diminuindo o consumo de electricidade.						
Eu, pessoalmente, não tenho disponibilidade financeira para contribuir mais para um melhor ambiente do que aquilo que já contribuo.						
Eu, pessoalmente, não tenho disponibilidade para dedicar mais do meu tempo para manter um ambiente melhor do que já dedico.						
Eu não sei de que forma posso colaborar mais do que já colaboro para manter um ambiente melhor.						

3. Compra habitualmente produtos amigos do ambiente (ou alguém no seu agregado o faz)?

☐ Sim ☐ Não

4. Já ouviu falar dos problemas ambientais que se encontram associados à utilização das energias provenientes dos combustíveis fósseis (como seja por exemplo o petróleo)?

☐ Sim ☐ Não

4.1. Se sim quais? (se considerar todos, por favor assinale apenas os três mais importantes na sua opinião)

☐ Acumulação de dióxido de carbono
☐ Alterações climáticas
☐ Poluição da água
☐ Perda de diversidade de espécies (animais e vegetais)
☐ Outros

5. Quais são as fontes de energia renováveis que conhece?

☐ Energia Eólica (do vento)
☐ Energia Fotovoltaica (solar)
☐ Biomassa (restos florestais)
☐ Energia Geotérmica (calor da terra)
☐ Energia Hídrica (barragens)
☐ Energia das Ondas
☐ Outras ____________

6. Qual a sua opinião relativamente a quão amigas do ambiente são estas fontes de energia? (Assinale com um X).

	Muito amiga	**Algo amiga**	**Indiferente**	**Algo não amiga**	**Não amiga**	**Não sabe**
Nuclear						
Hídrica (barragens)						
Carvão						
Gás natural						
Eólica (vento)						
Fotovoltaica (solar)						
Geotérmica (calor da terra)						
Biomassa (restos florestais)						
Fuel óleo (gasóleo)						
Energia das Ondas						

7. Alguma vez visitou uma das seguintes tecnologias de produção de energia renovável?

- ➔ Barragem ☐ Sim ☐ Não
- ➔ Parque eólico ☐ Sim ☐ Não
- ➔ Parque fotovoltaico ☐ Sim ☐ Não
- ➔ Central termoelétrica a biomassa ☐ Sim ☐ Não

8. Trabalha/trabalhou em alguma tecnologia de produção de energia renovável?

☐ Sim ☐ Não

8.1. Se **sim** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

9. Conhece alguém que trabalha/trabalhou em alguma tecnologia de produção de energia renovável?

☐ Sim ☐ Não

9.1. Se **sim** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

10. Quão importante é para si conhecer o tipo de energia renovável que se está a consumir (do vento, solar, hídrica, biomassa)? Numa escala de 0 a 5 em que, **0 significa sem opinião, 1 significa "não importante", 3 significa "importante" e 5 significa "muito importante".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. Qual o valor mensal (em média/aproximado) da sua conta de electricidade?

Valor_______________ não sei ______

12. Costuma observar pormenorizadamente a sua factura da electricidade?

☐ Não, limito-me a pagar ☐ Apenas o valor ☐ Sim, observo todos os detalhes

Secção II: Escolhas

A produção de electricidade através do aproveitamento da energia fotovoltaica (solar) realiza-se em parques fotovoltaicos. O uso desta fonte de energia pode provocar alguns efeitos ambientais que podem por sua vez causar-lhe algum incómodo. Os impactos podem depender da sua localização reflectindo-se na paisagem, em alterações na fauna/flora ou em reflexo da luz que pode ser incomodativo. Estes impactos podem ser reduzidos alterando algumas características da produção ou da localização, mas tal acarreta um custo adicional.

Seguidamente apresentamos 6 situações de escolha de entre duas formas alternativas de produção de electricidade através da energia fotovoltaica (solar). As alternativas variam nos seus impactos ambientais e no acréscimo de preço relativamente à sua conta mensal de electricidade actual. Em cada decisão deverá escolher a sua alternativa preferida, tal como o faria numa situação real. É importante que escolha com base unicamente nas alternativas apresentadas. No momento de escolha considere o seu rendimento mensal médio e as despesas do seu agregado familiar.

EXEMPLO: Considere a escolha entre a forma A de produção de electricidade através de energia fotovoltaica e a forma B de produção de electricidade <u>também</u> através de energia fotovoltaica. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Sim
Impacto significativo sobre a Fauna/Flora	Não	Sim
Reflete luz que afecta população	Sim	Não
Acréscimo no valor da factura mensal €	12	8
A sua escolha	☐	☐

Neste caso o respondente escolheu ter em sua casa electricidade produzida por energia fotovoltaica da forma A que produz um efeito significativo na paisagem, produz reflexos de luz, mas não tem impacto sobre a fauna e a flora e custa mais 12 euros por mês. Em vez de eletricidade produzida através da forma B, que sendo mais barata e não produz reflexos de luz, afecta a fauna e a flora. Pela resposta deste respondente podemos concluir que ele prefere pagar mais 12 euros mensais para evitar impactos negativos sobre a fauna e a flora, aceitando instalações com efeitos significativos sobre a paisagem e produção de reflexos de luz.

Tendo em conta o seu <u>rendimento mensal médio</u> e as <u>despesas do seu agregado familiar, faça agora as suas escolhas assinalando com um x a sua opção.</u>

Escolha 1 - Considere a escolha entre a forma A de produção de electricidade através de energia fotovoltaica e a forma B de produção de electricidade <u>também</u> através de energia fotovoltaica. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Sim	Não
Reflete luz que que afecta população	Sim	Não
Acréscimo no valor da factura mensal €	4	8
A sua escolha	☐	☐

13. Estaria disposto a comprar electricidade produzida da forma que escolheu com o acréscimo de preço especificado?

☐ Sim ☐ Não

14. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 2- Considere a escolha entre a forma A de produção de electricidade através de energia fotovoltaica e a forma B de produção de electricidade <u>também</u> através de energia fotovoltaica. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Não	Sim
Impacto significativo sobre a Fauna/Flora	Não	Sim
Reflete luz que afecta população	Sim	Não
Acréscimo no valor da factura mensal €	12	4
A sua escolha	☐	☐

15. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

16. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 3- Considere a escolha entre a forma A de produção de electricidade através de energia fotovoltaica e a forma B de produção de electricidade <u>também</u> através de energia fotovoltaica. Assinale a sua opção preferida:

	Forma A	**Forma B**
Impacto significativo sobre a Paisagem	Não	Sim
Impacto significativo sobre a Fauna/Flora	Sim	Não
Reflete luz que afecta população	Não	Sim
Acréscimo no valor da factura mensal €	12	12
A sua escolha	▢	▢

17. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?
▢ Sim ▢ Não

18. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0 ▢ 1 ▢ 2 ▢ 3 ▢ 4 ▢ 5 ▢ 6 ▢ 7 ▢ 8 ▢ 9 ▢ 10 ▢

Escolha 4- Considere a escolha entre a forma A de produção de electricidade através de energia fotovoltaica e a forma B de produção de electricidade <u>também</u> através de energia fotovoltaica. Assinale a sua opção preferida:

	Forma A	**Forma B**
Impacto significativo sobre a paisagem	Não	Sim
Impacto significativo sobre a Fauna/Flora	Não	Sim
Reflete luz que afecta população	Sim	Não
Acréscimo no valor da factura mensal €	4	12
A sua escolha	▢	▢

19. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?
▢ Sim ▢ Não

20. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0 ▢ 1 ▢ 2 ▢ 3 ▢ 4 ▢ 5 ▢ 6 ▢ 7 ▢ 8 ▢ 9 ▢ 10 ▢

Escolha 5- Considere a escolha entre a forma A de produção de electricidade através de energia fotovoltaica e a forma B de produção de electricidade <u>também</u> através de energia fotovoltaica. Assinale a sua opção preferida:

	Forma A	**Forma B**
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Sim	Não
Reflete luz que afecta população	Não	Sim
Acréscimo no valor da factura mensal €	8	4
A sua escolha	▢	▢

21. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?
▢ Sim ▢ Não

22. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0 ▢ 1 ▢ 2 ▢ 3 ▢ 4 ▢ 5 ▢ 6 ▢ 7 ▢ 8 ▢ 9 ▢ 10 ▢

Escolha 6- Considere a escolha entre a forma A de produção de electricidade através de energia fotovoltaica e a forma B de produção de electricidade <u>também</u> através de energia fotovoltaica. Assinale a sua opção preferida:

	Forma A	**Forma B**
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Não	Sim
Reflete luz que afecta população	Não	Sim
Acréscimo no valor da factura mensal €	8	8
A sua escolha	☐	☐

23. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

24. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

25. Nas escolhas que fez anteriormente considerou todos os atributos?

☐ Sim ☐ Não

25.1 Se **não,** quais os atributos a que deu mais importância? (Assinale todos os que se aplicam)

☐ *Preservação de fauna e flora.*
☐ *Preservação da paisagem*
☐ *Reflexo de luz*
☐ *Preço (acréscimo no valor da factura mensal)*

26. Quais das seguintes opções melhor explicam as razões das suas respostas às questões anteriores?

☐ *Na minha opinião os consumidores não deveriam ter de pagar mais para ter electricidade amiga do ambiente.*
☐ *Escolhi a alternativa que me dava mais valor pelo preço.*
☐ *É importante saber a que se destinam os pagamentos adicionais que se fazem às fontes de energia renovável.*
☐ *Preferia gastar o meu dinheiro para comprar electricidade produzida por outras fontes renováveis.*
☐ *Não tenho capacidade financeira para pagar mais por electricidade do que o que já pago.*

27. Como classificaria cada um dos impactos da produção de electricidade a partir de energia fotovoltaica (solar), sendo que 1 corresponde a "muito negativo" e 5 a "muito positivo"? (Assinale com um X).

Impactos	**Efeitos dos Parques Fotovoltaicos**					
	Muito negativo			**Muito positivo**		**Não sei**
	1	**2**	**3**	**4**	**5**	
Alteração da paisagem						
Alterações na fauna						
Alterações na flora						
Reflexo da luz						
Custo de produção						

Secção III: Opinião sobre energias renováveis em geral

28. Considera que Portugal tem condições naturais para fazer um bom aproveitamento das energias renováveis?

☐ Sim ☐ Não

29. Acredita que as energias renováveis trazem benefícios para a população?

☐ Sim ☐ Não

29.1. Se **sim**, na sua opinião, quais dos seguintes benefícios considera serem mais importantes?

☐ É inesgotável à escala humana
☐ Não produz emissões perigosas ou de sólidos tóxicos
☐ Reduz a contribuição para as alterações climáticas globais
☐ Favorável ao emprego e criação de postos de trabalho
☐ Reduz a dependência energética externa da nossa economia

Secção IV: Questões sociodemográficas

30. Sexo: ☐ Feminino ☐ Masculino

31. Estado Civil**:**

☐ Casado(a)/União de facto
☐ Divorciado(a)
☐ Solteiro(a)
☐ Viúvo(a)

32. Idade: ____________

33. Situação perante o emprego:

☐ Desempregado(a)
☐ Doméstico(a)
☐ Estudante
☐ Reformado(a)
☐ Trabalhador(a) por conta própria
☐ Trabalhador(a) por conta de outrém

34. Habilitações escolares:

☐ 1.º, 2.º, 3.º ou 4.º ano (antiga instrução primária)
☐ 5.º ou 6.º ano (antigo ciclo preparatório)
☐ 7.º, 8.º ou 9.º ano (antigo 3.º, 4.º e 5.º ano liceal)
☐ 10.º, 11.º ou 12.º (antigo 6.º e 7.º ano liceal / ano propedêutico)
☐ Bacharelato ou Licenciatura
☐ Mestrado
☐ Doutoramento
☐ Outro

35. Rendimento mensal líquido do agregado familiar (em euros):

- ☐ Inferior a 250€
- ☐ Entre 251 e 500€
- ☐ Entre 501 e 750€
- ☐ Entre 751 e 1000€
- ☐ Entre 1001 e 1250€
- ☐ Entre 1251 e 1500€
- ☐ Entre 1501 e 1750€
- ☐ Entre 1751 e 2000€
- ☐ Entre 2001 e 2250€
- ☐ Entre 2251 e 2500€
- ☐ Entre 2501 e 2750€
- ☐ Entre 2751 e 3000€
- ☐ Entre 3001 e 3250€
- ☐ Entre 3251 e 3500€
- ☐ Entre 3501 e 3750€
- ☐ Entre 3751 e 4000€
- ☐ Entre 4001 e 4250€
- ☐ Entre 4251 e 4500€
- ☐ Entre 4501 e 4750€
- ☐ Entre 4751 e 5000€
- ☐ Mais de 5000€

36. Número de pessoas do agregado familiar?

Crianças (<12) ________ Jovens (12-18 anos)________ Adultos (>18) _________

37. Da sua residência, local de trabalho ou deslocações diárias avista alguma instalação de produção de electricidade através de uma fonte de energia renovável?

☐ Sim ☐ Não

37.1. Se **sim**: qual a fonte de energia renovável?

- Eólica (vento) ☐
- Hídrica (barragem) ☐
- Biomassa (restos florestais) ☐
- Fotovoltaica (sol) ☐

37.2. Se **sim**: em que local?

☐ Residência ☐ Trabalho ☐ Deslocações

38. Qual o seu concelho de residência? _________________________

39. Classifique o seu comportamento face ao risco, usando uma escala de 1 (absolutamente nada arriscados) a 9 (mais do que extremamente arriscados). (Assinale com um X).

	Absolutamente nada arriscados (1)	Nada arriscados (2)	Pouco arriscados (3)	Algo arriscados (4)	Moderadamente arriscados (5)	Arriscados (6)	Muito arriscados (7)	Extremamente arriscados (8)	Mais do que extremamente arriscados (9)
Em GERAL, diria que o seu comportamento e as decisões que toma são:									
Na sua ATIVIDADE PROFISSIONAL, diria que o seu comportamento e as decisões que toma são:									
Relativamente às suas FINANÇAS, diria que o seu comportamento e as decisões que toma são:									
Relativamente à sua SAÚDE, diria que o seu comportamento e as decisões que toma são:									

40. Use o espaço abaixo para deixar o seu comentário.

MUITO OBRIGADA PELA SUA COLABORAÇÃO!

I.2.4. DCE Questionnaire on Hydropower

H

Caro(a) respondente,

Precisamos da sua colaboração num projeto de investigação conduzido por investigadores da Universidade do Minho. O seu principal objetivo é a valoração dos impactos ambientais associados a cada uma das diversas fontes de energia renováveis. O questionário que se segue é anónimo e confidencial. Agradecemos que responda com a maior sinceridade possível.

É muito importante que preencha o questionário até ao fim.

Secção I: Secção Introdutória

Nesta secção pretende-se ter uma ideia da sua familiaridade com as energias renováveis.

1. Quais são os problemas ambientais mais importantes em Portugal actualmente? (Indique apenas 3)

- ☐ Alterações Climáticas
- ☐ Poluição atmosférica
- ☐ Poluição das águas (rios e oceano)
- ☐ Sobre-exploração dos recursos naturais
- ☐ Diminuição da biodiversidade (variedade de espécies animais e vegetais)
- ☐ Lixo
- ☐ Outros

2. Diga de que forma concorda com as seguintes afirmações (assinale com um x).

	Concorda totalmente	**Concorda parcialmente**	**Não concorda nem discorda**	**Discorda parcialmente**	**Discorda totalmente**	**Não sabe**
O governo deve atuar para diminuir a poluição através de leis específicas.						
É importante a electricidade ter um preço baixo.						
Devemos reduzir a poluição ambiental e outros impactos ambientais causados pela produção de electricidade.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas formas de produção.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas fontes de energia mais amigas do ambiente e renováveis.						
As pessoas em geral podem fazer muito para melhorar o meio ambiente, por exemplo diminuindo o consumo de electricidade.						
Eu, pessoalmente, não tenho disponibilidade financeira para contribuir mais para um melhor ambiente do que aquilo que já contribuo.						
Eu, pessoalmente, não tenho disponibilidade para dedicar mais do meu tempo para manter um ambiente melhor do que já dedico.						
Eu não sei de que forma posso colaborar mais do que já colaboro para manter um ambiente melhor.						

3. Compra habitualmente produtos amigos do ambiente (ou alguém no seu agregado o faz)?

☐ Sim ☐ Não

4. Já ouviu falar dos problemas ambientais que se encontram associados à utilização das energias provenientes dos combustíveis fósseis (como seja por exemplo o petróleo)?

