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Preface

Between February 4 and 5, 2016, The Lisbon Superior Engineering Institute (ISEL) held the 1st Energy Economics Iberian Conference (EEIC 2016), organized by the Portuguese Association of Energy Economics (APEEN) in close collaboration with the Spanish Association of Energy Economics (AEEE), the Lisbon Superior Engineering Institute (ISEL) and the Research Unit in Governance, Competitiveness and Public Policies (GOVCOPP) of the University of Aveiro.

The EEIC 2016 scientific committee received 90 papers for the reviewing process, from which 73 were accepted for oral presentation in 18 parallel scientific sessions at the conference. Moreover, six work in progress presentations were made in two workshops. The parallel scientific sessions and the workshops covered a wide variety of topics in energy economics, including energy and climate policies, carbon markets, modeling simulation and forecasting, regulation and competition laws.

Besides the parallel scientific sessions and the workshops, the EEIC 2016 hosted three presentations from outstanding keynote speakers. In the first day of the conference, Pierre Dechamps from the European Commission talked about “Credible and Feasible decarbonisation pathways towards 2050”. In the second day, the keynote presentations were carried out by Reinhard Madlener from RWTH Aachen University, which presented “High shares of renewable energy sources and needs for electricity market reform”, and by Karen Turner from the University of Strathclyde with a presentation on “Beyond direct rebound: too complex a story for a single measure”. The EEIC 2016 also hosted a roundtable where representatives of the major Iberian utilities presented their viewpoints regarding recent developments, in particular oil price evolution, the Paris agreement and the EU energy union, and their impact upon the Iberian energy market.

The EEIC 2016 was a premier forum for the exchange of ideas and to discuss the development of the energy markets in the Iberian Peninsula, in Europe and throughout the world. The EEIC 2016 strengthened ties among the 155 participants, from 17 countries, of the academia, industry, regulators, competition authorities and policy makers.

For the success of the EEIC 2016 have also contributed our sponsors: EDP, REN, Siemens and GALP Energia.

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A survey on public perceptions of environmental impacts of renewable energy power plants

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SESSION: "Scientific session"

ABSTRACT

The demanding EU target regarding the share of renewables in primary energy consumption poses challenges to European governments regarding the choice of renewable energy sources and the sitting decisions of new power plants. Environmental impacts of renewable energy power plants are mostly negative for residents in the vicinity of power plants (e.g. noise, glare or visual annoyance). Nevertheless, impacts such as those on landscapes and on the fauna and flora may also affect the value that the general public attributes to renewables. Several authors have focused on the question of land availability for sitting large-scale power plants, and on the social acceptability of renewable power plants in general, and have emphasized the importance of the relationship between social acceptability and distance to power plants. This paper proposes to analyze how the perceptions of the general Portuguese population regarding the environmental friendliness of renewable and non-renewable energy power plants is affected by home location in relation to the power plant, visibility of power plants, familiarity with the different energy sources, involvement in terms of employment, and socioeconomic characteristics. The data consists of a sample of 1800 residents in mainland Portugal. Preliminary results show considerable variation regarding: the familiarity and involvement with energy sources, the degree of environmental friendliness, and the perception of specific environmental impacts by renewable energy source. In addition, visibility of renewable energy power plants varies significantly by district of residence. The understanding of public perceptions regarding renewable energy sources and of the socio-demographic characteristics of those in favor, or against, renewable energy power plants is crucial for the future feasibility and acceptability of new and eventually larger or more dispersed power plants projects.

KEYWORDS: social acceptance; perception of environmental impacts; renewable energy sources

1. INTRODUCTION

The use of renewable energy sources (RES) and energy efficiency are issues that are central to the European Union (EU) energy policy, as RES contribute substantially towards reducing CO_2 emissions, helping to meet EU's international commitments, either through curbing energy demand or by providing alternative carbon-free supplies. Furthermore, they improve energy security and can contribute to enhanced competitiveness. The use of RES for electricity generation has become a cornerstone of EU energy policy contributing to all three main energy policy goals: competitiveness, energy security and environment protection (EC, 2006).

