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Economic valuation of an offshore wind farm in Greece: The role of individual's base-state influences and beliefs in the value formation process

Isabella Georgiou, Francisco J. Areal *

School of Agriculture, Policy and Development, University of Reading, Reading, UK

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ABSTRACT

The increased concern for the impacts of climate change on the environment, along with the growing industry of renewable energy sources, and especially wind power, has made the valuation of environmental services and goods of great significance. Offshore wind energy is being exploited exponentially and its importance for renewable energy generation is increasing. We apply a double-bound dichotomous Contingent Valuation Method analysis in order to both (a) estimating the willingness to pay (WTP) of Greek residents for green electricity produced by offshore wind farm located between the islands of Tinos and Andros and (b) identifying factors behind respondents' WTP including individual's behaviour toward environment and individual's views on climate change and renewable energy. A total of 141 respondents participated in the questionnaire. Results show that the respondents are willing to pay on average 20€ every two months through their electricity bill in return for carbon-free electricity and water saving from the wind farm. Respondents' environmental consciousness and their perception towards climate change and renewable energy have a positive effect on their WTP.

Contents

1. Introduction

Although technological advances in renewable energy continue to contribute to reducing Greenhouse Gas (GHG) emissions, total energy consumption has also continued to increase during last decades being fossil fuels the major source of energy (Fig. 1). Hence, the associated impacts of GHG emissions on the environment are still a major concern for achieving sustainability [1,2].

* Correspondence to: Department of Agricultural and Food Economics, University of Reading, Earley Gate, PO Box 237, Reading RG6 6AR, UK. Tel.: +44 118 378 8970.
E-mail address: f.j.areal@reading.ac.uk (F.J. Areal).

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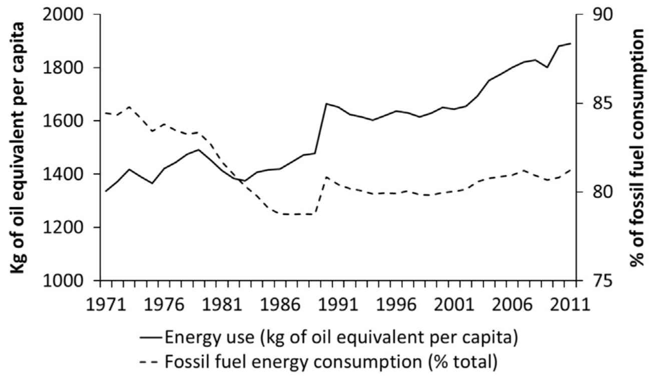

Fig. 1. *Source*: World Bank data (http://data.worldbank.org/topic/energy-and-mining).

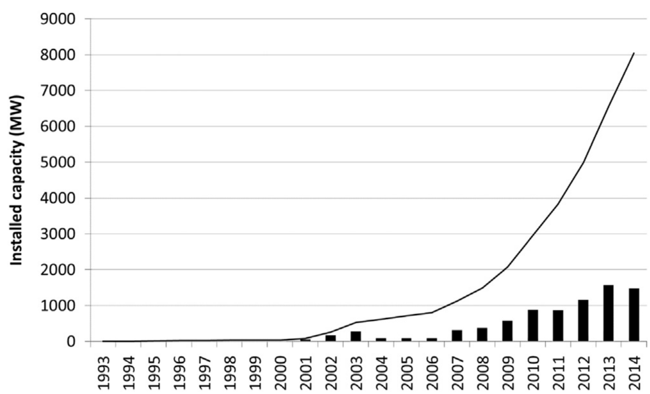

Fig. 2. Annual and cumulative off-shore wind installed capacity in Europe.

1.1. Wind farms and climate change mitigation

The development of green energy sources such as wind farms plays an important role on mitigating the effects of climate change. The European Union has supported and promoted the development of the renewable energy sector, setting targets for its member-states. According to the 20-20-20 goals set by the European Council in 2007, by 2020 the EU member-states must reduce the GHG emissions by 20%, increase the share of renewable energy by 20% and improve energy efficiency by 20%. Moreover, the EU Directive 2009/28/EC establishes that the share of energy from renewables for each member-state would be based on each member state's potential, its energy mix and would be calculated according to the gross energy consumption from renewable energy sources (RES) of each state. In 2012 Greece's renewable energy share accounted for the 15.1% of the total gross final energy consumption, while the EU's 2020 target for Greece is estimated to be 18% [3]. Currently, in Greece, most of the renewable energy power generated is derived from wind power (75%), followed by solar power [4]. Furthermore, Greece has declared that by 2020, 40% of its gross electrical energy demand will be supplied by electrical energy production derived from renewable energy sources, and 50% of this from wind power [5].