☐ Sim ☐ Não

4.1. Se sim quais? (se considerar todos, por favor assinale apenas os três mais importantes na sua opinião)

☐ Acumulação de dióxido de carbono
☐ Alterações climáticas
☐ Poluição da água
☐ Perda de diversidade de espécies (animais e vegetais)
☐ Outros

5. Quais são as fontes de energia renováveis que conhece?

☐ Energia Eólica (do vento)
☐ Energia Fotovoltaica (solar)
☐ Biomassa (restos florestais)
☐ Energia Geotérmica (calor da terra)
☐ Energia Hídrica (barragens)
☐ Energia das Ondas
☐ Outras ____________

6. Qual a sua opinião relativamente a quão amigas do ambiente são estas fontes de energia? (Assinale com um X).

	Muito amiga	**Algo amiga**	**Indiferente**	**Algo não amiga**	**Não amiga**	**Não sabe**
Nuclear						
Hídrica (barragens)						
Carvão						
Gás natural						
Eólica (vento)						
Fotovoltaica (solar)						
Geotérmica (calor da terra)						
Biomassa (restos florestais)						
Fuel óleo (gasóleo)						
Energia das Ondas						

7. Alguma vez visitou uma das seguintes tecnologias de produção de energia renovável?

- ➔ Barragem ☐ Sim ☐ Não
- ➔ Parque eólico ☐ Sim ☐ Não
- ➔ Parque fotovoltaico ☐ Sim ☐ Não
- ➔ Central termoelétrica a biomassa ☐ Sim ☐ Não

8. Trabalha/trabalhou em alguma tecnologia de produção de energia renovável?

☐ Sim ☐ Não

8.1. Se **sim** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

9. Conhece alguém que trabalha/trabalhou em alguma tecnologia de produção de energia renovável?

☐ Sim ☐ Não

9.1. Se **sim** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

10. Quão importante é para si conhecer o tipo de energia renovável que se está a consumir (do vento, solar, hídrica, biomassa)? Numa escala de 0 a 5 em que, **0 significa "sem opinião", 1 significa "não importante", 3 significa "importante" e 5 significa "muito importante".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. Qual o valor mensal (em média/aproximado) da sua conta de electricidade?

Valor_______________ não sei ______

12. Costuma observar pormenorizadamente a sua factura da electricidade?

☐ Não, limito-me a pagar ☐ Apenas o valor ☐ Sim, observo todos os detalhes

Secção II: Escolhas

A produção de electricidade através do aproveitamento da energia hídrica realiza-se em barragens. O uso desta fonte de energia pode provocar alguns efeitos ambientais que podem por sua vez causar-lhe algum incómodo. Os impactos podem depender da sua localização reflectindo-se na paisagem, em alterações na fauna/flora, em destruição de património (nomeadamente habitações, capelas e vestígios de construções ou obras antigas) ou na produção de um ruído que pode ser incomodativo. Estes impactos podem ser reduzidos alterando algumas características da produção ou da localização, mas tal acarreta um custo adicional.

Seguidamente apresentamos 8 situações de escolha de entre duas formas alternativas de produção de electricidade através da energia hídrica (barragens). As alternativas variam nos seus impactos ambientais e no acréscimo de preço relativamente à sua conta mensal de electricidade actual. Em cada decisão deverá escolher a sua alternativa preferida, tal como o faria numa situação real. É importante que escolha com base unicamente nas alternativas apresentadas. No momento de escolha considere o seu rendimento mensal médio e as despesas do seu agregado familiar.

EXEMPLO: Considere a escolha entre a forma A de produção de electricidade através de energia hídrica e a forma B de produção de electricidade também através de energia hídrica. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Sim
Impacto significativo sobre a Fauna/Flora	Não	Sim
Produz ruído que afecta população	Não	Sim
Destrói património	Sim	Não
Acréscimo no valor da factura mensal €	12	8
A sua escolha	☐	☐

Neste caso o respondente escolheu ter em sua casa electricidade produzida por energia hídrica da forma A que produz um efeito significativo na paisagem e destrói património, mas não tem impacto sobre a fauna e a flora, nem produz ruído e custa mais 12 euros por mês. Em vez de eletricidade produzida através da forma B, que sendo mais barata e não destrói património, produz ruído e afecta a fauna e a flora. Pela resposta deste respondente podemos concluir que ele prefere pagar mais 12 euros mensais para evitar impactos negativos sobre a fauna e a flora e produção de ruído, aceitando instalações com efeitos significativos sobre a paisagem e destruição de património.

Tendo em conta o seu rendimento mensal médio e as despesas do seu agregado familiar, faça agora as suas escolhas assinalando com um x a sua opção.

Escolha 1 - Considere a escolha entre a forma A de produção de electricidade através de energia hídrica e a forma B de produção de electricidade também através de energia hídrica. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Não	Sim
Impacto significativo sobre a Fauna/Flora	Sim	Não
Produz ruído que afecta população	Sim	Não
Destrói património	Sim	Não
Acréscimo no valor da factura mensal €	4	8
A sua escolha	☐	☐

13. Estaria disposto a comprar electricidade produzida da forma que escolheu com o acréscimo de preço especificado?

☐ Sim ☐ Não

14. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 2- Considere a escolha entre a forma A de produção de electricidade através de energia hídrica e a forma B de produção de electricidade também através de energia hídrica. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Não	Sim
Impacto significativo sobre a Fauna/Flora	Não	Sim
Produz ruído que afecta população	Não	Não
Destrói património	Não	Sim
Acréscimo no valor da factura mensal €	4	12
A sua escolha	☐	☐

15. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

16. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 3- Considere a escolha entre a forma A de produção de electricidade através de energia hídrica e a forma B de produção de electricidade <u>também</u> através de energia hídrica. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a Paisagem	Não	Sim
Impacto significativo sobre a Fauna/Flora	Não	Sim
Produz ruído que afecta população	Sim	Não
Destrói património	Sim	Não
Acréscimo no valor da factura mensal €	12	8
A sua escolha	☐	☐

17. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

18. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 4- Considere a escolha entre a forma A de produção de electricidade através de energia hídrica e a forma B de produção de electricidade <u>também</u> através de energia hídrica. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Sim	Não
Produz ruído que afecta população	Não	Sim
Destrói património	Sim	Não
Acréscimo no valor da factura mensal €	8	12
A sua escolha	☐	☐

19. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

20. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 5- Considere a escolha entre a forma A de produção de electricidade através de energia hídrica e a forma B de produção de electricidade <u>também</u> através de energia hídrica. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Sim	Não
Produz ruído que afecta população	Sim	Não
Destrói património	Não	Sim
Acréscimo no valor da factura mensal €	8	4
A sua escolha	☐	☐

21. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

22. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 6- Considere a escolha entre a forma A de produção de electricidade através de energia hídrica e a forma B de produção de electricidade <u>também</u> através de energia hídrica. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Não	Sim
Impacto significativo sobre a Fauna/Flora	Sim	Não
Produz ruído que afecta população	Não	Sim
Destrói património	Não	Sim
Acréscimo no valor da factura mensal €	8	4
A sua escolha	☐	☐

23. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

24. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 7- Considere a escolha entre a forma A de produção de electricidade através de energia hídrica e a forma B de produção de electricidade <u>também</u> através de energia hídrica. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Não	Sim
Produz ruído que afecta população	Não	Sim
Destrói património	Sim	Não
Acréscimo no valor da factura mensal €	12	4
A sua escolha	☐	☐

25. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

26. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 8- Considere a escolha entre a forma A de produção de electricidade através de energia hídrica e a forma B de produção de electricidade <u>também</u> através de energia hídrica. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Não	Sim
Produz ruído que afecta população	Sim	Sim
Destrói património	Não	Sim
Acréscimo no valor da factura mensal €	4	8
A sua escolha	☐	☐

27. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

28. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

29. Nas escolhas que fez anteriormente considerou todos os atributos?

☐ Sim ☐ Não

29.1 Se **não,** quais os atributos a que deu mais importância? (Assinale todos os que se aplicam)

☐ *Preservação de fauna e flora.*
☐ *Preservação da paisagem*
☐ *Preservação do património (edifícios e povoações)*
☐ *Ruído*
☐ *Preço (acréscimo no valor da factura mensal)*

30. Quais das seguintes opções melhor explicam as razões das suas respostas às questões anteriores?

☐ *Na minha opinião os consumidores não deveriam ter de pagar mais para ter electricidade amiga do ambiente.*
☐ *Escolhi a alternativa que me dava mais valor pelo preço.*
☐ *É importante saber a que se destinam os pagamentos adicionais que se fazem às fontes de energia renovável.*
☐ *Preferia gastar o meu dinheiro para comprar electricidade produzida por outras fontes renováveis.*
☐ *Não tenho capacidade financeira para pagar mais por electricidade do que o que já pago.*

31. Como classificaria cada um dos impactos da produção de electricidade a partir de barragens, sendo que 1 corresponde a "muito negativo" e 5 a "muito positivo"? (Assinale com um X).

Impactos	**Efeitos das Barragens**					
	Muito negativo			**Muito positivo**		**Não sei**
	1	**2**	**3**	**4**	**5**	
Alteração da paisagem						
Alterações na fauna						
Alterações na flora						
Destruição do património						
Ruído						
Custo de produção						

Secção III: Opinião sobre energias renováveis em geral

32. Considera que Portugal tem condições naturais para fazer um bom aproveitamento das energias renováveis?

☐ Sim ☐ Não

33. Acredita que as energias renováveis trazem benefícios para a população?

☐ Sim ☐ Não

33.1. Se **sim**, na sua opinião, quais dos seguintes benefícios considera serem mais importantes?

☐ É inesgotável à escala humana
☐ Não produz emissões perigosas ou de sólidos tóxicos
☐ Reduz a contribuição para as alterações climáticas globais
☐ Favorável ao emprego e criação de postos de trabalho
☐ Reduz a dependência energética externa da nossa economia

Secção IV: Questões sociodemográficas

34. Sexo: ☐ Feminino ☐ Masculino

35. Estado Civil**:**

- ☐ Casado(a)/União de facto
- ☐ Divorciado(a)
- ☐ Solteiro(a)
- ☐ Viúvo(a)

36. Idade: ____________

37. Situação perante o emprego:

- ☐ Desempregado(a)
- ☐ Doméstico(a)
- ☐ Estudante
- ☐ Reformado(a)
- ☐ Trabalhador(a) por conta própria
- ☐ Trabalhador(a) por conta de outrém

38. Habilitações escolares:

- ☐ 1.º, 2.º, 3.º ou 4.º ano (antiga instrução primária)
- ☐ 5.º ou 6.º ano (antigo ciclo preparatório)
- ☐ 7.º, 8.º ou 9.º ano (antigo 3.º, 4.º e 5.º ano liceal)
- ☐ 10.º, 11.º ou 12.º (antigo 6.º e 7.º ano liceal / ano propedêutico)
- ☐ Bacharelato ou Licenciatura
- ☐ Mestrado
- ☐ Doutoramento
- ☐ Outro

39. Rendimento mensal líquido do agregado familiar (em euros):

- ☐ Inferior a 250€
- ☐ Entre 251 e 500€
- ☐ Entre 501 e 750€
- ☐ Entre 751 e 1000€
- ☐ Entre 1001 e 1250€
- ☐ Entre 1251 e 1500€
- ☐ Entre 1501 e 1750€
- ☐ Entre 1751 e 2000€
- ☐ Entre 2001 e 2250€
- ☐ Entre 2251 e 2500€
- ☐ Entre 2501 e 2750€
- ☐ Entre 2751 e 3000€
- ☐ Entre 3001 e 3250€
- ☐ Entre 3251 e 3500€
- ☐ Entre 3501 e 3750€
- ☐ Entre 3751 e 4000€
- ☐ Entre 4001 e 4250€
- ☐ Entre 4251 e 4500€
- ☐ Entre 4501 e 4750€
- ☐ Entre 4751 e 5000€
- ☐ Mais de 5000€

40. Número de pessoas do agregado familiar?

Crianças (<12)__________ Jovens (12-18 anos)__________ Adultos (>18) __________

41. Da sua residência, local de trabalho ou deslocações diárias avista alguma instalação de produção de electricidade através de uma fonte de energia renovável?

☐ Sim ☐ Não

41.1. Se **sim**: qual a fonte de energia renovável?

- Eólica (vento) ☐
- Hídrica (barragem) ☐
- Biomassa (restos florestais) ☐
- Fotovoltaica (sol) ☐

41.2. Se **sim**: em que local?

☐ Residência ☐ Trabalho ☐ Deslocações

42. Qual o seu concelho de residência? ________________________

43. Classifique o seu comportamento face ao risco, usando uma escala de 1 (absolutamente nada arriscados) a 9 (mais do que extremamente arriscados). (Assinale com um X).

	Absolutamente nada arriscados (1)	Nada arriscados (2)	Pouco arriscados (3)	Algo arriscados (4)	Moderadamente arriscados (5)	Arriscados (6)	Muito arriscados (7)	Extremamente arriscados (8)	Mais do que extremamente arriscados (9)
Em GERAL, diria que o seu comportamento e as decisões que toma são:									
Na sua ATIVIDADE PROFISSIONAL, diria que o seu comportamento e as decisões que toma são:									
Relativamente às suas FINANÇAS, diria que o seu comportamento e as decisões que toma são:									
Relativamente à sua SAÚDE, diria que o seu comportamento e as decisões que toma são:									

44. Use o espaço abaixo para deixar o seu comentário.

MUITO OBRIGADA PELA SUA COLABORAÇÃO!

I.2.5. DCE Questionnaire on the Renewables: Wind, Photovoltaic and Hydropower

E, F, H

Questionário:

Caro(a) respondente,

Precisamos da sua colaboração num projeto de investigação conduzido por investigadores da Universidade do Minho. O seu principal objetivo é a valoração dos impactos ambientais associados a cada uma das diversas fontes de energia renováveis. O questionário que se segue é anónimo e confidencial. Agradecemos que responda com a maior sinceridade possível.

É muito importante que preencha o questionário até ao fim.

Secção I: Secção Introdutória

Nesta secção pretende-se ter uma ideia da sua familiaridade com as energias renováveis.

1. Quais são os problemas ambientais mais importantes em Portugal actualmente? (Indique apenas 3).

- ☐ Alterações Climáticas
- ☐ Poluição atmosférica
- ☐ Poluição das águas (rios e oceano)
- ☐ Sobre-exploração dos recursos naturais
- ☐ Diminuição da biodiversidade (variedade de espécies animais e vegetais)
- ☐ Lixo
- ☐ Outros

2. Diga de que forma concorda com as seguintes afirmações (assinale com um x).

	Concorda totalmente	**Concorda parcialmente**	**Não concorda nem discorda**	**Discorda parcialmente**	**Discorda totalmente**	**Não sabe**
O governo deve atuar para diminuir a poluição através de leis específicas.						
É importante a electricidade ter um preço baixo.						
Devemos reduzir a poluição ambiental e outros impactos ambientais causados pela produção de electricidade.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas formas de produção.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas fontes de energia mais amigas do ambiente e renováveis.						
As pessoas em geral podem fazer muito para melhorar o meio ambiente, por exemplo diminuindo o consumo de electricidade.						
Eu, pessoalmente, não tenho disponibilidade financeira para contribuir mais para um melhor ambiente do que aquilo que já contribuo.						
Eu, pessoalmente, não tenho disponibilidade para dedicar mais do meu tempo para manter um ambiente melhor do que já dedico.						
Eu não sei de que forma posso colaborar mais do que já colaboro para manter um ambiente melhor.						

3. Compra habitualmente produtos amigos do ambiente (ou alguém no seu agregado o faz)?

☐ Sim ☐ Não

4. Já ouviu falar dos problemas ambientais que se encontram associados à utilização das energias provenientes dos combustíveis fósseis (como seja por exemplo o petróleo)?

☐ Sim ☐ Não

4.1. Se sim quais? (se considerar todos, por favor assinale apenas os três mais importantes na sua opinião)

☐ Acumulação de dióxido de carbono
☐ Alterações climáticas
☐ Poluição da água
☐ Perda de diversidade de espécies (animais e vegetais)
☐ Outros

5. Quais são as fontes de energia renováveis que conhece?

☐ Energia Eólica (do vento)
☐ Energia Fotovoltaica (solar)
☐ Biomassa (restos florestais)
☐ Energia Geotérmica (calor da terra)
☐ Energia Hídrica (barragens)
☐ Energia das Ondas
☐ Outras ____________

6. Qual a sua opinião relativamente a quão amigas do ambiente são estas fontes de energia? (Assinale com um X).

	Muito amiga	**Algo amiga**	**Indiferente**	**Algo não amiga**	**Não amiga**	**Não sabe**
Nuclear						
Hídrica (barragens)						
Carvão						
Gás natural						
Eólica (vento)						
Fotovoltaica (solar)						
Geotérmica (calor da terra)						
Biomassa (restos florestais)						
Fuel óleo (gasóleo)						
Energia das Ondas						

7. Alguma vez visitou uma das seguintes tecnologias de produção de energia renovável?

➔ Barragem ☐ Sim ☐ Não
➔ Parque eólico ☐ Sim ☐ Não
➔ Parque fotovoltaico ☐ Sim ☐ Não
➔ Central termoelétrica a biomassa ☐ Sim ☐ Não

8. Trabalha/trabalhou em alguma tecnologia de produção de energia renovável?

☐ Sim ☐ Não

8.1. Se **sim** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

9. Conhece alguém que trabalha/trabalhou em alguma tecnologia de produção de energia renovável?

☐ Sim ☐ Não

9.1. Se **sim** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

10. Quão importante é para si conhecer o tipo de energia renovável que se está a consumir (do vento, solar, hídrica, biomassa)? Numa escala de 0 a 5 em que, **0 significa "sem opinião", 1 significa "não importante", 3 significa "importante" e 5 significa "muito importante".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. Qual o valor mensal (em média/aproximado) da sua conta de electricidade?