Despite the unquestionable advantages associated to the use of RES for electricity production, these are not free of negative impacts, affecting individuals' wellbeing, particularly those living in the vicinity of the different facilities. These facilities include solar photovoltaic panels, wind turbines, forest biomass fuelled plants and dams. Since each of these renewable energy technologies capture different natural resources in different ways, the socioeconomic and environmental impacts of each technology may also vary (Devine-Wright, 2008). The following negative effects associated with the activity of these facilities are common to all RES, namely the impact on landscape (e.g. Ouyang *et al.,* 2010; Dockerty *et al*., 2012; Gordon, 2001; Chiabrando *et al.,* 2009); the occupation of land and the opportunity cost of the area occupied (e.g. Denholm *et al.,* 2009; Sarlos *et al*., 2003; Rashad and Ismail, 2000); and the effects on fauna and flora (e.g. Travassos *et* al., 2005; Wang and Chen, 2013; Jonsell, 2007; Chiabrando et al., 2009). More specific to each source is the noise effect in the case of wind farms (e.g. Pederson *et al.,* 2009; Van den Berg, 2005, 2006), and to a less extent dams (e.g. JKA, 2010); specific to photovoltaic farms are the glare effect (e.g. Chiabrando *et al*., 2009) and the rise in soil temperature (e.g. Gunerhan *et al*., 2009). The installation of hydropower dams implies, in most cases, the destruction of some heritage, which can have a significant social impact (e.g. Bakken *et al.,* 2012; Ferreiro *et al*., 2013). The public perception of these impacts, regardless of the proximity of the individuals' home location in relation to the different facilities, may affect the value given to RES and the acceptability (or lack of it) regarding the construction of new power plant projects. As stressed by several studies (e.g., Wustenhagen *et al.,* 2007; Moula *et al.,* 2013; Ribeiro *et al*., 2014; Rijnsoever *et al*., 2015), social acceptance is crucial for successful implementation of renewable energy technologies and thus must not be neglected in any efficient energy decision-making process.

This paper proposes to analyze how the perceptions of the general Portuguese population regarding the environmental friendliness of renewable energy power plants is affected by variables such as: home location, visibility of power plants, familiarity with the different energy sources, involvement in terms of employment, and socioeconomic characteristics. For the empirical study, we collected a total of 1800 questionnaires among the resident population in mainland Portugal; the questionnaires were administered during the year of 2014 by a specialized survey firm on a national sample through personal interviews.

The reminder of this paper is organized as follows. In section 2 we discuss the social acceptance of renewables. Section 3 provides an overview of the main methodological issues. In section 4 we present and discuss the results. Finally, in section 5 the main conclusions of this paper are presented.

2. SOCIAL ACCEPTANCE

Social acceptance as a decisive factor for renewables' implementation was extensively ignored in the 1980's when renewable energy policy programs began. As stressed by Wüstenhagen *et al*. (2007), most decision-makers considered that implementation was not a problem, mainly because the first surveys on renewables' acceptance, in particular regarding wind energy source, revealed very high levels of public support. However, more thorough studies analyzing the effective support of the different renewables' technologies showed that public support could not be taken for granted. Carlman (1984), one of the first researchers to address this issue, carried out a study on the acceptance of wind power among decision-makers and concluded that sitting wind turbines was closely related to important issues such as public, political, and regulatory acceptance. Other studies followed and revealed a growing concern in some aspects, such as the lack of support from key stakeholders, lack of commitment and dedication from policy makers, lack of understanding of public attitudes regarding renewables, and underestimation of the importance and significance of impacts such as landscape intrusion (Wüstenhagen *et al*., 2007).