Valor_______________ não sei ______

12. Costuma observar pormenorizadamente a sua fatura da electricidade?

☐ Não, limito-me a pagar ☐ Apenas o valor ☐ Sim, observo todos os detalhes

Secção II: Escolhas

A produção de electricidade a partir de fontes de energia renovável, tal como a energia eólica (vento), a energia hídrica (barragens) e a energia fotovoltaica (solar), pode provocar alguns efeitos ambientais que podem causar-lhe algum incómodo. Os impactos podem depender da sua localização, refletindo-se na paisagem, em alterações na fauna/flora, na produção de ruído que pode ser incomodativo e afetar a população da zona envolvente e na destruição de património (nomeadamente habitações, capelas e construções dos nossos antepassados). Todos os impactos referidos podem ser reduzidos alterando algumas características da produção ou da localização, mas tal acarreta um custo adicional.

Seguidamente, apresentamos 9 situações de escolha de entre duas formas alternativas de produção de electricidade (Forma A e Forma B). As alternativas variam no tipo de fonte de energia utilizada, nos seus impactos ambientais e no acréscimo de preço relativamente à sua conta de electricidade actual. Em cada decisão deverá escolher a sua alternativa preferida, tal como o faria numa situação real. É importante que escolha com base unicamente nas alternativas apresentadas. No momento de escolha considere o seu rendimento mensal médio e as despesas do seu agregado familiar.

EXEMPLO: Considere a escolha entre a forma A e a forma B de produção de electricidade. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Não	Não
Impacto significativo sobre a Fauna/Flora	Não	Sim
Destrói património	Sim	Não
Produz ruído que afecta a população	Não	Não
Fonte de energia	Hídrica	Fotovoltaica
Acréscimo no valor da factura mensal €	8	12
A sua escolha	☐	☐

Neste caso o respondente escolheu ter em sua casa electricidade produzida num parque fotovoltaico que não produz um efeito significativo sobre a paisagem, não destrói património, nem produz ruído, mas tem impacto significativo sobre a fauna e a flora e custa mais 12 Euros por mês. Em vez de electricidade produzida através de uma barragem que, sendo mais barata e não afecta a fauna e flora, destrói património. Pela resposta deste respondente podemos concluir que ele prefere pagar mais 12 euros mensais para evitar que património seja destruído, aceitando instalações que afectam a fauna e a flora.

Tendo em conta o seu <u>rendimento mensal médio</u> e as <u>despesas do seu agregado familiar, faça agora as suas escolhas assinalando com um X a sua opção.</u>

Escolha 1 - Considere a escolha entre a forma A e a forma B de produção de electricidade. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Não	Sim
Destrói património	Não	Não
Produz ruído que afecta a população	Não	Não
Fonte de energia	Eólica	Fotovoltaica
Acréscimo no valor da factura mensal €	4	8
A sua escolha	☐	☐

13. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

14. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 2 - Considere a escolha entre a forma A e a forma B de produção de electricidade. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Não	Sim
Destrói património	Não	Sim
Produz ruído que afecta a população	Não	Sim
Fonte de energia	Fotovoltaica	Hídrica
Acréscimo no valor da factura mensal €	4	8
A sua escolha	☐	☐

15. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

16. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 3 - Considere a escolha entre a forma A e a forma B de produção de electricidade. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Não	Sim
Impacto significativo sobre a Fauna/Flora	Não	Sim
Destrói património	Não	Não
Produz ruído que afecta a população	Sim	Não
Fonte de energia	Eólica	Hídrica
Acréscimo no valor da factura mensal €	8	12
A sua escolha	☐	☐

17. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

18. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ ☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 4 - Considere a escolha entre a forma A e a forma B de produção de electricidade. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Não	Sim
Impacto significativo sobre a Fauna/Flora	Não	Sim
Destrói património	Não	Sim
Produz ruído que afecta a população	Não	Sim
Fonte de energia	Hídrica	Hídrica
Acréscimo no valor da factura mensal €	8	4
A sua escolha	☐	☐

19. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

20. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ ☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 5 - Considere a escolha entre a forma A e a forma B de produção de electricidade. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Sim	Não
Destrói património	Não	Não
Produz ruído que afecta a população	Não	Sim
Fonte de energia	Eólica	Hídrica
Acréscimo no valor da factura mensal €	8	4
A sua escolha	☐	☐

21. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

22. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ ☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 6 - Considere a escolha entre a forma A e a forma B de produção de electricidade. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Sim	Não
Destrói património	Não	Sim
Produz ruído que afecta a população	Sim	Não
Fonte de energia	Hídrica	Hídrica
Acréscimo no valor da factura mensal €	8	12
A sua escolha	☐	☐

23. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

24. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ ☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 7 - Considere a escolha entre a forma A e a forma B de produção de electricidade. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Não	Sim
Destrói património	Não	Não
Produz ruído que afecta a população	Sim	Não
Fonte de energia	Hídrica	Fotovoltaica
Acréscimo no valor da factura mensal €	12	4
A sua escolha	☐	☐

25. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

26. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ ☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 8 - Considere a escolha entre a forma A e a forma B de produção de electricidade. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Não	Sim
Destrói património	Sim	Não
Produz ruído que afecta a população	Não	Sim
Fonte de energia	Hídrica	Eólica
Acréscimo no valor da factura mensal €	8	12
A sua escolha	☐	☐

27. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

28. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ ☐ 6☐ 7☐ 8☐ 9☐ 10☐

Escolha 9 – Considere a escolha entre a forma A e a forma B de produção de electricidade. Assinale a sua opção preferida:

	Forma A	Forma B
Impacto significativo sobre a paisagem	Sim	Não
Impacto significativo sobre a Fauna/Flora	Não	Sim
Destrói património	Não	Não
Produz ruído que afecta a população	Não	Não
Fonte de energia	Fotovoltaica	Hídrica
Acréscimo no valor da factura mensal €	12	4
A sua escolha	☐	☐

29. Estaria disposto a comprar electricidade produzida da forma que escolheu ao preço especificado?

☐ Sim ☐ Não

30. Numa escala de 0 a 10, onde 0 corresponde a "Muito pouca certeza" e 10 a "Certeza Absoluta", diga com que grau de certeza pagaria o montante indicado na sua escolha.

0☐ 1☐ 2☐ 3☐ 4☐ ☐ 6☐ 7☐ 8☐ 9☐ 10☐

31. Nas escolhas que fez anteriormente considerou todos os atributos?

☐ Sim ☐ Não

31.1 Se **não,** quais os atributos a que deu mais importância? (Assinale todos os que se aplicam).

☐ *Preservação de fauna e flora.*
☐ *Preservação da paisagem*
☐ *Preservação do património (edifícios e povoações)*
☐ *Ruído*
☐ *Tipo de fonte de energia*
☐ *Preço (acréscimo no valor da factura mensal)*

32. Quais das seguintes opções melhor explicam as razões das suas respostas às questões anteriores?

☐ *Na minha opinião os consumidores não deveriam ter de pagar mais para ter electricidade amiga do ambiente.*
☐ *Escolhi a alternativa que me dava mais valor pelo preço.*
☐ *É importante saber a que se destinam os pagamentos adicionais que se fazem às fontes de energia renovável.*
☐ *Preferia gastar o meu dinheiro para comprar electricidade produzida por outras fontes renováveis.*
☐ *Não tenho capacidade financeira para pagar mais por electricidade do que o que já pago.*

33. Como classificaria cada um dos impactos da produção de electricidade a partir de energia hídrica (barragens), sendo que 1 corresponde ao muito negativo e 5 a muito positivo.

Impactos	**Efeitos das Barragens**					
	Muito negativo			**Muito positivo**		**Não sei**
	1	**2**	**3**	**4**	**5**	
Alteração da paisagem						
Alterações na fauna						
Alterações na flora						
Ruído						
Destruição de património						
Custo de produção						

34. Como classificaria cada um dos impactos da produção de electricidade a partir de energia fotovoltaica (parque de painéis fotovoltaicos), sendo que 1 corresponde ao muito negativo e 5 a muito positivo.

Impactos	**Efeitos dos Parques Fotovoltaicos**					
	Muito negativo			**Muito positivo**		**Não sei**
	1	**2**	**3**	**4**	**5**	
Alteração da paisagem						
Alterações na fauna						
Alterações na flora						
Reflexo de luz						
Custo de produção						

35. Como classificaria cada um dos impactos da produção de electricidade a partir de energia eólica (vento), sendo que 1 corresponde ao muito negativo e 5 a muito positivo.

Impactos	**Efeitos dos Parques Eólicos**					
	Muito negativo			**Muito positivo**		**Não sei**
	1	**2**	**3**	**4**	**5**	
Alteração da paisagem						
Alterações na fauna						
Alterações na flora						
Ruído						
Custo de produção						

Secção III: Opinião sobre energias renováveis em geral

36. Considera que Portugal tem condições naturais para fazer um bom aproveitamento das energias renováveis?

☐ Sim ☐ Não

37. Acredita que as energias renováveis trazem benefícios para a população?

☐ Sim ☐ Não

37.1. Se **sim**, na sua opinião, quais dos seguintes benefícios considera serem mais importantes?

☐ É inesgotável à escala humana
☐ Não produz emissões perigosas ou de sólidos tóxicos
☐ Reduz a contribuição para as alterações climáticas globais
☐ Favorável ao emprego e criação de postos de trabalho
☐ Reduz a dependência energética externa da nossa economia

Secção IV: Questões sociodemográficas

38. Sexo: ☐ Feminino ☐ Masculino

39. Estado Civil**:**

☐ Casado(a)/União de facto
☐ Divorciado(a)
☐ Solteiro(a)
☐ Viúvo(a)

40. Idade: ____________

41. Situação perante o emprego:

- ☐ Desempregado(a)
- ☐ Doméstico(a)
- ☐ Estudante
- ☐ Reformado(a)
- ☐ Trabalhador(a) por conta própria
- ☐ Trabalhador(a) por conta de outrém

42. Habilitações escolares:

- ☐ 1.º, 2.º, 3.º ou 4.º ano (antiga instrução primária)
- ☐ 5.º ou 6.º ano (antigo ciclo preparatório)
- ☐ 7.º, 8.º ou 9.º ano (antigo 3.º, 4.º e 5.º ano liceal)
- ☐ 10.º, 11.º ou 12.º (antigo 6.º e 7.º ano liceal / ano propedêutico)
- ☐ Bacharelato ou Licenciatura
- ☐ Mestrado
- ☐ Doutoramento
- ☐ Outro

43. Rendimento mensal líquido do agregado familiar (em euros):

- ☐ Inferior a 250€
- ☐ Entre 251 e 500€
- ☐ Entre 501 e 750€
- ☐ Entre 751 e 1000€
- ☐ Entre 1001 e 1250€
- ☐ Entre 1251 e 1500€
- ☐ Entre 1501 e 1750€
- ☐ Entre 1751 e 2000€
- ☐ Entre 2001 e 2250€
- ☐ Entre 2251 e 2500€
- ☐ Entre 2501 e 2750€
- ☐ Entre 2751 e 3000€
- ☐ Entre 3001 e 3250€
- ☐ Entre 3251 e 3500€
- ☐ Entre 3501 e 3750€
- ☐ Entre 3751 e 4000€
- ☐ Entre 4001 e 4250€
- ☐ Entre 4251 e 4500€
- ☐ Entre 4501 e 4750€
- ☐ Entre 4751 e 5000€
- ☐ Mais de 5000€

44. Número de pessoas do agregado familiar?

Crianças (<12)_________ Jovens (12-18 anos)_________ Adultos (>18) __________

45. Da sua residência, local de trabalho ou deslocações diárias avista alguma instalação de produção de electricidade através de uma fonte de energia renovável?

☐ Sim ☐ Não

45.1. Se **sim**: qual a fonte de energia renovável?

- Eólica (vento) ☐
- Hídrica (barragem) ☐
- Biomassa (restos florestais) ☐
- Fotovoltaica (sol) ☐

45.2. Se **sim**: em que local?

☐ Residência ☐ Trabalho ☐ Deslocações

46. Qual o seu concelho de residência? ________________________

47. Classifique o seu comportamento face ao risco, usando uma escala de 1 (absolutamente nada arriscados) a 9 (mais do que extremamente arriscados). (Assinale com um X).

	Absolutamente nada arriscados (1)	Nada arriscados (2)	Pouco arriscados (3)	Algo arriscados (4)	Moderadamente arriscados (5)	Arriscados (6)	Muito arriscados (7)	Extremamente arriscados (8)	Mais do que extremamente arriscados (9)
Em GERAL, diria que o seu comportamento e as decisões que toma são:									
Na sua ATIVIDADE PROFISSIONAL, diria que o seu comportamento e as decisões que toma são:									
Relativamente às suas FINANÇAS, diria que o seu comportamento e as decisões que toma são:									
Relativamente à sua SAÚDE, diria que o seu comportamento e as decisões que toma são:									

48. Use o espaço abaixo para deixar o seu comentário.

MUITO OBRIGADA PELA SUA COLABORAÇÃO!

I.3. Images Annexes to the DCE Questionnaires

A Panoramic Image of a Dam:

A Panoramic Image of a Photovoltaic Farm:

A Panoramic Image of a Wind Farm:

A Panoramic Image of a Biomass Power Plant:

Appendix II:
II.1. English Translation of CV Questionnaires
II.1.1. CV Questionnaire on Forest Biomass Power

B

Dear respondent,

We need your collaboration in a research project conducted by researchers of the University of Minho. Its main objective is the valuation of the environmental impacts associated with each of the different renewable energy sources. The following questionnaire is anonymous and confidential. We appreciate that you respond with the greatest sincerity possible. **Note that there are no good or bad answers. We only want to know your opinion.**

It is very important to fill in the questionnaire to the end.

Section I: Introductory Section

In this section we intend to have an idea of your familiarity with renewable energy.

1. What are the most important environmental problems in Portugal currently? (Indicate only 3).

- ☐ Climate change
- ☐ Atmospheric pollution
- ☐ Water pollution (rivers and ocean)
- ☐ Over-exploitation of natural resources
- ☐ Biodiversity decline (variety of animal and plant species)
- ☐ Waste
- ☐ Other

2. Say in which way you agree with the following statements (mark with an x).

	Agree totally	**Agree partially**	**Do not agree nor disagree**	**Disagree partially**	**Disagree totally**	**Do not know**
The government should act to reduce pollution by specific laws.						
It is important electricity have a low price.						
We should reduce environmental pollution and other environmental impacts caused by the electricity generation.						
The government should help reduce the costs of electricity production financing new forms of production.						
The government should help reduce the costs of electricity production financing new energy sources more environmentally friendly and renewable.						
People in general can do much to improve the environment, for instance by lowering electricity consumption.						
I, personally, do not have financial availability to contribute more to a better environment than what I already contribute.						
I, personally, do not have availability to dedicate more of my time to keep a better environment than I already dedicate.						
I do not know in what way I may collaborate more than I already collaborate to maintain a better environment.						

3. Do you usually buy environmentally friendly products (or someone in your household does)?

☐ Yes ☐ No

4. Have you ever heard of the environmental problems that are associated with the use of energy from fossil fuels (such as oil)?

☐ Yes ☐ No

4.1. If yes which ones? (If you consider all please tick only the three most important in your opinion)

☐ Accumulation of carbon dioxide
☐ Climate change
☐ Water pollution
☐ Loss of species diversity (animal and vegetal)
☐ Other

5. What are the renewable energy sources that you know for electricity production?

☐ Wind Power
☐ Photovoltaic Power (solar)
☐ Biomass (forest remains)
☐ Geothermal Energy (heat of the earth)
☐ Hydropower (dams)
☐ Wave Energy
☐ Other ____________

6. What is your opinion on how environmentally friendly are these energy sources? (Indicate with an X).

	Very friend	**Somewhat friend**	**Indifferent**	**Somewhat not friend**	**Not friend**	**Do not know**
Nuclear						
Hydropower (dams)						
Coal						
Natural gas						
Wind power						
Photovoltaic (solar)						
Geothermal (heat of the earth)						
Biomass (forest waste)						
Fuel oil (gas oil)						
Wave Energy						

7. Have you ever visited one of the following technologies of production of renewable energy?

➔ Dam ☐ Yes ☐ No
➔ Wind farm ☐ Yes ☐ No
➔ Photovoltaic farm ☐ Yes ☐ No
➔ Biomass power plant ☐ Yes ☐ No

8. Do you work/worked in any power generation technology through renewable energy sources?

☐ Yes ☐ No

8.1. If **yes,** specify in which one(s):

☐ Wind farm
☐ Photovoltaic farm (solar)
☐ Dam
☐ Biomass power plant

9. Do you know someone that works/worked in any power generation technology through renewable energy sources?

☐ Yes ☐ No

9.1. If **yes**, specify in which one(s):

☐ Wind farm
☐ Photovoltaic farm (solar)
☐ Dam
☐ Biomass power plant

10. How important is for you to know the type of renewable energy that is being consumed in the production of electricity (wind, solar, hydro, biomass)? On a scale from 0 to 5, **wherein 0 means "without opinion", 1 means "not important", 3 means "important" and 5 means "very important".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. What is the monthly amount (average /approximate) of your energy bill?

Value_______________ do not know ______

12. Do you usually observe in detail your electricity bill?

☐ No, I limit myself to pay ☐ Just the value ☐ Yes, I observe every details

Section II: Valuation Question

The production of electricity, in Portugal, is made from various energy sources. In this study, we give special attention to renewable energy sources such as wind power (wind), hydropower (dams), photovoltaics (solar) and biomass energy (utilization of forest residues).

Biomass energy is considered a clean energy source, environmentally friendly and sustainable. To this energy source are not associated environmental disadvantages as the contribution to global warming, though it releases some gases to the atmosphere. However, it may cause some environmental effects that may cause you some nuisance.

The environmental impacts from the **biomass power plants (biomass from forest remains)** may depend on its location, causing some changes in the landscape and in the fauna/flora and odors that may be annoying for the population of the surrounding area.

13. Do you know the biomass power plant located here in the area?

☐ Yes ☐ No

14. The biomass power plant located here in the area is visible from your residence, place of work or daily commuting?

☐ Yes ☐ No

15. On a scale of 1 to 5, where 1 means "nothing bothered" and 5 "very bothered", how do you feel given the presence of the biomass power plant?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

16. What are the reasons why you feel more bothered, where 1 means "nothing bothered" and 5 "very bothered"?

	1	**2**	**3**	**4**	**5**
Noise	☐	☐	☐	☐	☐
Fauna	☐	☐	☐	☐	☐
Flora	☐	☐	☐	☐	☐
Landscape	☐	☐	☐	☐	☐
Odours	☐	☐	☐	☐	☐
Increase in the number of people and traffic in the area	☐	☐	☐	☐	☐

Taking into account your income and your usual expenses, answer the following question:

17. What is the minimum amount that you would be willing to receive as compensation for the burdens caused by the presence of the biomass power plant? The amount would be credited to your monthly electricity bill.

Would you be willing to receive? _______________ Euros per month.

18. On a scale of 0 to 10, where 0 corresponds to "very little certainty" and 10 "absolute certainty," say with which degree of certainty you would be willing to receive the amount stated in the previous answer.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

19. If you answered zero in question 17, please indicate (with a cross) which of the reasons best justify your answer:

I do not consider relevant the impacts caused by the biomass power plant (do not affect me)	
I do not think that the impacts caused by the biomass power plant may be somewhat compensated with the payment of a monetary amount	
The biomass power plant has advantages	
I do not believe that someone is willing to make that discount	

20. How would you classify each of the impacts of electricity generation from biomass power plants in general, where 1 corresponds to "very negative" and 5 to "very positive".

Impacts	**Effects of Biomass Power Plants**					
	Very negative			**Very positive**		**Do not know**
	1	**2**	**3**	**4**	**5**	
Landscape change						
Changes in the fauna						
Changes in the flora						
Odour						
Noise						
Production cost						

Section III: Opinion on renewable energy on general

21. Do you consider that Portugal has natural conditions to make good use of renewable energy in electricity production?

☐ Yes ☐ No

22. Do you believe that renewable energy in electricity production bring benefits to the population?

☐ Yes ☐ No

22.1. If **yes**, in your opinion, which of the following benefits you consider to be more important?

☐ It is inexhaustible on a human scale
☐ It does not produce harmful emissions or toxic solids
☐ It reduces the contribution to global climate change
☐ It is beneficial to employment and job creation
☐ It reduces external energy dependence of our economy

Section IV: Sociodemographic questions

23. Gender: ☐ Female ☐ Male

24. Marital Status**:**

☐ Married/Facto Union
☐ Divorced
☐ Single
☐ Widower

25. Age: ____________

26. Situation in employment:

☐ Unemployed
☐ Domestic
☐ Student
☐ Retired
☐ Self employed
☐ Worker as an employed person

27. School qualifications:

- ☐ 1st, 2nd, 3rd or 4th year (former primary instruction)
- ☐ 5th or 6th year (former preparatory cycle)
- ☐ 7th, 8th or 9th year (former 3rd, 4th and 5th lyceum year)
- ☐ 10th, 11th or 12th (former 6th and 7th lyceum year/introductory year)
- ☐ Bachelor or Degree
- ☐ Master
- ☐ Doctoral Degree (PhD)
- ☐ Other

28. Monthly net household income (in euros):

- ☐ Less than 250€
- ☐ Between 251 and 500€
- ☐ Between 501 and 750€
- ☐ Between 751 and 1000€
- ☐ Between 1001 and 1250€
- ☐ Between 1251 and 1500€
- ☐ Between 1501 and 1750€
- ☐ Between 1751 and 2000€
- ☐ Between 2001 and 2250€
- ☐ Between 2251 and 2500€
- ☐ Between 2501 and 2750€
- ☐ Between 2751 and 3000€
- ☐ Between 3001 and 3250€
- ☐ Between 3251 and 3500€
- ☐ Between 3501 and 3750€
- ☐ Between 3751 and 4000€
- ☐ Between 4001 and 4250€
- ☐ Between 4251 and 4500€
- ☐ Between 4501 and 4750€
- ☐ Between 4751 and 5000€
- ☐ More than 5000€

29. Number of persons of the household:

Children (<12 years) ______ Young (12-18 years) _______ Adults (>18 years) _______

30. What is your municipality of residence? ___________________________

31. What is your parish of residence? _________________________________

32. Rate your behaviour towards risk, using a scale from 1 (absolutely nothing risky) to 9 (more than extremely risky). (Indicate with an X).

	Absolutely nothing risky (1)	**Nothing risky (2)**	**Little risky (3)**	**Somethin g risky (4)**	**Moderately risky (5)**	**Risky (6)**	**Very risky (7)**	**Extremel y risky (8)**	**More than extremely risky (9)**
In GENERAL, would you say that your behaviour and the decisions you make are:									
In your PROFESSIONAL ACTIVITY, would you say that your behaviour and the decisions you make are:									
With regard to your FINANCES, would you say that your behaviour and the decisions you make are:									
With regard to your HEALTH, would you say that your behaviour and the decisions you make are:									

33. Use the space below to leave your comment.

THANK YOU VERY MUCH FOR YOUR COOPERATION!

II.1.2. CV Questionnaire on Wind Power

W

Dear respondent,

We need your collaboration in a research project conducted by researchers of the University of Minho. Its main objective is the valuation of the environmental impacts associated with each of the different renewable energy sources. The following questionnaire is anonymous and confidential. We appreciate that you respond with the greatest sincerity possible. **Note that there are no good or bad answers. We only want to know your opinion.**

It is very important to fill in the questionnaire to the end.

Section I: Introductory Section

In this section we intend to have an idea of your familiarity with renewable energy.

1. What are the most important environmental problems in Portugal currently? (Indicate only 3).

- ☐ Climate change
- ☐ Atmospheric pollution
- ☐ Water pollution (rivers and ocean)
- ☐ Over-exploitation of natural resources
- ☐ Biodiversity decline (variety of animal and plant species)
- ☐ Waste
- ☐ Other

2. Say in which way you agree with the following statements (mark with an x).

	Agree totally	**Agree partially**	**Do not agree nor disagree**	**Disagree partially**	**Disagree totally**	**Do not know**
The government should act to reduce pollution by specific laws.						
It is important electricity have a low price.						
We should reduce environmental pollution and other environmental impacts caused by the electricity generation.						
The government should help reduce the costs of electricity production financing new forms of production.						
The government should help reduce the costs of electricity production financing new energy sources more environmentally friendly and renewable.						
People in general can do much to improve the environment, for instance by lowering electricity consumption.						
I, personally, do not have financial availability to contribute more to a better environment than what I already contribute.						
I, personally, do not have availability to dedicate more of my time to keep a better environment than I already dedicate.						
I do not know in what way I may collaborate more than I already collaborate to maintain a better environment.						

3. Do you usually buy environmentally friendly products (or someone in your household does)?

☐ Yes ☐ No

4. Have you ever heard of the environmental problems that are associated with the use of energy from fossil fuels (such as oil)?

☐ Yes ☐ No

4.1. If yes which ones? (If you consider all please tick only the three most important in your opinion)

☐ Accumulation of carbon dioxide
☐ Climate change
☐ Water pollution
☐ Loss of species diversity (animal and vegetal)
☐ Other

5. What are the renewable energy sources that you know for electricity production?

☐ Wind Power
☐ Photovoltaic Power (solar)
☐ Biomass (forest remains)
☐ Geothermal Energy (heat of the earth)
☐ Hydropower (dams)
☐ Wave Energy
☐ Other ____________

6. What is your opinion on how environmentally friendly are these energy sources? (Indicate with an X).

	Very friend	**Somewhat friend**	**Indifferent**	**Somewhat not friend**	**Not friend**	**Do not know**
Nuclear						
Hydropower (dams)						
Coal						
Natural gas						
Wind power						
Photovoltaic (solar)						
Geothermal (heat of the earth)						
Biomass (forest waste)						
Fuel oil (gas oil)						
Wave Energy						

7. Have you ever visited one of the following technologies of production of renewable energy?

➔ Dam ☐ Yes ☐ No
➔ Wind farm ☐ Yes ☐ No
➔ Photovoltaic farm ☐ Yes ☐ No
➔ Biomass power plant ☐ Yes ☐ No

8. Do you work/worked in any power generation technology through renewable energy sources?

☐ Yes ☐ No

8.1. If **yes,** specify in which one(s):

☐ Wind farm
☐ Photovoltaic farm (solar)
☐ Dam
☐ Biomass power plant

9. Do you know someone that works/worked in any power generation technology through renewable energy sources?

Yes ☐ No ☐

9.1. If **yes**, specify in which one(s):

☐ Wind farm
☐ Photovoltaic farm (solar)
☐ Dam
☐ Biomass power plant

10. How important is for you to know the type of renewable energy that is being consumed in the production of electricity (wind, solar, hydro, biomass)? On a scale from 0 to 5, **wherein 0 means "without opinion", 1 means "not important", 3 means "important" and 5 means "very important".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. What is the monthly amount (average /approximate) of your energy bill?

Value________________ do not know ______

12. Do you usually observe in detail your electricity bill?

☐ No, I limit myself to pay ☐ Just the value ☐ Yes, I observe every details

Section II: Valuation Question

The production of electricity, in Portugal, is made from various energy sources. In this study, we give special attention to renewable energy sources such as wind power (wind), hydropower (dams), photovoltaics (solar) and biomass energy (utilization of forest residues).

Wind energy is considered a clean energy source, environmentally friendly and sustainable. To this energy source are not associated environmental disadvantages as the contribution to global warming. However, it may cause some environmental effects that may cause you some nuisance.

The environmental impacts from the **wind farms** may depend on its location, causing some changes in the landscape and in the fauna/flora and the production of noise that may be annoying and affect the population of the surrounding area.

13. Do you know the wind farm located here in the area?

☐ Yes ☐ No

14. The wind farm located here in the area is visible from your residence, place of work or daily commuting?

☐ Yes ☐ No

15. On a scale of 1 to 5, where 1 means "nothing bothered" and 5 "very bothered", how do you feel given the presence of the wind farm?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

16. What are the reasons why you feel more bothered, where 1 means "nothing bothered" and 5 "very bothered"?

	1	**2**	**3**	**4**	**5**
Noise	☐	☐	☐	☐	☐
Fauna	☐	☐	☐	☐	☐
Flora	☐	☐	☐	☐	☐
Landscape	☐	☐	☐	☐	☐
Increase in the number of people and traffic in the area	☐	☐	☐	☐	☐
New accesses to the local	☐	☐	☐	☐	☐

Taking into account your income and your usual expenses, answer the following question:

17. What is the minimum amount that you would be willing to receive as compensation for the burdens caused by the presence of the wind farm? The amount would be credited to your monthly electricity bill.

Would you be willing to receive? _______________ Euros per month.

18. On a scale of 0 to 10, where 0 corresponds to "very little certainty" and 10 "absolute certainty," say with which degree of certainty you would be willing to receive the amount stated in the previous answer.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

19. If you answered zero in question 17, please indicate (with a cross) which of the reasons best justify your answer:

I do not consider relevant the impacts caused by the wind farm (do not affect me)	
I do not think that the impacts caused by the wind farm may be somewhat compensated with the payment of a monetary amount	
The wind farm has advantages	
I do not believe that someone is willing to make that discount	

20. How would you classify each of the impacts of electricity generation from wind power in general, where 1 corresponds to "very negative" and 5 to "very positive".

Impacts	**Effects of Wind Farms**					
	Very negative			**Very positive**		**Do not know**
	1	**2**	**3**	**4**	**5**	
Landscape change						
Changes in the fauna						
Changes in the flora						
Noise						
Production cost						

Section III: Opinion on renewable energy on general

21. Do you consider that Portugal has natural conditions to make good use of renewable energy in electricity production?

☐ Yes ☐ No

22. Do you believe that renewable energy in electricity production bring benefits to the population?

☐ Yes ☐ No

22.1. If **yes**, in your opinion, which of the following benefits you consider to be more important?

☐ It is inexhaustible on a human scale
☐ It does not produce harmful emissions or toxic solids
☐ It reduces the contribution to global climate change
☐ It is beneficial to employment and job creation
☐ It reduces external energy dependence of our economy

Section IV: Sociodemographic questions

23. Gender: ☐ Female ☐ Male

24. Marital Status**:**

☐ Married/Facto Union
☐ Divorced
☐ Single
☐ Widower

25. Age: ____________

26. Situation in employment:

☐ Unemployed
☐ Domestic
☐ Student
☐ Retired
☐ Self employed
☐ Worker as an employed person

27. School qualifications:

- ☐ 1st, 2nd, 3rd or 4th year (former primary instruction)
- ☐ 5th or 6th year (former preparatory cycle)
- ☐ 7th, 8th or 9th year (former 3rd, 4th and 5th lyceum year)
- ☐ 10th, 11th or 12th (former 6th and 7th lyceum year/introductory year)
- ☐ Bachelor or Degree
- ☐ Master
- ☐ Doctoral Degree (PhD)
- ☐ Other

28. Monthly net household income (in euros):

- ☐ Less than 250€
- ☐ Between 251 and 500€
- ☐ Between 501 and 750€
- ☐ Between 751 and 1000€
- ☐ Between 1001 and 1250€
- ☐ Between 1251 and 1500€
- ☐ Between 1501 and 1750€
- ☐ Between 1751 and 2000€
- ☐ Between 2001 and 2250€
- ☐ Between 2251 and 2500€
- ☐ Between 2501 and 2750€
- ☐ Between 2751 and 3000€
- ☐ Between 3001 and 3250€
- ☐ Between 3251 and 3500€
- ☐ Between 3501 and 3750€
- ☐ Between 3751 and 4000€
- ☐ Between 4001 and 4250€
- ☐ Between 4251 and 4500€
- ☐ Between 4501 and 4750€
- ☐ Between 4751 and 5000€
- ☐ More than 5000€

29. Number of persons of the household:

Children (<12 years)______ Young (12-18 years) _______ Adults (>18 years) _______

30. What is your municipality of residence? ___________________________

31. What is your parish of residence? ________________________________

32. Rate your behaviour towards risk, using a scale from 1 (absolutely nothing risky) to 9 (more than extremely risky). (Indicate with an X).

	Absolutely nothing risky (1)	**Nothing risky (2)**	**Little risky (3)**	**Somethin g risky (4)**	**Moderately risky (5)**	**Risky (6)**	**Very risky (7)**	**Extremel y risky (8)**	**More than extremely risky (9)**
In GENERAL, would you say that your behaviour and the decisions you make are:									
In your PROFESSIONAL ACTIVITY, would you say that your behaviour and the decisions you make are:									
With regard to your FINANCES, would you say that your behaviour and the decisions you make are:									
With regard to your HEALTH, would you say that your behaviour and the decisions you make are:									

33. Use the space below to leave your comment.

THANK YOU VERY MUCH FOR YOUR COOPERATION!