The debate on social acceptance is rich and continuously changing, mainly because there are several features of renewable energy innovation that constantly bring new aspects into consideration, in particular i) renewable energy plants tend to be of smaller scale than conventional power plants, increasing the number of location decisions to be made; ii) given the widespread creation of externalities by the energy sector as a whole, 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; iii) resource extraction in fossil or nuclear energy happens below the earth' surface and thus is invisible to most of the population, while in renewable plants the energy production is highly visible and closer to where the energy consumer lives: the so-called "backyard" (Wüstenhagen *et al.,* 2007).

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 authors such as Wolsink (1994, 2000, 2006, 2007) who studied the validity of the NIMBYism for the specific case of wind power. According to Wolsink, the NIMBY explanation is too simplistic and considers at most a secondary issue for people opposing local renewable energy projects. Instead, Wolsink considers that institutional factors are highly important and that open collaborative approaches with the involved actors are crucial to the development of the renewable energy technologies. In another study, Bell *et al.* (2005, p.460) state that "the NIMBY concept has rightly been criticized 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 towards RES.

There is no doubt about the complexity around the social acceptance of renewable energy innovations. According to Wüstenhagen *et al.* (2007), the concept of social acceptance of renewable energy innovations is multi-dimensional, including socio-political acceptance, community acceptance and market acceptance.

Socio-political acceptance is "social acceptance on the broadest, most general level" (Wüstenhagen *et al.*, 2007, p. 2684). It refers to the role of citizens. It is primarily manifested through general support for a renewable-based technology or for policies supporting its development. This is often measured through opinion polls that represent the individuals' aggregated attitudes (Lippmann, 1922; Rijnsoever and Farla*,* 2014; Rijnsoever *et al.,* 2015). 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).

Community acceptance refers to the role of consumers as voluntary or involuntary users of technology. It plays an important role in the cases where the adoption of an innovation affects groups of agents, such as the sitting decisions for renewable energy installations (Rijnsoever *et al.,* 2015). An efficient community approach is essential to renewables deployment. 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).

Finally, we have market acceptance, or the process of market adoption of an innovation. One of the main problems associated with green power marketing (and trading) is the separation between (physical) supply and demand. In the renewable energy market, consumers 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 meet this demand. 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). To better understand the concept of market acceptance, we 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. Moreover, other aspects to consider are how international companies act in different countries, how their position affects the opportunities of other potential investors and how they use their influence in crucial political decisions (Wüstenhagen *et al.,* 2007).

This model of analysis has the merit of clarifying the complex concept of social acceptance through its different components. In this paper we focus on socio-political acceptance as an aggregate of the individual attitudes of citizens.

3. SURVEY DESIGN AND IMPLEMENTATION

With the aim of understanding public perceptions regarding the use of RES for electricity generation in Portugal, we designed five different questionnaires: one for each energy source (photovoltaics, hydro, wind, and forest biomass) and one questionnaire for all renewables (forest biomass was excluded given the unfamiliarity revealed by the population regarding this particular energy source, as explained in next section). The survey was conducted through personal interviews during the first semester of 2014. A total of 1800 questionnaires was collected, of which 1523 were complete.

The questionnaires are divided in three sections. The first section focuses on respondents' knowledge, opinions and preferences over renewable energy sources; the second focuses on the elicitation of respondents' valuation regarding the effects of RES on the environment. Finally, the third section contains questions on socio-demographic characteristics. Except for the second section, most questions are comparable across questionnaires, being exactly the same in the first part of all questionnaires. The focus of the present investigation is thus on the first part of the questionnaire. The instrument was developed in an interactive process using focus group discussions and think-aloud sessions to improve the questionnaire (Botelho *et al*., 2014).

4. RESULTS

The sample, composed of 1523 complete questionnaires, is characterized by subjects with mean age of 49 years old, while the youngest and oldest respondent were 18 and 91 years old, respectively; most respondents were married (64%) or single (24%). Regarding the work situation, most respondents are employed or retired (46% and 24% respectively), and have either secondary or higher education (29% and 32%); however approximately 14% have only attained primary school level education.