II.1.3. CV Questionnaire on Photovoltaic Power

P

Dear respondent,

We need your collaboration in a research project conducted by researchers of the University of Minho. Its main objective is the valuation of the environmental impacts associated with each of the different renewable energy sources. The following questionnaire is anonymous and confidential. We appreciate that you respond with the greatest sincerity possible. **Note that there are no good or bad answers. We only want to know your opinion.**

It is very important to fill in the questionnaire to the end.

Section I: Introductory Section

In this section we intend to have an idea of your familiarity with renewable energy.

1. What are the most important environmental problems in Portugal currently? (Indicate only 3).

- ☐ Climate change
- ☐ Atmospheric pollution
- ☐ Water pollution (rivers and ocean)
- ☐ Over-exploitation of natural resources
- ☐ Biodiversity decline (variety of animal and plant species)
- ☐ Waste
- ☐ Other

2. Say in which way you agree with the following statements (mark with an x).

	Agree totally	**Agree partially**	**Do not agree nor disagree**	**Disagree partially**	**Disagree totally**	**Do not know**
The government should act to reduce pollution by specific laws.						
It is important electricity have a low price.						
We should reduce environmental pollution and other environmental impacts caused by the electricity generation.						
The government should help reduce the costs of electricity production financing new forms of production.						
The government should help reduce the costs of electricity production financing new energy sources more environmentally friendly and renewable.						
People in general can do much to improve the environment, for instance by lowering electricity consumption.						
I, personally, do not have financial availability to contribute more to a better environment than what I already contribute.						
I, personally, do not have availability to dedicate more of my time to keep a better environment than I already dedicate.						
I do not know in what way I may collaborate more than I already collaborate to maintain a better environment.						

3. Do you usually buy environmentally friendly products (or someone in your household does)?

☐ Yes ☐ No

4. Have you ever heard of the environmental problems that are associated with the use of energy from fossil fuels (such as oil)?

☐ Yes ☐ No

4.1. If yes which ones? (If you consider all please tick only the three most important in your opinion)

☐ Accumulation of carbon dioxide
☐ Climate change
☐ Water pollution
☐ Loss of species diversity (animal and vegetal)
☐ Other

5. What are the renewable energy sources that you know for electricity production?

☐ Wind Power
☐ Photovoltaic Power (solar)
☐ Biomass (forest remains)
☐ Geothermal Energy (heat of the earth)
☐ Hydropower (dams)
☐ Wave Energy
☐ Other ____________

6. What is your opinion on how environmentally friendly are these energy sources? (Indicate with an X).

	Very friend	**Somewhat friend**	**Indifferent**	**Somewhat not friend**	**Not friend**	**Do not know**
Nuclear						
Hydropower (dams)						
Coal						
Natural gas						
Wind power						
Photovoltaic (solar)						
Geothermal (heat of the earth)						
Biomass (forest waste)						
Fuel oil (gas oil)						
Wave Energy						

7. Have you ever visited one of the following technologies of production of renewable energy?

- ➔ Dam ☐ Yes ☐ No
- ➔ Wind farm ☐ Yes ☐ No
- ➔ Photovoltaic farm ☐ Yes ☐ No
- ➔ Biomass power plant ☐ Yes ☐ No

8. Do you work/worked in any power generation technology through renewable energy sources?

☐ Yes ☐ No

8.1. If **yes,** specify in which one(s):

☐ Wind farm
☐ Photovoltaic farm (solar)
☐ Dam
☐ Biomass power plant

9. Do you know someone that works/worked in any power generation technology through renewable energy sources?

Yes ☐ No ☐

9.1. If **yes**, specify in which one(s):

☐ Wind farm
☐ Photovoltaic farm (solar)
☐ Dam
☐ Biomass power plant

10. How important is for you to know the type of renewable energy that is being consumed in the production of electricity (wind, solar, hydro, biomass)? On a scale from 0 to 5, **wherein 0 means "without opinion", 1 means "not important", 3 means "important" and 5 means "very important".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. What is the monthly amount (average /approximate) of your energy bill?

Value_______________ do not know ______

12. Do you usually observe in detail your electricity bill?

☐ No, I limit myself to pay ☐ Just the value ☐ Yes, I observe every details

Section II: Valuation Question

The production of electricity, in Portugal, is made from various energy sources. In this study, we give special attention to renewable energy sources such as wind power (wind), hydropower (dams), photovoltaics (solar) and biomass energy (utilization of forest residues).

Solar energy is considered a clean energy source, environmentally friendly and sustainable. To this energy source are not associated environmental disadvantages as the contribution to global warming. However, it may cause some environmental effects that may cause you some nuisance.

The environmental impacts from the **photovoltaic farms** may depend on its location, causing some changes in the landscape and in the fauna/flora and the production of glare that may be annoying and affect the population of the surrounding area.

13. Do you know the photovoltaic farm located here in the area?

☐ Yes ☐ No

14. The photovoltaic farm located here in the area is visible from your residence, place of work or daily commuting?

☐ Yes ☐ No

15. On a scale of 1 to 5, where 1 means "nothing bothered" and 5 "very bothered", how do you feel given the presence of the photovoltaic farm?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

16. What are the reasons why you feel more bothered, where 1 means "nothing bothered" and 5 "very bothered"?

	1	**2**	**3**	**4**	**5**
Glare	☐	☐	☐	☐	☐
Fauna	☐	☐	☐	☐	☐
Flora	☐	☐	☐	☐	☐
Landscape	☐	☐	☐	☐	☐
Increase in the number of people and traffic in the area	☐	☐	☐	☐	☐

Taking into account your income and your usual expenses, answer the following question:

17. What is the minimum amount that you would be willing to receive as compensation for the burdens caused by the presence of the photovoltaic farm? The amount would be credited to your monthly electricity bill.

Would you be willing to receive? _______________ Euros per month.

18. On a scale of 0 to 10, where 0 corresponds to "very little certainty" and 10 "absolute certainty," say with which degree of certainty you would be willing to receive the amount stated in the previous answer.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

19. If you answered zero in question 17, please indicate (with a cross) which of the reasons best justify your answer:

I do not consider relevant the impacts caused by the photovoltaic farm (do not affect me)	
I do not think that the impacts caused by the photovoltaic farm may be somewhat compensated with the payment of a monetary amount	
The photovoltaic farm has advantages	
I do not believe that someone is willing to make that discount	

20. How would you classify each of the impacts of electricity generation from photovoltaic power (farm of photovoltaic panels) in general, where 1 corresponds to "very negative" and 5 to "very positive".

Impacts	Effects of Photovoltaic Farms					
	Very negative			Very positive		Do not know
	1	2	3	4	5	
Landscape change						
Changes in the fauna						
Changes in the flora						
Glare						
Production cost						

Section III: Opinion on renewable energy on general

21. Do you consider that Portugal has natural conditions to make good use of renewable energy in electricity production?

☐ Yes ☐ No

22. Do you believe that renewable energy in electricity production bring benefits to the population?

☐ Yes ☐ No

22.1. If **yes**, in your opinion, which of the following benefits you consider to be more important?

☐ It is inexhaustible on a human scale
☐ It does not produce harmful emissions or toxic solids
☐ It reduces the contribution to global climate change
☐ It is beneficial to employment and job creation
☐ It reduces external energy dependence of our economy

Section IV: Sociodemographic questions

23. Gender: ☐ Female ☐ Male

24. Marital Status**:**

☐ Married/Facto Union
☐ Divorced
☐ Single
☐ Widower

25. Age: ____________

26. Situation in employment:

☐ Unemployed
☐ Domestic
☐ Student
☐ Retired
☐ Self employed
☐ Worker as an employed person

27. School qualifications:

- ☐ 1st, 2nd, 3rd or 4th year (former primary instruction)
- ☐ 5th or 6th year (former preparatory cycle)
- ☐ 7th, 8th or 9th year (former 3rd, 4th and 5th lyceum year)
- ☐ 10th, 11th or 12th (former 6th and 7th lyceum year/introductory year)
- ☐ Bachelor or Degree
- ☐ Master
- ☐ Doctoral Degree (PhD)
- ☐ Other

28. Monthly net household income (in euros):

- ☐ Less than 250€
- ☐ Between 251 and 500€
- ☐ Between 501 and 750€
- ☐ Between 751 and 1000€
- ☐ Between 1001 and 1250€
- ☐ Between 1251 and 1500€
- ☐ Between 1501 and 1750€
- ☐ Between 1751 and 2000€
- ☐ Between 2001 and 2250€
- ☐ Between 2251 and 2500€
- ☐ Between 2501 and 2750€
- ☐ Between 2751 and 3000€
- ☐ Between 3001 and 3250€
- ☐ Between 3251 and 3500€
- ☐ Between 3501 and 3750€
- ☐ Between 3751 and 4000€
- ☐ Between 4001 and 4250€
- ☐ Between 4251 and 4500€
- ☐ Between 4501 and 4750€
- ☐ Between 4751 and 5000€
- ☐ More than 5000€

29. Number of persons of the household:

Children (<12 years)______ Young (12-18 years) ______Adults (>18 years) _______

30. What is your municipality of residence? _________________________

31. What is your parish of residence? ______________________________

32. Rate your behaviour towards risk, using a scale from 1 (absolutely nothing risky) to 9 (more than extremely risky). (Indicate with an X).

	Absolutely nothing risky (1)	**Nothing risky (2)**	**Little risky (3)**	**Somethin g risky (4)**	**Moderately risky (5)**	**Risky (6)**	**Very risky (7)**	**Extremel y risky (8)**	**More than extremely risky (9)**
In GENERAL, would you say that your behaviour and the decisions you make are:									
In your PROFESSIONAL ACTIVITY, would you say that your behaviour and the decisions you make are:									
With regard to your FINANCES, would you say that your behaviour and the decisions you make are:									
With regard to your HEALTH, would you say that your behaviour and the decisions you make are:									

33. Use the space below to leave your comment.

THANK YOU VERY MUCH FOR YOUR COOPERATION!

II.1.4. CV Questionnaire on Hydropower

H

Dear respondent,

We need your collaboration in a research project conducted by researchers of the University of Minho. Its main objective is the valuation of the environmental impacts associated with each of the different renewable energy sources. The following questionnaire is anonymous and confidential. We appreciate that you respond with the greatest sincerity possible. **Note that there are no good or bad answers. We only want to know your opinion.**

It is very important to fill in the questionnaire to the end.

Section I: Introductory Section

In this section we intend to have an idea of your familiarity with renewable energy.

1. What are the most important environmental problems in Portugal currently? (Indicate only 3).

- ☐ Climate change
- ☐ Atmospheric pollution
- ☐ Water pollution (rivers and ocean)
- ☐ Over-exploitation of natural resources
- ☐ Biodiversity decline (variety of animal and plant species)
- ☐ Waste
- ☐ Other

2. Say in which way you agree with the following statements (mark with an x).

	Agree totally	**Agree partially**	**Do not agree nor disagree**	**Disagree partially**	**Disagree totally**	**Do not know**
The government should act to reduce pollution by specific laws.						
It is important electricity have a low price.						
We should reduce environmental pollution and other environmental impacts caused by the electricity generation.						
The government should help reduce the costs of electricity production financing new forms of production.						
The government should help reduce the costs of electricity production financing new energy sources more environmentally friendly and renewable.						
People in general can do much to improve the environment, for instance by lowering electricity consumption.						
I, personally, do not have financial availability to contribute more to a better environment than what I already contribute.						
I, personally, do not have availability to dedicate more of my time to keep a better environment than I already dedicate.						
I do not know in what way I may collaborate more than I already collaborate to maintain a better environment.						

3. Do you usually buy environmentally friendly products (or someone in your household does)?

☐ Yes ☐ No

4. Have you ever heard of the environmental problems that are associated with the use of energy from fossil fuels (such as oil)?

☐ Yes ☐ No

4.1. If yes which ones? (If you consider all please tick only the three most important in your opinion)

☐ Accumulation of carbon dioxide
☐ Climate change
☐ Water pollution
☐ Loss of species diversity (animal and vegetal)
☐ Other

5. What are the renewable energy sources that you know for electricity production?

☐ Wind Power
☐ Photovoltaic Power (solar)
☐ Biomass (forest remains)
☐ Geothermal Energy (heat of the earth)
☐ Hydropower (dams)
☐ Wave Energy
☐ Other ____________

6. What is your opinion on how environmentally friendly are these energy sources? (Indicate with an X).

	Very friend	Somewhat friend	Indifferent	Somewhat not friend	Not friend	Do not know
Nuclear						
Hydropower (dams)						
Coal						
Natural gas						
Wind power						
Photovoltaic (solar)						
Geothermal (heat of the earth)						
Biomass (forest waste)						
Fuel oil (gas oil)						
Wave Energy						

7. Have you ever visited one of the following technologies of production of renewable energy?

- ➔ Dam ☐ Yes ☐ No
- ➔ Wind farm ☐ Yes ☐ No
- ➔ Photovoltaic farm ☐ Yes ☐ No
- ➔ Biomass power plant ☐ Yes ☐ No

8. Do you work/worked in any power generation technology through renewable energy sources?

☐ Yes ☐ No

8.1. If **yes,** specify in which one(s):

☐ Wind farm
☐ Photovoltaic farm (solar)
☐ Dam
☐ Biomass power plant

9. Do you know someone that works/worked in any power generation technology through renewable energy sources?

☐ Yes ☐ No

9.1. If **yes**, specify in which one(s):

☐ Wind farm
☐ Photovoltaic farm (solar)
☐ Dam
☐ Biomass power plant

10. How important is for you to know the type of renewable energy that is being consumed in the production of electricity (wind, solar, hydro, biomass)? On a scale from 0 to 5, **wherein 0 means "without opinion", 1 means "not important", 3 means "important" and 5 means "very important".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. What is the monthly amount (average /approximate) of your energy bill?

Value_______________ do not know ______

12. Do you usually observe in detail your electricity bill?

☐ No, I limit myself to pay ☐ Just the value ☐ Yes, I observe every details

Section II: Valuation Question

The production of electricity, in Portugal, is made from various energy sources. In this study, we give special attention to renewable energy sources such as wind power (wind), hydropower (dams), photovoltaics (solar) and biomass energy (utilization of forest residues).

Hydropower is considered a clean energy source, environmentally friendly and sustainable. To this energy source are not associated environmental disadvantages as the contribution to global warming. However, it may cause some environmental effects that may cause you some nuisance.

The environmental impacts from the **dams** may depend on its location, causing some changes in the landscape and in the fauna/flora, the production of noise that may be annoying and affect the population of the surrounding area and the destruction of heritage (namely houses, chapels and buildings of our ancestors).

13. Do you know the dam located/in construction/ to be built here in the area?

☐ Yes ☐ No

14. The dam located/in construction here in the area is visible from your residence, place of work or daily commuting?

☐ Yes ☐ No

15. On a scale of 1 to 5, where 1 means "nothing bothered" and 5 "very bothered", how do you feel given the presence/future presence of the dam?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

16. What are the reasons why you feel more bothered, where 1 means "nothing bothered" and 5 "very bothered"?

	1	**2**	**3**	**4**	**5**
Noise	☐	☐	☐	☐	☐
Landscape	☐	☐	☐	☐	☐
Destruction of heritage	☐	☐	☐	☐	☐
Destruction of own or family property	☐	☐	☐	☐	☐
Fauna	☐	☐	☐	☐	☐
Flora	☐	☐	☐	☐	☐
Increase of the number of people and traffic in the area	☐	☐	☐	☐	☐

Taking into account your income and your usual expenses, answer the following question:

17. What is the minimum amount that you would be willing to receive as compensation for the burdens caused by the presence of the dam, or expect will cause? The amount would be credited to your monthly electricity bill.

Would you be willing to receive? _______________ Euros per month.

18. On a scale of 0 to 10, where 0 corresponds to "very little certainty" and 10 "absolute certainty," say with which degree of certainty you would be willing to receive the amount stated in the previous answer.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

19. If you answered zero in question 17, please indicate (with a cross) which of the reasons best justify your answer:

I do not consider relevant the impacts caused by the dam (do not affect me)	
I do not think that the impacts caused by the dam may be somewhat compensated with the payment of a monetary amount	
The dam has advantages	
I do not believe that someone is willing to make that discount	

20. How would you classify each of the impacts of electricity generation from hydropower (dams) in general, where 1 corresponds to "very negative" and 5 to "very positive".