Due to high non-response rate regarding the income variable (only 36% of the respondents answered the question), the value of the monthly electricity bill is used as a proxy for the income level for comparison purposes. It is assumed that a higher electricity bill is related to more electrical appliances and thus higher income. Average electricity bill is 66 Euros.

In order to understand the social acceptability of RES power plants it is important to characterize respondents' attitudes towards environmental issues. When asked about the major environmental problems in Portugal, respondents consider water and air pollution the most significant (51% and 50% respectively), followed by waste management (48%) and climate change (46%). RES are familiar to most respondents, the least familiar are wave-energy, geothermic and forest biomass. Wave energy is just exploratory in Portugal, thus respondents' unfamiliarity is expected, and the same is true for the case of geothermic energy which is not present in mainland Portugal (only in the archipelagos). Forest biomass, however, is present in Portugal, although with a significantly lower penetration rate, so it is therefore surprising that only 54% of the respondents indicate knowledge of this particular energy source. In line with previous results (e.g. Pinto *et al.,* 2015; Sousa, P. *et al*., 2015; Sousa, S. *et al*., 2015), 27% of the respondents see some RES power plant in their daily lives, and, of those who indicated this, the most frequent are wind farms (72%), solar PV farms (35%), hydropower (13%), and only 3% state seeing forest biomass power plants. Most frequently the power plants are seen from either respondents' homes or during their daily commuting (Table 1).

Table 1: Descriptive statistics

Variable	Description	Mean/frequency
Age	Age of respondent	49.11 (16.55)
Work situation	Unemployed	12.7%
	Housemaid	3.01%
	Student	3.71%
	Retired	24.23%
	Self-Employed	10.02%
	Employed	46.33%
Marital status	Married	64.03%
	Divorced	6.25%
	Single	23.94%
	Widow	5.78%
Schooling	Primary school (years 1-4)	13.60%
	Preparatory school (years 5-6)	4.92%
	Secondary school (years 7-9)	13.60%
	Post-secondary (years 10-12)	28.80%
	Undergraduate degree	32.49%
	Master degree	5.21%
	PhD	0.94%
	Other	0.43%
Electricity bill	Monthly electricity bill in Euros	66.47 (63.63)
Environmental problems	Air pollution	50.85%
	Water pollution	51.48%
	Over-exploitation of natural resources	9.10%
	Decreased biodiversity	16.96%
	Climate change	46.03%
	Waste	48.19%
	Other	3.28%
Knowledge	Wind	98.55%
	Solar	95.33%
	Forest biomass	53.58%
	Geothermic	56.51%
	Hydropower	94.94%
	Wave	70.83%
See RES power plant		26.99%
If yes,	See wind farm	72.20%
If yes,	See forest biomass	2.93%
If yes,	See hydropower plant	12.68%
If yes,	See solar	34.63%
If yes,	See from residence	50.85%
If yes,	See from work	11.68%
If yes,	See daily commute	54.74%

(Standard deviations in parentheses)

There, however, are some important regional variations, reflecting the geographic distribution of RES power plants. In Viana do Castelo, Portalegre and Guarda, more than 60% of the respondents view some RES power plant; while less than 20% see some in the districts of Beja, Braga, Porto, Setúbal and Évora. Regarding wind farms, in Bragança, Guarda, Leiria, Lisboa, Portalegre, Santarém, Viana do Castelo, Vila Real, and Viseu, more than 60% of the sample see a wind farm from their homes, work, or daily commutes; while in Évora is the only district where respondents do not see any wind farm from their homes or in daily commutes. Respondents from Beja and Portalegre are the ones that see hydropower plants with highest frequency. In most districts the percentage of respondents that state seeing a hydropower plant is lower than 10%, which is reasonable given the location of dams in Portugal. Respondents' answers regarding solar-photovoltaic is not reliable as in most districts respondents state they see these farms daily, while the only solar-photovoltaic farms in Portugal are located in Beja and Évora, so, respondents may be referring to individual panels in buildings or in some industrial facility, rather than to actual farms. In 11 districts no respondent states seeing a forest biomass power plant; in the others the percentage stating seeing a forest biomass power plant is lower than 10%, and again there are some responses in the data which probably are not accurate because of lack of information and familiarity with this RES, in particular (Table 2).