Impacts	Effects of Dams					
	Very negative			Very positive		Do not know
	1	2	3	4	5	
Landscape change						
Changes in the fauna						
Changes in the flora						
Production of noise for the populations						
Destruction of heritage						
Production cost						

Section III: Opinion on renewable energy on general

21. Do you consider that Portugal has natural conditions to make good use of renewable energy in electricity production?

☐ Yes ☐ No

22. Do you believe that renewable energy in electricity production bring benefits to the population?

☐ Yes ☐ No

22.1. If **yes**, in your opinion, which of the following benefits you consider to be more important?

☐ It is inexhaustible on a human scale
☐ It does not produce harmful emissions or toxic solids
☐ It reduces the contribution to global climate change
☐ It is beneficial to employment and job creation
☐ It reduces external energy dependence of our economy

Section IV: Sociodemographic questions

23. Gender: ☐ Female ☐ Male

24. Marital Status**:**

☐ Married/Facto Union
☐ Divorced
☐ Single
☐ Widower

25. Age: ____________

26. Situation in employment:

☐ Unemployed
☐ Domestic
☐ Student
☐ Retired
☐ Self employed
☐ Worker as an employed person

27. School qualifications:

- ▢ 1st, 2nd, 3rd or 4th year (former primary instruction)
- ▢ 5th or 6th year (former preparatory cycle)
- ▢ 7th, 8th or 9th year (former 3rd, 4th and 5th lyceum year)
- ▢ 10th, 11th or 12th (former 6th and 7th lyceum year/introductory year)
- ▢ Bachelor or Degree
- ▢ Master
- ▢ Doctoral Degree (PhD)
- ▢ Other

28. Monthly net household income (in euros):

- ▢ Less than 250€
- ▢ Between 251 and 500€
- ▢ Between 501 and 750€
- ▢ Between 751 and 1000€
- ▢ Between 1001 and 1250€
- ▢ Between 1251 and 1500€
- ▢ Between 1501 and 1750€
- ▢ Between 1751 and 2000€
- ▢ Between 2001 and 2250€
- ▢ Between 2251 and 2500€
- ▢ Between 2501 and 2750€
- ▢ Between 2751 and 3000€
- ▢ Between 3001 and 3250€
- ▢ Between 3251 and 3500€
- ▢ Between 3501 and 3750€
- ▢ Between 3751 and 4000€
- ▢ Between 4001 and 4250€
- ▢ Between 4251 and 4500€
- ▢ Between 4501 and 4750€
- ▢ Between 4751 and 5000€
- ▢ More than 5000€

29. Number of persons of the household:

Children (<12 years)______ Young (12-18 years) ______ Adults (>18 years) ______

30. What is your municipality of residence? ________________________

31. What is your parish of residence? ____________________________

32. Rate your behaviour towards risk, using a scale from 1 (absolutely nothing risky) to 9 (more than extremely risky). (Indicate with an X).

	Absolutely nothing risky (1)	**Nothing risky (2)**	**Little risky (3)**	**Somethin g risky (4)**	**Moderately risky (5)**	**Risky (6)**	**Very risky (7)**	**Extremel y risky (8)**	**More than extremely risky (9)**
In GENERAL, would you say that your behaviour and the decisions you make are:									
In your PROFESSIONAL ACTIVITY, would you say that your behaviour and the decisions you make are:									
With regard to your FINANCES, would you say that your behaviour and the decisions you make are:									
With regard to your HEALTH, would you say that your behaviour and the decisions you make are:									

33. Use the space below to leave your comment.

THANK YOU VERY MUCH FOR YOUR COOPERATION!

II.2. Portuguese Original CV Questionnaires
II.2.1. CV Questionnaire on Forest Biomass Power

B

Caro(a) respondente,

Precisamos da sua colaboração num projeto de investigação conduzido por investigadores da Universidade do Minho. O seu principal objetivo é a valoração dos impactos ambientais associados a cada uma das diversas fontes de energia renováveis. O questionário que se segue é anónimo e confidencial. Agradecemos que responda com a maior sinceridade possível. **Note que não há boas ou más respostas. Importa-nos apenas saber a sua opinião.**

É muito importante que preencha o questionário até ao fim.

Secção I: Secção Introdutória

Nesta secção pretende-se ter uma ideia da sua familiaridade com as energias renováveis.

1. Quais são os problemas ambientais mais importantes em Portugal actualmente? (Indique apenas 3).

- ☐ Alterações climáticas
- ☐ Poluição atmosférica
- ☐ Poluição das águas (rios e oceano)
- ☐ Sobre-exploração dos recursos naturais
- ☐ Diminuição da biodiversidade (variedade de espécies animais e vegetais)
- ☐ Lixo
- ☐ Outros

2. Diga de que forma concorda com as seguintes afirmações (assinale com um x).

	Concorda totalmente	**Concorda parcialmente**	**Não concorda nem discorda**	**Discorda parcialmente**	**Discorda totalmente**	**Não sabe**
O governo deve atuar para diminuir a poluição através de leis específicas.						
É importante a electricidade ter um preço baixo.						
Devemos reduzir a poluição ambiental e outros impactos ambientais causados pela produção de electricidade.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas formas de produção.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas fontes de energia mais amigas do ambiente e renováveis.						
As pessoas em geral podem fazer muito para melhorar o meio ambiente, por exemplo diminuindo o consumo de electricidade.						
Eu, pessoalmente, não tenho disponibilidade financeira para contribuir mais para um melhor ambiente do que aquilo que já contribuo.						
Eu, pessoalmente, não tenho disponibilidade para dedicar mais do meu tempo para manter um ambiente melhor do que já dedico.						
Eu não sei de que forma posso colaborar mais do que já colaboro para manter um ambiente melhor.						

3. Compra habitualmente produtos amigos do ambiente (ou alguém no seu agregado o faz)?

☐ Sim ☐ Não

4. Já ouviu falar dos problemas ambientais que se encontram associados à utilização das energias provenientes dos combustíveis fósseis (como seja por exemplo o petróleo)?

☐ Sim ☐ Não

4.1. Se sim quais? (se considerar todos, por favor assinale apenas os três mais importantes na sua opinião)

- ☐ Acumulação de dióxido de carbono
- ☐ Alterações climáticas
- ☐ Poluição da água
- ☐ Perda de diversidade de espécies (animais e vegetais)
- ☐ Outros

5. Quais são as fontes de energia renováveis que conhece para produção de electricidade?

- ☐ Energia Eólica (do vento)
- ☐ Energia Fotovoltaica (solar)
- ☐ Biomassa (restos florestais)
- ☐ Energia Geotérmica (calor da terra)
- ☐ Energia Hídrica (barragens)
- ☐ Energia das Ondas
- ☐ Outras ___________

6. Qual a sua opinião relativamente a quão amigas do ambiente são estas fontes de energia? (Assinale com um X).

	Muito amiga	**Algo amiga**	**Indiferente**	**Algo não amiga**	**Não amiga**	**Não sabe**
Nuclear						
Hídrica (barragens)						
Carvão						
Gás natural						
Eólica (vento)						
Fotovoltaica (solar)						
Geotérmica (calor da terra)						
Biomassa (restos florestais)						
Fuel óleo (gasóleo)						
Energia das Ondas						

7. Alguma vez visitou uma das seguintes tecnologias de produção de energia renovável?

- ➔ Barragem ☐ Sim ☐ Não
- ➔ Parque eólico ☐ Sim ☐ Não
- ➔ Parque fotovoltaico ☐ Sim ☐ Não
- ➔ Central termoelétrica a biomassa ☐ Sim ☐ Não

8. Trabalha/trabalhou em alguma tecnologia de produção de electricidade através de fontes de energia renovável?

☐ Sim ☐ Não

8.1. Se **sim,** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

9. Conhece alguém que trabalha/trabalhou em alguma tecnologia de produção de electricidade através de fontes de energia renovável?

☐ Sim ☐ Não

9.1. Se **sim,** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

10. Quão importante é para si conhecer o tipo de energia renovável que se está a consumir na produção de electricidade (do vento, solar, hídrica, biomassa)? Numa escala de 0 a 5, em que **0 significa "sem opinião", 1 significa "não importante", 3 significa "importante" e 5 significa "muito importante".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. Qual o valor mensal (em média/aproximado) da sua conta de electricidade?

Valor_______________ não sei ______

12. Costuma observar pormenorizadamente a sua fatura da electricidade?

☐ Não, limito-me a pagar ☐ Apenas o valor ☐ Sim, observo todos os detalhes

Secção II: Questão de Valoração

A produção de eletricidade, em Portugal, é realizada a partir de várias fontes de energia. Neste estudo, damos especial atenção às fontes de energia renovável, tal como a energia eólica (vento), a energia hídrica (barragens), a energia fotovoltaica (solar) e a energia da biomassa (aproveitamento de restos florestais).

A **energia da biomassa** é considerada uma fonte de energia limpa, amiga do ambiente e sustentável. A esta não são apontadas desvantagens ambientais como a contribuição para o aquecimento global, embora liberte alguns gases para a atmosfera. No entanto, pode provocar alguns efeitos ambientais que podem causar-lhe algum incómodo.

Os impactos ambientais das **centrais termoeléctricas (biomassa de aproveitamento de restos florestais)** podem depender da sua localização, refletindo-se na paisagem, em alterações na fauna/flora e odores que podem ser incomodativos para a população da zona envolvente.

13. Conhece a instalação termoelétrica de aproveitamento de biomassa localizada aqui na zona?

☐ Sim ☐ Não

14. A instalação termoeléctrica de aproveitamento de biomassa localizada aqui na zona é vivível da sua residência, local de trabalho, ou nas suas deslocações diárias?

☐ Sim ☐ Não

15. Numa escala de 1 a 5, em que 1 significa "nada incomodado" e 5 "muito incomodado", como se sente face à presença da instalação termoelétrica a biomassa?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

16. Quais as razões pelas quais se sente mais incomodado, em que 1 significa "nada incomodado" e 5 "muito incomodado"?

	1	**2**	**3**	**4**	**5**
Ruído	☐	☐	☐	☐	☐
Fauna	☐	☐	☐	☐	☐
Flora	☐	☐	☐	☐	☐
Paisagem	☐	☐	☐	☐	☐
Odores	☐	☐	☐	☐	☐
Aumento do número de pessoas e do trânsito na zona	☐	☐	☐	☐	☐

Tendo em conta o seu rendimento e as suas despesas habituais, responda a seguinte questão:

17. Qual o montante mínimo que estaria disposto a receber como compensação pelos incómodos que a presença da central termoelétrica lhe causa. O montante seria abatido à sua conta de electricidade mensal.

Estaria disposto a receber? _______________ Euros por mês.

18. Numa escala de 0 a 10, onde 0 corresponde a "muito pouca certeza" e 10 a "certeza absoluta", diga com que grau de certeza estaria disposto a receber o montante indicado na resposta anterior.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

19. Se respondeu zero na questão 17, por favor indique (com uma cruz) quais das razões justificam melhor a sua resposta:

Não considero relevante os impactos causados pela central termoeléctrica a biomassa (não me afectam)	
Não acho que os impactos causados pela central termoeléctrica (biomassa) possam ser de alguma forma compensados pelo pagamento de uma quantia monetária	
A central termoeléctrica (biomassa) traz vantagens	
Não acredito que alguém esteja disposto a fazer esse desconto	

20. Como classificaria cada um dos impactos da produção de electricidade a partir de centrais termoeléctricas (biomassa) em geral, sendo que 1 corresponde a "muito negativo" e 5 a "muito positivo".

Impactos	Efeitos das Centrais Termoeléctricas (biomassa)					
	Muito negativo			Muito positivo		Não sei
	1	2	3	4	5	
Alteração da paisagem						
Alterações na fauna						
Alterações na flora						
Odor						
Ruído						
Custo de produção						

Secção III: Opinião sobre energias renováveis em geral

21. Considera que Portugal tem condições naturais para fazer um bom aproveitamento das energias renováveis na produção de electricidade?

☐ Sim ☐ Não

22. Acredita que as energias renováveis na produção de electricidade trazem benefícios para a população?

☐ Sim ☐ Não

22.1. Se **sim**, na sua opinião, quais dos seguintes benefícios considera serem mais importantes?

☐ É inesgotável à escala humana
☐ Não produz emissões perigosas ou de sólidos tóxicos
☐ Reduz a contribuição para as alterações climáticas globais
☐ Favorável ao emprego e criação de postos de trabalho
☐ Reduz a dependência energética externa da nossa economia

Secção IV: Questões sociodemográficas

23. Sexo: ☐ Feminino ☐ Masculino

24. Estado Civil**:**

☐ Casado(a)/União de facto
☐ Divorciado(a)
☐ Solteiro(a)
☐ Viúvo(a)

25. Idade: ____________

26. Situação perante o emprego:

☐ Desempregado(a)
☐ Doméstico(a)
☐ Estudante
☐ Reformado(a)
☐ Trabalhador(a) por conta própria
☐ Trabalhador(a) por conta de outrém

27. Habilitações escolares:

- ▢ 1.º, 2.º, 3.º ou 4.º ano (antiga instrução primária)
- ▢ 5.º ou 6.º ano (antigo ciclo preparatório)
- ▢ 7.º, 8.º ou 9.º ano (antigo 3.º, 4.º e 5.º ano liceal)
- ▢ 10.º, 11.º ou 12.º (antigo 6.º e 7.º ano liceal / ano propedêutico)
- ▢ Bacharelato ou Licenciatura
- ▢ Mestrado
- ▢ Doutoramento
- ▢ Outro

28. Rendimento mensal líquido do agregado familiar (em euros):

- ▢ Inferior a 250€
- ▢ Entre 251 e 500€
- ▢ Entre 501 e 750€
- ▢ Entre 751 e 1000€
- ▢ Entre 1001 e 1250€
- ▢ Entre 1251 e 1500€
- ▢ Entre 1501 e 1750€
- ▢ Entre 1751 e 2000€
- ▢ Entre 2001 e 2250€
- ▢ Entre 2251 e 2500€
- ▢ Entre 2501 e 2750€
- ▢ Entre 2751 e 3000€
- ▢ Entre 3001 e 3250€
- ▢ Entre 3251 e 3500€
- ▢ Entre 3501 e 3750€
- ▢ Entre 3751 e 4000€
- ▢ Entre 4001 e 4250€
- ▢ Entre 4251 e 4500€
- ▢ Entre 4501 e 4750€
- ▢ Entre 4751 e 5000€
- ▢ Mais de 5000€

29. Número de pessoas do agregado familiar:

Crianças (<12 anos)______ Jovens (12-18 anos)_______Adultos (>18 anos)_______

30. Qual o seu concelho de residência? _________________________

31. Qual a sua freguesia de residência? _________________________

32. Classifique o seu comportamento face ao risco, usando uma escala de 1 (absolutamente nada arriscados) a 9 (mais do que extremamente arriscados). (Assinale com um X).

	Absolutamente nada arriscados (1)	Nada arriscados (2)	Pouco arriscados (3)	Algo arriscados (4)	Moderadamente arriscados (5)	Arriscados (6)	Muito arriscados (7)	Extremamente arriscados (8)	Mais do que extremamente arriscados (9)
Em GERAL, diria que o seu comportamento e as decisões que toma são:									
Na sua ATIVIDADE PROFISSIONAL, diria que o seu comportamento e as decisões que toma são:									
Relativamente às suas FINANÇAS, diria que o seu comportamento e as decisões que toma são:									
Relativamente à sua SAÚDE, diria que o seu comportamento e as decisões que toma são:									

33. Use o espaço abaixo para deixar o seu comentário.

MUITO OBRIGADA PELA SUA COLABORAÇÃO!

II.2.2. CV Questionnaire on Wind Power

E

Caro(a) respondente,

Precisamos da sua colaboração num projeto de investigação conduzido por investigadores da Universidade do Minho. O seu principal objetivo é a valoração dos impactos ambientais associados a cada uma das diversas fontes de energia renováveis. O questionário que se segue é anónimo e confidencial. Agradecemos que responda com a maior sinceridade possível. **Note que não há boas ou más respostas. Importa-nos apenas saber a sua opinião.**

É muito importante que preencha o questionário até ao fim.

Secção I: Secção Introdutória

Nesta secção pretende-se ter uma ideia da sua familiaridade com as energias renováveis.

1. Quais são os problemas ambientais mais importantes em Portugal actualmente? (Indique apenas 3).

- ☐ Alterações climáticas
- ☐ Poluição atmosférica
- ☐ Poluição das águas (rios e oceano)
- ☐ Sobre-exploração dos recursos naturais
- ☐ Diminuição da biodiversidade (variedade de espécies animais e vegetais)
- ☐ Lixo
- ☐ Outros

2. Diga de que forma concorda com as seguintes afirmações (assinale com um x).

	Concorda totalmente	**Concorda parcialmente**	**Não concorda nem discorda**	**Discorda parcialmente**	**Discorda totalmente**	**Não sabe**
O governo deve atuar para diminuir a poluição através de leis específicas.						
É importante a electricidade ter um preço baixo.						
Devemos reduzir a poluição ambiental e outros impactos ambientais causados pela produção de electricidade.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas formas de produção.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas fontes de energia mais amigas do ambiente e renováveis.						
As pessoas em geral podem fazer muito para melhorar o meio ambiente, por exemplo diminuindo o consumo de electricidade.						
Eu, pessoalmente, não tenho disponibilidade financeira para contribuir mais para um melhor ambiente do que aquilo que já contribuo.						
Eu, pessoalmente, não tenho disponibilidade para dedicar mais do meu tempo para manter um ambiente melhor do que já dedico.						
Eu não sei de que forma posso colaborar mais do que já colaboro para manter um ambiente melhor.						