Table 2: Descriptive statistics by district – visibility of power plant

District	See RES	See wind	See forest biomass	See hydropower plant	See solar power plant
Aveiro	24.10	55.17	0.00	3.45	58.62
Beja	28.57	100.00	0.00	50.00	50.00
Braga	20.14	60.71	3.57	10.71	50.00
Bragança	47.37	88.89	0.00	11.11	33.33
Castelo Branco	35.71	80.00	0.00	10.00	40.00
Coimbra	41.54	77.78	3.70	11.11	33.33
Faro	30.30	80.00	0.00	20.00	25.00
Guarda	64.00	93.75	6.25	25.00	6.25
Leiria	43.30	78.57	0.00	4.76	33.33
Lisboa	21.73	82.35	0.00	1.47	35.29
Portalegre	52.63	90.00	0.00	30.00	0.00
Porto	16.67	33.33	4.44	35.56	44.44
Santarém	31.94	69.57	4.35	8.70	39.13
Setúbal	14.38	52.38	23.81	14.29	42.86
Viana Castelo	67.57	100.00	4.00	8.00	4.00
Vila Real	33.33	90.00	0.00	10.00	10.00
Viseu	45.10	77.27	0.00	13.64	36.36
Évora	4.00	0.00	0.00	0.00	100.00

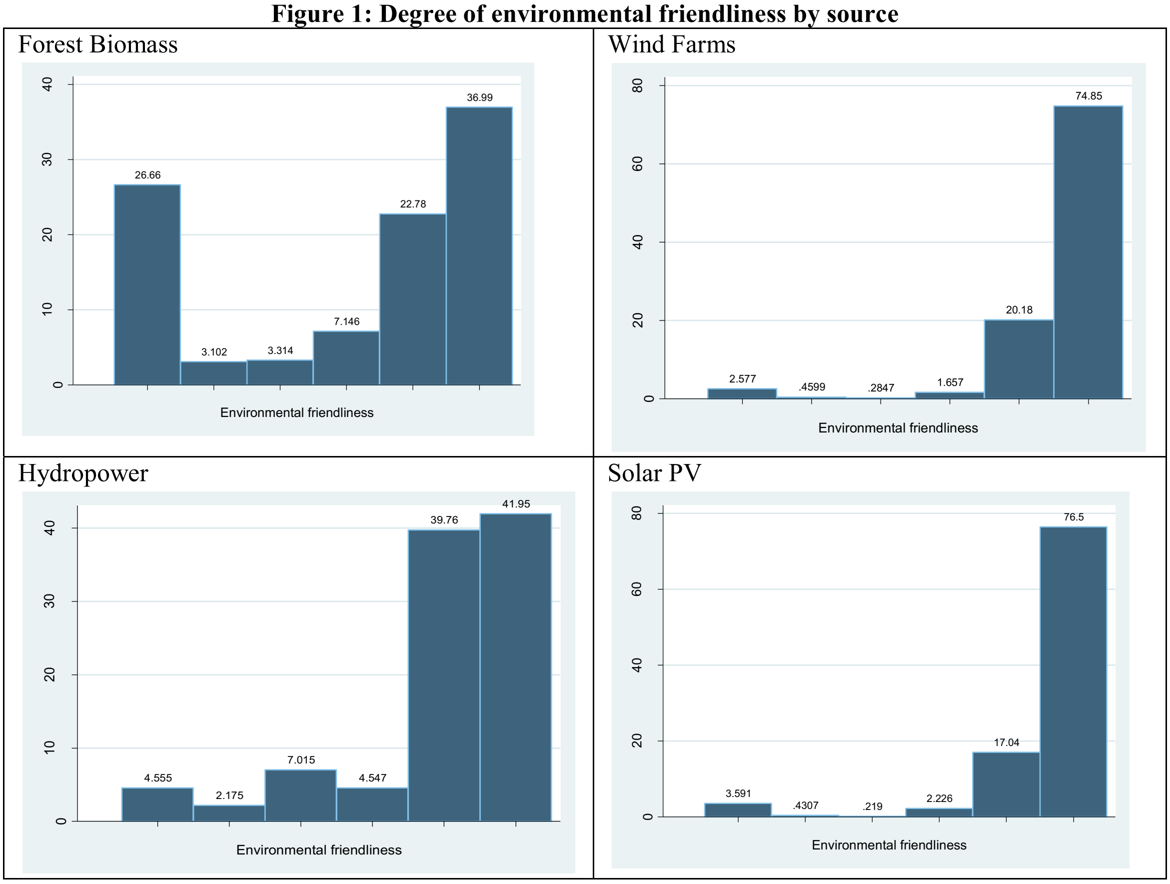
Regarding respondents' knowledge with respect to the different RES, wind, solar-photovoltaic and hydropower are known to most respondents in all districts. The energy source that is less familiar is forest biomass. Residents in Beja and Castelo Branco are the less familiar with this RES. The most familiar live in Guarda district (Table 3).

Table 3: Descriptive statistics by district – knowledge about the different RES

District	Know wind	Know forest biomass	Know hydropower plant	Know solar power plant	Know geothermic	Know wave energy
Aveiro	93.13	58.88	95.33	98.13	57.94	68.22
Beja	100.00	21.43	100.00	100.00	35.71	42.86
Braga	97.84	56.83	90.65	94.96	58.27	69.78
Bragança	100.00	57.89	100.00	84.21	68.42	73.68
Castelo Branco	89.29	35.71	89.29	92.86	39.29	39.28
Coimbra	96.92	64.62	93.85	98.46	64.62	72.31
Faro	98.45	43.94	96.97	96.97	50.00	68.18
Guarda	100.00	68.00	88.00	88.00	44.00	68.00
Leiria	97.94	60.82	93.81	92.78	62.89	70.10
Lisboa	99.36	49.20	97.76	96.79	56.87	76.67
Portalegre	94.74	47.37	94.74	94.74	52.63	57.89
Porto	98.89	53.70	95.56	94.81	55.93	74.81
Santarém	100.00	61.97	98.59	100.00	50.70	76.06
Setúbal	99.31	53.76	93.84	92.47	63.36	69.86
Viana Castelo	97.30	45.95	97.30	94.59	48.65	72.97
Vila Real	100	46.67	90.00	96.67	36.67	50.00
Viseu	98.04	58.82	96.08	98.04	62.75	66.67
Évora	100.00	44.00	80.00	84.00	50.00	60.00

To understand the perception by respondents of the degree of environmental friendliness of RES, they were asked to rate each RES on a 5 point scale (1 not friendly; 2 somewhat not friendly; 3 indifferent; 4 somewhat friendly, 5 very friendly). Overall, more than 5% find all four RES as somewhat or very environmental friendly. However there is some variation across sources (Figure 1); in the case of forest biomass there is a significant percentage of respondents that are not familiar with the source and consequently are unable to rate it with respect to its environmental friendliness. Concerning hydropower and forest biomass plants, a non-trivial percentage of respondents find them not friendly (respectively 9.2% and 6.4%). Results on the four RES considered reveal significant regional differences between respondents' opinion of the degree of environmental friendliness of RES.