3. Compra habitualmente produtos amigos do ambiente (ou alguém no seu agregado o faz)?

☐ Sim ☐ Não

4. Já ouviu falar dos problemas ambientais que se encontram associados à utilização das energias provenientes dos combustíveis fósseis (como seja por exemplo o petróleo)?

☐ Sim ☐ Não

4.1. Se sim quais? (se considerar todos, por favor assinale apenas os três mais importantes na sua opinião)

☐ Acumulação de dióxido de carbono
☐ Alterações climáticas
☐ Poluição da água
☐ Perda de diversidade de espécies (animais e vegetais)
☐ Outros

5. Quais são as fontes de energia renováveis que conhece para produção de electricidade?

☐ Energia Eólica (do vento)
☐ Energia Fotovoltaica (solar)
☐ Biomassa (restos florestais)
☐ Energia Geotérmica (calor da terra)
☐ Energia Hídrica (barragens)
☐ Energia das Ondas
☐ Outras ____________

6. Qual a sua opinião relativamente a quão amigas do ambiente são estas fontes de energia para produção de electricidade? (Assinale com um X).

	Muito amiga	**Algo amiga**	**Indiferente**	**Algo não amiga**	**Não amiga**	**Não sabe**
Nuclear						
Hídrica (barragens)						
Carvão						
Gás natural						
Eólica (vento)						
Fotovoltaica (solar)						
Geotérmica (calor da terra)						
Biomassa (restos florestais)						
Fuel óleo (gasóleo)						
Energia das Ondas						

7. Alguma vez visitou uma das seguintes tecnologias de produção de energia renovável?

➔ Barragem ☐ Sim ☐ Não
➔ Parque eólico ☐ Sim ☐ Não
➔ Parque fotovoltaico ☐ Sim ☐ Não
➔ Central termoelétrica a biomassa ☐ Sim ☐ Não

8. Trabalha/trabalhou em alguma tecnologia de produção de electricidade através de fontes de energia renovável?

☐ Sim ☐ Não

8.1. Se **sim,** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

9. Conhece alguém que trabalha/trabalhou em alguma tecnologia de produção de electricidade através de fontes de energia renovável?

☐ Sim ☐ Não

9.1. Se **sim,** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

10. Quão importante é para si conhecer o tipo de energia renovável que se está a consumir na produção de electricidade (do vento, solar, hídrica, biomassa)? Numa escala de 0 a 5, em que **0 significa "sem opinião", 1 significa "não importante", 3 significa "importante" e 5 significa "muito importante".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. Qual o valor mensal (em média/aproximado) da sua conta de electricidade?

Valor_______________ não sei ______

12. Costuma observar pormenorizadamente a sua fatura da electricidade?

☐ Não, limito-me a pagar ☐ Apenas o valor ☐ Sim, observo todos os detalhes

Secção II: Questão de Valoração

A produção de eletricidade, em Portugal, é realizada a partir de várias fontes de energia. Neste estudo, damos especial atenção às fontes de energia renovável, tal como a energia eólica (vento), a energia hídrica (barragens), a energia fotovoltaica (solar) e a energia da biomassa (aproveitamento de restos florestais).

A **energia eólica** é considerada uma fonte de energia limpa, amiga do ambiente e sustentável. A esta não são apontadas desvantagens ambientais como a contribuição para o aquecimento global. No entanto, pode provocar alguns efeitos ambientais que podem causar-lhe algum incómodo.

Os impactos ambientais dos **parques eólicos** podem depender da sua localização, refletindo-se na paisagem, em alterações na fauna/flora e na produção de ruído que pode ser incomodativo e afectar a população da zona envolvente.

13. Conhece o parque eólico localizado aqui na zona?

☐ Sim ☐ Não

14. O parque eólico localizado aqui na zona é visível da sua residência, local de trabalho, ou nas suas deslocações diárias?

☐ Sim ☐ Não

15. Numa escala de 1 a 5, em que 1 significa "nada incomodado" e 5 "muito incomodado", como se sente face à presença do parque eólico?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

16. Quais as razões pelas quais se sente mais incomodado, em que 1 significa "nada incomodado" e 5 "muito incomodado"?

	1	**2**	**3**	**4**	**5**
Ruído	☐	☐	☐	☐	☐
Fauna	☐	☐	☐	☐	☐
Flora	☐	☐	☐	☐	☐
Paisagem	☐	☐	☐	☐	☐
Aumento do número de pessoas e do trânsito na zona	☐	☐	☐	☐	☐
Novos acessos ao local	☐	☐	☐	☐	☐

<u>Tendo em conta o seu rendimento e as suas despesas habituais, responda a seguinte questão</u>:

17. Qual o montante mínimo que estaria disposto a receber como compensação pelos incómodos que a presença do parque eólico lhe causa. O montante seria abatido à sua conta de electricidade mensal.

Estaria disposto a receber? _______________ Euros por mês.

18. Numa escala de 0 a 10, onde 0 corresponde a "muito pouca certeza" e 10 a "certeza absoluta", diga com que grau de certeza estaria disposto a receber o montante indicado na resposta anterior.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

19. Se respondeu zero na questão 17, por favor indique (com uma cruz) quais das razões justificam melhor a sua resposta:

Não considero relevante os impactos causados pelo parque eólico (não me afectam)	
Não acho que os impactos causados pelo parque eólico possam ser de alguma forma compensados pelo pagamento de uma quantia monetária	
O parque eólico traz vantagens	
Não acredito que alguém esteja disposto a fazer esse desconto	

20. Como classificaria cada um dos impactos da produção de electricidade a partir de energia eólica (vento) em geral, sendo que 1 corresponde a "muito negativo" e 5 a "muito positivo".

Impactos	**Efeitos dos Parques Eólicos**					
	Muito negativo			**Muito positivo**		**Não sei**
	1	**2**	**3**	**4**	**5**	
Alteração da paisagem						
Alterações na fauna						
Alterações na flora						
Ruído						
Custo de produção						

Secção III: Opinião sobre energias renováveis em geral

21. Considera que Portugal tem condições naturais para fazer um bom aproveitamento das energias renováveis na produção de electricidade?

☐ Sim ☐ Não

22. Acredita que as energias renováveis na produção de electricidade trazem benefícios para a população?

☐ Sim ☐ Não

22.1. Se **sim**, na sua opinião, quais dos seguintes benefícios considera serem mais importantes?

☐ É inesgotável à escala humana
☐ Não produz emissões perigosas ou de sólidos tóxicos
☐ Reduz a contribuição para as alterações climáticas globais
☐ Favorável ao emprego e criação de postos de trabalho
☐ Reduz a dependência energética externa da nossa economia

Secção IV: Questões sociodemográficas

23. Sexo: ☐ Feminino ☐ Masculino

24. Estado Civil**:**

☐ Casado(a)/União de facto
☐ Divorciado(a)
☐ Solteiro(a)
☐ Viúvo(a)

25. Idade: ____________

26. Situação perante o emprego:

☐ Desempregado(a)
☐ Doméstico(a)
☐ Estudante
☐ Reformado(a)
☐ Trabalhador(a) por conta própria
☐ Trabalhador(a) por conta de outrém

27. Habilitações escolares:

- ▢ 1.º, 2.º, 3.º ou 4.º ano (antiga instrução primária)
- ▢ 5.º ou 6.º ano (antigo ciclo preparatório)
- ▢ 7.º, 8.º ou 9.º ano (antigo 3.º, 4.º e 5.º ano liceal)
- ▢ 10.º, 11.º ou 12.º (antigo 6.º e 7.º ano liceal / ano propedêutico)
- ▢ Bacharelato ou Licenciatura
- ▢ Mestrado
- ▢ Doutoramento
- ▢ Outro

28. Rendimento mensal líquido do agregado familiar (em euros):

- ▢ Inferior a 250€
- ▢ Entre 251 e 500€
- ▢ Entre 501 e 750€
- ▢ Entre 751 e 1000€
- ▢ Entre 1001 e 1250€
- ▢ Entre 1251 e 1500€
- ▢ Entre 1501 e 1750€
- ▢ Entre 1751 e 2000€
- ▢ Entre 2001 e 2250€
- ▢ Entre 2251 e 2500€
- ▢ Entre 2501 e 2750€
- ▢ Entre 2751 e 3000€
- ▢ Entre 3001 e 3250€
- ▢ Entre 3251 e 3500€
- ▢ Entre 3501 e 3750€
- ▢ Entre 3751 e 4000€
- ▢ Entre 4001 e 4250€
- ▢ Entre 4251 e 4500€
- ▢ Entre 4501 e 4750€
- ▢ Entre 4751 e 5000€
- ▢ Mais de 5000€

29. Número de pessoas do agregado familiar:

Crianças (<12 anos) ______ Jovens (12-18 anos) ______ Adultos (>18 anos) ______

30. Qual o seu concelho de residência? _________________________

31. Qual a sua freguesia de residência? _________________________

32. Classifique o seu comportamento face ao risco, usando uma escala de 1 (absolutamente nada arriscados) a 9 (mais do que extremamente arriscados). (Assinale com um X).

	Absolutamente nada arriscados (1)	Nada arriscados (2)	Pouco arriscados (3)	Algo arriscados (4)	Moderadamente arriscados (5)	Arriscados (6)	Muito arriscados (7)	Extremamente arriscados (8)	Mais do que extremamente arriscados (9)
Em GERAL, diria que o seu comportamento e as decisões que toma são:									
Na sua ATIVIDADE PROFISSIONAL, diria que o seu comportamento e as decisões que toma são:									
Relativamente às suas FINANÇAS, diria que o seu comportamento e as decisões que toma são:									
Relativamente à sua SAÚDE, diria que o seu comportamento e as decisões que toma são:									

33. Use o espaço abaixo para deixar o seu comentário.

MUITO OBRIGADA PELA SUA COLABORAÇÃO!

II.2.3. CV Questionnaire on Photovoltaic Power

F

Caro(a) respondente,

Precisamos da sua colaboração num projeto de investigação conduzido por investigadores da Universidade do Minho. O seu principal objetivo é a valoração dos impactos ambientais associados a cada uma das diversas fontes de energia renováveis. O questionário que se segue é anónimo e confidencial. Agradecemos que responda com a maior sinceridade possível. **Note que não há boas ou más respostas. Importa-nos apenas saber a sua opinião.**

É muito importante que preencha o questionário até ao fim.

Secção I: Secção Introdutória

Nesta secção pretende-se ter uma ideia da sua familiaridade com as energias renováveis.

1. Quais são os problemas ambientais mais importantes em Portugal actualmente? (Indique apenas 3).

- ☐ Alterações climáticas
- ☐ Poluição atmosférica
- ☐ Poluição das águas (rios e oceano)
- ☐ Sobre-exploração dos recursos naturais
- ☐ Diminuição da biodiversidade (variedade de espécies animais e vegetais)
- ☐ Lixo
- ☐ Outros

2. Diga de que forma concorda com as seguintes afirmações (assinale com um x).

	Concorda totalmente	**Concorda parcialmente**	**Não concorda nem discorda**	**Discorda parcialmente**	**Discorda totalmente**	**Não sabe**
O governo deve atuar para diminuir a poluição através de leis específicas.						
É importante a electricidade ter um preço baixo.						
Devemos reduzir a poluição ambiental e outros impactos ambientais causados pela produção de electricidade.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas formas de produção.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas fontes de energia mais amigas do ambiente e renováveis.						
As pessoas em geral podem fazer muito para melhorar o meio ambiente, por exemplo diminuindo o consumo de electricidade.						
Eu, pessoalmente, não tenho disponibilidade financeira para contribuir mais para um melhor ambiente do que aquilo que já contribuo.						
Eu, pessoalmente, não tenho disponibilidade para dedicar mais do meu tempo para manter um ambiente melhor do que já dedico.						
Eu não sei de que forma posso colaborar mais do que já colaboro para manter um ambiente melhor.						

3. Compra habitualmente produtos amigos do ambiente (ou alguém no seu agregado o faz)?

☐ Sim ☐ Não

4. Já ouviu falar dos problemas ambientais que se encontram associados à utilização das energias provenientes dos combustíveis fósseis (como seja por exemplo o petróleo)?

☐ Sim ☐ Não

4.1. Se sim quais? (se considerar todos, por favor assinale apenas os três mais importantes na sua opinião)

- ☐ Acumulação de dióxido de carbono
- ☐ Alterações climáticas
- ☐ Poluição da água
- ☐ Perda de diversidade de espécies (animais e vegetais)
- ☐ Outros

5. Quais são as fontes de energia renováveis que conhece para produção de electricidade?

- ☐ Energia Eólica (do vento)
- ☐ Energia Fotovoltaica (solar)
- ☐ Biomassa (restos florestais)
- ☐ Energia Geotérmica (calor da terra)
- ☐ Energia Hídrica (barragens)
- ☐ Energia das Ondas
- ☐ Outras ____________

6. Qual a sua opinião relativamente a quão amigas do ambiente são estas fontes de energia para produção de electricidade? (Assinale com um X).

	Muito amiga	**Algo amiga**	**Indiferente**	**Algo não amiga**	**Não amiga**	**Não sabe**
Nuclear						
Hídrica (barragens)						
Carvão						
Gás natural						
Eólica (vento)						
Fotovoltaica (solar)						
Geotérmica (calor da terra)						
Biomassa (restos florestais)						
Fuel óleo (gasóleo)						
Energia das Ondas						

7. Alguma vez visitou uma das seguintes tecnologias de produção de energia renovável?

- ➔ Barragem ☐ Sim ☐ Não
- ➔ Parque eólico ☐ Sim ☐ Não
- ➔ Parque fotovoltaico ☐ Sim ☐ Não
- ➔ Central termoelétrica a biomassa ☐ Sim ☐ Não

8. Trabalha/trabalhou em alguma tecnologia de produção de electricidade através de fontes de energia renovável?

☐ Sim ☐ Não

8.1. Se **sim,** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

9. Conhece alguém que trabalha/trabalhou em alguma tecnologia de produção de electricidade através de fontes de energia renovável?

☐ Sim ☐ Não

9.1 Se **sim,** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

10. Quão importante é para si conhecer o tipo de energia renovável que se está a consumir na produção de electricidade (do vento, solar, hídrica, biomassa)? Numa escala de 0 a 5, em que **0 significa "sem opinião", 1 significa "não importante", 3 significa "importante" e 5 significa "muito importante".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. Qual o valor mensal (em média/aproximado) da sua conta de electricidade?

Valor_______________ não sei ______

12. Costuma observar pormenorizadamente a sua fatura da electricidade?

☐ Não, limito-me a pagar ☐ Apenas o valor ☐ Sim, observo todos os detalhes

Secção II: Questão de Valoração

A produção de eletricidade, em Portugal, é realizada a partir de várias fontes de energia. Neste estudo, damos especial atenção às fontes de energia renovável, tal como a energia eólica (vento), a energia hídrica (barragens), a energia fotovoltaica (solar) e a energia da biomassa (aproveitamento de restos florestais).

A **energia solar** é considerada uma fonte de energia limpa, amiga do ambiente e sustentável. A esta não são apontadas desvantagens ambientais como a contribuição para o aquecimento global. No entanto, pode provocar alguns efeitos ambientais que podem causar-lhe algum incómodo.

Os impactos ambientais dos **parques fotovoltaicos** podem depender da sua localização, refletindo-se na paisagem, em alterações na fauna/flora e na produção de reflexos de luz que pode ser incomodativo e afectar a população da zona envolvente.

13. Conhece o parque fotovoltaico localizado aqui na zona?

☐ Sim ☐ Não

14. O parque fotovoltaico localizado aqui na zona é visível da sua residência, local de trabalho, ou nas suas deslocações diárias?

☐ Sim ☐ Não

15. Numa escala de 1 a 5, em que 1 significa "nada incomodado" e 5 "muito incomodado", como se sente face à presença do parque fotovoltaico?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

16. Quais as razões pelas quais se sente mais incomodado, em que 1 significa "nada incomodado" e 5 "muito incomodado"?

	1	**2**	**3**	**4**	**5**
Reflexos da luz	☐	☐	☐	☐	☐
Fauna	☐	☐	☐	☐	☐
Flora	☐	☐	☐	☐	☐
Paisagem	☐	☐	☐	☐	☐
Aumento do número de pessoas e do trânsito na zona	☐	☐	☐	☐	☐

Tendo em conta o seu rendimento e as suas despesas habituais, responda a seguinte questão:

17. Qual o montante mínimo que estaria disposto a receber como compensação pelos incómodos que a presença do parque fotovoltaico lhe causa. O montante seria abatido à sua conta de electricidade mensal.

Estaria disposto a receber? _______________ Euros por mês.