Figure 1: Degree of environmental friendliness by source



Legend: 0 don't know; 1 not friendly; 2 somewhat not friendly; 3 indifferent; 4 somewhat friendly, 5 very friendly

To explain the degree of environmental friendliness of RES, and to analyze the regional variability in respondents' preferences, an ordered probit model is specified. The dependent variable is the degree of friendliness varying between 1 and 5, as explanatory variables we include the district of residency, the age and gender of the respondent, whether the respondent buys environmentally friendly products (to proxy for environmental preferences), a variable relating to the involvement of the respondent with the RES, a binary variable taking the value 1 if the respondent sees a RES power plants daily, and finally the amount of respondents' electricity bill (as a proxy for income, as the variable income had many missing observations).

Results in Table 4 reveal consistency across RES. Respondents involved with the RES are more likely to consider the RES environmentally friendly, as expected. Also relevant is whether respondents see RES power plants in their daily lives. For wind farms, the effect of seeing a RES power plant on respondents' probability of finding environmentally friendly is positive, however, the effect for Hydropower environmental friendliness is negative.

Also noteworthy is the regional variation in results. Residents in Beja and Viana do Castelo consider the RES less environmental friendly, while residents in Lisboa, Santarém and Setúbal find them more environmental friendly, than residents in Aveiro. Residents in Lisbon, in general, find RES more environmental friendly (except for forest biomass). The remaining districts do not show statistically significant differences.

In summary, respondents from different districts have different opinions regarding each RES, and their opinion is not independent of the particular RES under consideration. Wind farms and solar photovoltaic farms are more likely considered very environmental friendly than other sources. If we consider the probability of being classified as friendly or very friendly, these two energy sources have a probability of 98% and 97%, respectively, while hydropower has a probability of 85% and forest biomass has 83%.

Although all four renewable energy sources considered in this study are environmental friendly, in the opinion of the majority of the respondents, the degree of friendliness varies between sources and between districts of residence.

Table 4: Ordered probit estimation results by RES

	WF	HP	SPV	FB
	Coeficient (robust stdev)	Coeficient (robust stdev)	Coeficient (robust stdev)	Coeficient (robust stdev)
Age	-0.0011 (0.0022)	0.0011 (0.0018)	-0.0015 (0.0023)	0.0015 (0.0022)
Male	-0.0110 (0.0741)	0.0375 (0.0602)	-0.0435 (0.0759)	-0.1494** (0.0696)
Electricity bill	0.0007 (0.0006)	0.0005 (0.0007)	0.0003 (0.0006)	0.0009 (0.0006)
Env. Products	0.1454 (0.0967)	0.0812 (0.0804)	0.1536 (0.1009)	0.0753 (0.09489)
See-RES	0.1432* (0.0883)	-0.1664** (0.0690)	0.1396 (0.0890)	-0.0930 (0.0764)
Involvement	0.2410** (0.1117)	0.1266 (0.0905)	0.2982*** (0.1182)	0.2195** (0.0980)
District$^{\alpha}$				
Beja	-0.6816** (0.3337)	-0.0113 (0.2591)	-0.7342** (0.3198)	-1.5871*** (0.4507)
Braga	-0.0472 (0.1673)	0.1073 (0.1464)	02158 (0.1804)	0.1028 (0.1707)
Bragança	-0.1047 (0.2904)	0.1930 (0.2264)	-0.2511 (0.2984	-0.2854 (0.3106)
Castelo Branco	-0.2430 (0.2597)	-0.3210 (0.2063)	-0.3898 (0.2647)	-0.1894 (0.2492)
Coimbra	-0.2169 (0.1986)	0.0704 (0.1656)	-0.2073 (0.1956)	0.0058 (0.1863)
Faro	0.0279 (0.2008)	0.0834 (0.1690)	-0.1797 (0.2046)	0.1830 (0.2141)
Guarda	0.1347 (0.3765)	-0.2294 (0.2965)	-0.1259 (0.3477)	0.2200 (0.3505)
Leiria	0.2659 (0.1894)	0.3390** (0.1635)	0.0516 (0.1846)	0.0665 (0.1833)
Lisboa	0.6167*** (0.1531)	0.2897** (0.1308)	0.4693*** (0.1547)	0.0888 (0.1490)
Portalegre	0.2169 (0.3675)	0.3706 (0.2341)	0.1204 (0.5132)	0.4790 (0.5334)
Porto	0.2687* (0.1481)	-0.0532 (0.1298)	0.3013** (0.1525)	0.0570 (0.1526)
Santarém	0.2367 (0.1957)	0.1298 (0.1807)	0.3502* (0.2082)	0.4587** (0.2003)
Setúbal	0.6321*** (0.1818)	0.4203*** (0.1636)	0.5598*** (0.1889)	0.0442 (0.1798)
Viana Castelo	-0.4176** (0.2040)	0.1107 (0.2089)	-0.4923** (0.2167)	-0.1486 (0.2465)
Vila Real	-0.1683 (0.2397)	0.0947 (0.2123)	-0.2289 (0.2777)	-0.1287 (0.2700)
Viseu	0.0593 (0.2146)	0.0003 (0.1761)	0.0147 (0.2201)	0.1349 (0.1992)
Évora	0.4860 (0.3110)	0.4698* (0.2808)	0.3088 (0.3262)	0.8468** (0.3315)
Prob (outcome 1)		0.0257*** (0.0041)	0.0050*** (0.0018)	0.0413*** (0.0058)
Prob (outcome 2)	0.0036** (0.0016)	0.0713*** (0.0068)	0.0021* (0.0012)	0.0483*** (0.0064)
Prob (outcome 3)	0.0156*** (0.0032)	0.0455*** (0.0054)	0.0212*** (0.0037)	0.0821*** (0.0082)
Prob (outcome 4)	0.1894***	0.3951***	0.1599***	0.3026***