18. Numa escala de 0 a 10, onde 0 corresponde a "muito pouca certeza" e 10 a "certeza absoluta", diga com que grau de certeza estaria disposto a receber o montante indicado na resposta anterior.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

19. Se respondeu zero na questão 17, por favor indique (com uma cruz) quais das razões justificam melhor a sua resposta:

Não considero relevante os impactos causados pelo parque fotovoltaico (não me afectam)	
Não acho que os impactos causados pelo parque fotovoltaico possam ser de alguma forma compensados pelo pagamento de uma quantia monetária	
O parque fotovoltaico traz vantagens	
Não acredito que alguém esteja disposto a fazer esse desconto	

20. Como classificaria cada um dos impactos da produção de electricidade a partir de energia fotovoltaica (parque de painéis fotovoltaicos) em geral, sendo que 1 corresponde a "muito negativo" e 5 a "muito positivo".

Impactos	Efeitos dos Parques Fotovoltaicos					
	Muito negativo			Muito positivo		Não sei
	1	2	3	4	5	
Alteração da paisagem						
Alterações na fauna						
Alterações na flora						
Reflexo de luz						
Custo de produção						

Secção III: Opinião sobre energias renováveis em geral

21. Considera que Portugal tem condições naturais para fazer um bom aproveitamento das energias renováveis na produção de electricidade?

☐ Sim ☐ Não

22. Acredita que as energias renováveis na produção de electricidade trazem benefícios para a população?

☐ Sim ☐ Não

22.1. Se **sim**, na sua opinião, quais dos seguintes benefícios considera serem mais importantes?

- ☐ É inesgotável à escala humana
- ☐ Não produz emissões perigosas ou de sólidos tóxicos
- ☐ Reduz a contribuição para as alterações climáticas globais
- ☐ Favorável ao emprego e criação de postos de trabalho
- ☐ Reduz a dependência energética externa da nossa economia

Secção IV: Questões sociodemográficas

23. Sexo: ☐ Feminino ☐ Masculino

24. Estado Civil**:**

- ☐ Casado(a)/União de facto
- ☐ Divorciado(a)
- ☐ Solteiro(a)
- ☐ Viúvo(a)

25. Idade: ____________

26. Situação perante o emprego:

- ☐ Desempregado(a)
- ☐ Doméstico(a)
- ☐ Estudante
- ☐ Reformado(a)
- ☐ Trabalhador(a) por conta própria
- ☐ Trabalhador(a) por conta de outrém

27. Habilitações escolares:

- ▢ 1.º, 2.º, 3.º ou 4.º ano (antiga instrução primária)
- ▢ 5.º ou 6.º ano (antigo ciclo preparatório)
- ▢ 7.º, 8.º ou 9.º ano (antigo 3.º, 4.º e 5.º ano liceal)
- ▢ 10.º, 11.º ou 12.º (antigo 6.º e 7.º ano liceal / ano propedêutico)
- ▢ Bacharelato ou Licenciatura
- ▢ Mestrado
- ▢ Doutoramento
- ▢ Outro

28. Rendimento mensal líquido do agregado familiar (em euros):

- ▢ Inferior a 250€
- ▢ Entre 251 e 500€
- ▢ Entre 501 e 750€
- ▢ Entre 751 e 1000€
- ▢ Entre 1001 e 1250€
- ▢ Entre 1251 e 1500€
- ▢ Entre 1501 e 1750€
- ▢ Entre 1751 e 2000€
- ▢ Entre 2001 e 2250€
- ▢ Entre 2251 e 2500€
- ▢ Entre 2501 e 2750€
- ▢ Entre 2751 e 3000€
- ▢ Entre 3001 e 3250€
- ▢ Entre 3251 e 3500€
- ▢ Entre 3501 e 3750€
- ▢ Entre 3751 e 4000€
- ▢ Entre 4001 e 4250€
- ▢ Entre 4251 e 4500€
- ▢ Entre 4501 e 4750€
- ▢ Entre 4751 e 5000€
- ▢ Mais de 5000€

29. Número de pessoas do agregado familiar:

Crianças (<12 anos)______ Jovens (12-18 anos)______Adultos (>18 anos)______

30. Qual o seu concelho de residência? _________________________

31. Qual a sua freguesia de residência? _________________________

32. Classifique o seu comportamento face ao risco, usando uma escala de 1 (absolutamente nada arriscados) a 9 (mais do que extremamente arriscados). (Assinale com um X).

	Absolutamente nada arriscados (1)	Nada arriscados (2)	Pouco arriscados (3)	Algo arriscados (4)	Moderadamente arriscados (5)	Arriscados (6)	Muito arriscados (7)	Extremamente arriscados (8)	Mais do que extremamente arriscados (9)
<u>Em GERAL</u>, diria que o seu comportamento e as decisões que toma são:									
<u>Na sua ATIVIDADE PROFISSIONAL</u>, diria que o seu comportamento e as decisões que toma são:									
<u>Relativamente às suas FINANÇAS</u>, diria que o seu comportamento e as decisões que toma são:									
<u>Relativamente à sua SAÚDE</u>, diria que o seu comportamento e as decisões que toma são:									

33. Use o espaço abaixo para deixar o seu comentário.

MUITO OBRIGADA PELA SUA COLABORAÇÃO!

II.2.4. CV Questionnaire on Hydropower

H

Caro(a) respondente,

Precisamos da sua colaboração num projeto de investigação conduzido por investigadores da Universidade do Minho. O seu principal objetivo é a valoração dos impactos ambientais associados a cada uma das diversas fontes de energia renováveis. O questionário que se segue é anónimo e confidencial. Agradecemos que responda com a maior sinceridade possível. **Note que não há boas ou más respostas. Importa-nos apenas saber a sua opinião.**

É muito importante que preencha o questionário até ao fim.

Secção I: Secção Introdutória

Nesta secção pretende-se ter uma ideia da sua familiaridade com as energias renováveis.

1. Quais são os problemas ambientais mais importantes em Portugal actualmente? (Indique apenas 3).

- ☐ Alterações climáticas
- ☐ Poluição atmosférica
- ☐ Poluição das águas (rios e oceano)
- ☐ Sobre-exploração dos recursos naturais
- ☐ Diminuição da biodiversidade (variedade de espécies animais e vegetais)
- ☐ Lixo
- ☐ Outros

2. Diga de que forma concorda com as seguintes afirmações (assinale com um x).

	Concorda totalmente	**Concorda parcialmente**	**Não concorda nem discorda**	**Discorda parcialmente**	**Discorda totalmente**	**Não sabe**
O governo deve atuar para diminuir a poluição através de leis específicas.						
É importante a electricidade ter um preço baixo.						
Devemos reduzir a poluição ambiental e outros impactos ambientais causados pela produção de electricidade.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas formas de produção.						
O governo deveria ajudar a reduzir os custos de produção de electricidade financiando novas fontes de energia mais amigas do ambiente e renováveis.						
As pessoas em geral podem fazer muito para melhorar o meio ambiente, por exemplo diminuindo o consumo de electricidade.						
Eu, pessoalmente, não tenho disponibilidade financeira para contribuir mais para um melhor ambiente do que aquilo que já contribuo.						
Eu, pessoalmente, não tenho disponibilidade para dedicar mais do meu tempo para manter um ambiente melhor do que já dedico.						
Eu não sei de que forma posso colaborar mais do que já colaboro para manter um ambiente melhor.						

3. Compra habitualmente produtos amigos do ambiente (ou alguém no seu agregado o faz)?

☐ Sim ☐ Não

4. Já ouviu falar dos problemas ambientais que se encontram associados à utilização das energias provenientes dos combustíveis fósseis (como seja por exemplo o petróleo)?

☐ Sim ☐ Não

4.1. Se sim quais? (se considerar todos, por favor assinale apenas os três mais importantes na sua opinião)

☐ Acumulação de dióxido de carbono
☐ Alterações climáticas
☐ Poluição da água
☐ Perda de diversidade de espécies (animais e vegetais)
☐ Outros

5. Quais são as fontes de energia renováveis que conhece para produção de electricidade?

☐ Energia Eólica (do vento)
☐ Energia Fotovoltaica (solar)
☐ Biomassa (restos florestais)
☐ Energia Geotérmica (calor da terra)
☐ Energia Hídrica (barragens)
☐ Energia das Ondas
☐ Outras ____________

6. Qual a sua opinião relativamente a quão amigas do ambiente são estas fontes de energia para produção de electricidade? (Assinale com um X).

	Muito amiga	**Algo amiga**	**Indiferente**	**Algo não amiga**	**Não amiga**	**Não sabe**
Nuclear						
Hídrica (barragens)						
Carvão						
Gás natural						
Eólica (vento)						
Fotovoltaica (solar)						
Geotérmica (calor da terra)						
Biomassa (restos florestais)						
Fuel óleo (gasóleo)						
Energia das Ondas						

7. Alguma vez visitou uma das seguintes tecnologias de produção de energia renovável?

➔ Barragem ☐ Sim ☐ Não
➔ Parque eólico ☐ Sim ☐ Não
➔ Parque fotovoltaico ☐ Sim ☐ Não
➔ Central termoelétrica a biomassa ☐ Sim ☐ Não

8. Trabalha/trabalhou em alguma tecnologia de produção de electricidade através de fontes de energia renovável?

☐ Sim ☐ Não

8.1. Se **sim,** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

9. Conhece alguém que trabalha/trabalhou em alguma tecnologia de produção de electricidade através de fontes de energia renovável?

☐ Sim ☐ Não

9.1. Se **sim,** especifique em qual/quais:

☐ Parque eólico (vento)
☐ Parque fotovoltaico (solar)
☐ Barragem
☐ Central termoelétrica (biomassa)

10. Quão importante é para si conhecer o tipo de energia renovável que se está a consumir na produção de electricidade (do vento, solar, hídrica, biomassa)? Numa escala de 0 a 5, em que **0 significa "sem opinião", 1 significa "não importante", 3 significa "importante" e 5 significa "muito importante".**

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. Qual o valor mensal (em média/aproximado) da sua conta de electricidade?

Valor_______________ não sei ______

12. Costuma observar pormenorizadamente a sua fatura da electricidade?

☐ Não, limito-me a pagar ☐ Apenas o valor ☐ Sim, observo todos os detalhes

Secção II: Questão de Valoração

A produção de eletricidade, em Portugal, é realizada a partir de várias fontes de energia. Neste estudo, damos especial atenção às fontes de energia renovável, tal como a energia eólica (vento), a energia hídrica (barragens), a energia fotovoltaica (solar) e a energia da biomassa (aproveitamento de restos florestais).

A **energia hídrica** é considerada uma fonte de energia limpa, amiga do ambiente e sustentável. A esta não são apontadas desvantagens ambientais como a contribuição para o aquecimento global. No entanto, pode provocar alguns efeitos ambientais que podem causar-lhe algum incómodo.

Os impactos ambientais das **barragens** podem depender da sua localização, refletindo-se na paisagem, em alterações na fauna/flora, na produção de ruído que pode ser incomodativo e afectar a população da zona envolvente e na destruição de património (nomeadamente habitações, capelas e construções dos nossos antepassados).

13. Conhece a barragem localizada/em construção/ a construir aqui na zona?

☐ Sim ☐ Não

14. A barragem localizada/em construção aqui na zona é visível da sua residência, local de trabalho, ou nas suas deslocações diárias?

☐ Sim ☐ Não

15. Numa escala de 1 a 5, em que 1 significa "nada incomodado" e 5 "muito incomodado", como se sente face à presença/futura presença da barragem?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

16. Quais as razões pelas quais se sente mais incomodado, ou se espera vir a sentir mais incomodado, em que 1 significa "nada incomodado" e 5 "muito incomodado"?

	1	**2**	**3**	**4**	**5**
Ruído	☐	☐	☐	☐	☐
Paisagem	☐	☐	☐	☐	☐
Destruição de património	☐	☐	☐	☐	☐
Destruição de propriedade própria ou da família	☐	☐	☐	☐	☐
Fauna	☐	☐	☐	☐	☐
Flora	☐	☐	☐	☐	☐
Aumento do número de pessoas e trânsito na zona	☐	☐	☐	☐	☐

Tendo em conta o seu rendimento e as suas despesas habituais, responda a seguinte questão:

17. Qual o montante mínimo que estaria disposto a receber como compensação pelos incómodos que a presença da barragem lhe causa, ou espera que lhe venha a causar. O montante seria abatido à sua conta de electricidade mensal.

Estaria disposto a receber? _______________ Euros por mês.

18. Numa escala de 0 a 10, onde 0 corresponde a "muito pouca certeza" e 10 a "certeza absoluta", diga com que grau de certeza estaria disposto a receber o montante indicado na resposta anterior.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

19. Se respondeu zero na questão 17, por favor indique (com uma cruz) quais das razões justificam melhor a sua resposta:

Não considero relevante os impactos causados pela barragem (não me afectam)	
Não acho que os impactos causados pela barragem possam ser de alguma forma compensados pelo pagamento de uma quantia monetária	
A barragem traz vantagens	
Não acredito que alguém esteja disposto a fazer esse desconto	

20. Como classificaria cada um dos impactos da produção de electricidade a partir de energia hídrica (barragens) em geral, sendo que 1 corresponde a "muito negativo" e 5 a "muito positivo".

Impactos	**Efeitos das Barragens**					
	Muito negativo			**Muito positivo**		**Não sei**
	1	**2**	**3**	**4**	**5**	
Alteração da paisagem						
Alterações na fauna						
Alterações na flora						
Ruído						
Destruição de património						
Custo de produção						

Secção III: Opinião sobre energias renováveis em geral

21. Considera que Portugal tem condições naturais para fazer um bom aproveitamento das energias renováveis na produção de electricidade?

☐ Sim ☐ Não

22. Acredita que as energias renováveis na produção de electricidade trazem benefícios para a população?

☐ Sim ☐ Não

22.1. Se **sim**, na sua opinião, quais dos seguintes benefícios considera serem mais importantes?

☐ É inesgotável à escala humana
☐ Não produz emissões perigosas ou de sólidos tóxicos
☐ Reduz a contribuição para as alterações climáticas globais
☐ Favorável ao emprego e criação de postos de trabalho
☐ Reduz a dependência energética externa da nossa economia

Secção IV: Questões sociodemográficas

23. Sexo: ☐ Feminino ☐ Masculino

24. Estado Civil**:**

☐ Casado(a)/União de facto
☐ Divorciado(a)
☐ Solteiro(a)
☐ Viúvo(a)

25. Idade: ____________

26. Situação perante o emprego:

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☐ Reformado(a)
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☐ Trabalhador(a) por conta de outrém

27. Habilitações escolares:

- ▢ 1.º, 2.º, 3.º ou 4.º ano (antiga instrução primária)
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- ▢ 7.º, 8.º ou 9.º ano (antigo 3.º, 4.º e 5.º ano liceal)
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- ▢ Bacharelato ou Licenciatura
- ▢ Mestrado
- ▢ Doutoramento
- ▢ Outro

28. Rendimento mensal líquido do agregado familiar (em euros):

- ▢ Inferior a 250€
- ▢ Entre 251 e 500€
- ▢ Entre 501 e 750€
- ▢ Entre 751 e 1000€
- ▢ Entre 1001 e 1250€
- ▢ Entre 1251 e 1500€
- ▢ Entre 1501 e 1750€
- ▢ Entre 1751 e 2000€
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- ▢ Entre 2251 e 2500€
- ▢ Entre 2501 e 2750€
- ▢ Entre 2751 e 3000€
- ▢ Entre 3001 e 3250€
- ▢ Entre 3251 e 3500€
- ▢ Entre 3501 e 3750€
- ▢ Entre 3751 e 4000€
- ▢ Entre 4001 e 4250€
- ▢ Entre 4251 e 4500€
- ▢ Entre 4501 e 4750€
- ▢ Entre 4751 e 5000€
- ▢ Mais de 5000€

29. Número de pessoas do agregado familiar:

Crianças (<12 anos)______ Jovens (12-18 anos)______ Adultos (>18 anos)______

30. Qual o seu concelho de residência? _________________________

31. Qual a sua freguesia de residência? _________________________

32. Classifique o seu comportamento face ao risco, usando uma escala de 1 (absolutamente nada arriscados) a 9 (mais do que extremamente arriscados). (Assinale com um X).

	Absolutamente nada arriscados (1)	Nada arriscados (2)	Pouco arriscados (3)	Algo arriscados (4)	Moderadamente arriscados (5)	Arriscados (6)	Muito arriscados (7)	Extremamente arriscados (8)	Mais do que extremamente arriscados (9)
Em GERAL, diria que o seu comportamento e as decisões que toma são:									
Na sua ATIVIDADE PROFISSIONAL, diria que o seu comportamento e as decisões que toma são:									
Relativamente às suas FINANÇAS, diria que o seu comportamento e as decisões que toma são:									
Relativamente à sua SAÚDE, diria que o seu comportamento e as decisões que toma são:									

33. Use o espaço abaixo para deixar o seu comentário.

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