	(0.0098)	(0.0127)	(0.0093)	(0.0137)
Prob (outcome 5)	0.7909*** (0.0102)	0.4624*** (0.0129)	0.8118*** (0.0099)	0.5257*** (0.0147)
N	1484	1448	1467	1117
Wald-chi2	80.21***	43.38***	77.01***	45.9***

$^{\alpha}$ reference category is Aveiro. *significant at 10%; **significant at 5%, ***significant at 1%. Robust standard deviations in parentheses; WF: wind farms, HP: hydropower, SPV: solar photovoltaic, FB: forest biomass.

5. DISCUSSION AND CONCLUSIONS

Renewable energy sources have become popular in the context of climate change policies. The EU has set increasingly more stringent targets for greenhouse gas emissions, whose attainment relies heavily on a more intensive use of renewable energy sources. The intensification of use of RES requires the installation of new wind and solar farms, hydropower plants and biomass plants, which then requires sitting decisions for these facilities. As argued previously, these decisions are multidimensional and affect a multitude of stakeholders. Botelho *et al.* (2015) find significant effects of the installation of RES facilities on residents living nearby. The results obtained in the present study support the general claim that renewable energy sources are perceived as environmentally friendly, and consequently socially acceptable. However, the results also support the hypothesis that the acceptability of renewable energy sources varies across sources and locations. Moreover, the degree of environmental friendliness varies not only by district of residence, but also with socio-demographic characteristics of the respondents and also their relationship with the environment and the RES in particular.

While out results are in line with previous literature, showing a general social acceptance of RES, the present paper adds some qualifications to this general result. First, there is a considerable difference between respondents' opinion regarding the specific RES, in particular wind and solar energy are considered the friendliest, followed by hydropower and forest biomass. In addition, we observe regional and socio-demographic variation which suggest preferences vary with experience and familiarity with specific energy sources. Therefore a more nuanced and detailed analysis of the social acceptance of the different RES is called for when discussing and developing renewable energy power plants.

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