Due to its nature wind energy production is difficult to predict and its energy generation is neither constant nor stable [6,7]. Despite such difficulties associated with its predictability and instability of wind energy generation, wind energy is one of the fastest growing energy industries with the EU having a leading role having a capacity of covering 8% of the EU's total energy demand from wind power [8,9]. Two types of wind power can be distinguished according to the location of the wind power installation: onshore, if the installation is located in mainland areas and offshore if installations are located in the sea, away from the coast. On January 2015 there were a total of 2488 offshore wind turbines installed and grid connected in 74 wind farms in 11 countries in Europe with a combined capacity of 8045 MW [10] (Fig. 2). The industry expects reaching 10 GW by 2015 [11]. Further in the future the European Wind Energy Association (EWEA) has identified 26.4 GW of consented offshore wind farms in Europe and future plans for offshore wind farms totalling more than 98 GW, 0.71 GW in Greece [11]. The estimated available offshore area available in Greece is over 30,000 km^2 with an unrestricted technical potential[1] for offshore wind energy in 2030 Greece of approximately 100,000 MW and for all EU countries 3,400,000 MW [12]. Offshore wind production in Greece is a relatively new and highly growing industry with the number of offshore wind farms constantly increasing due to the fact that over 70% of the maritime areas in Greece have a significant wind capacity [12].

It is worth mentioning that recently it has been pointed out that climate change itself may affect winds too becoming an important factor to take into account when planning locations to develop wind farms [13]. Since wind speeds are sensitive to climate variability, wind speeds will increase in some areas and decrease in other areas. Hence, whereas there will be areas where the expansion of wind energy installed will become favourable other areas or current installations may become less productively attractive.

1.2. Economics of wind farms

Within an economic framework the evaluation of a construction and implementation of offshore wind farms can be seen from both private and social perspectives.

1.2.1. Private perspective

From a private perspective, offshore wind farm benefits are linked to consumer demand for wind energy whereas wind farm costs are those associated with the development of wind farms, which can be classified into initial costs (i.e. construction and connection to the electricity grid) and maintenance costs. These costs are relatively high, especially in cases where the accessibility to the offshore wind farm site is difficult due to severe climatic conditions [14]. Hence, the selection of the site for the development of wind farms is key for the success of the investment of developing a wind farm since such success depends on the wind capacity of the site, which may vary from year to year. Thus, the electricity generation capacity of an offshore wind farm in certain site may be higher than an equivalent wind farm onshore and vice versa. The electricity generation capacity of an offshore wind farm in Greece is up to 40% higher than an equivalent wind farm onshore since the wind capacity in maritime areas is significantly higher than mainland areas, especially in the region of Aegean Sea. Regarding the development and maintenance costs of wind farms offshore wind farms are more expensive than onshore wind farms [15]. However, offshore wind farms development is happening predominantly in European Union Member States due to the expected benefits of higher wind speeds and the lower visual and noise impact [15].

1.2.2. Social perspective

From a social viewpoint broader benefits and costs need to be taken into account. Social benefits can be derived from substituting polluting sources of electricity (e.g. fossil fuels, coal) for offshore wind farms. Such benefits are obtained from reducing

[1] This does not take into account other uses of the sea area (e.g. shipping routes, military use of offshore areas, oil and gas exploration, and tourist zones), which may limit the potential for offshore wind developments.

environmental impacts associated with energy production derived from polluting sources (i.e. benefits associated with reduction of GHG or costs avoided due to such reduction). The main benefit of wind energy production is that it contributes to GHG emissions abatement and improvement of atmospheric quality [16-18]. Also, an offshore wind farm can offset up to 2.1 million of gallons of fresh water per year, as conventional power plants use a large amount of water for their operation [6]. Finally, it has been reported that offshore wind farms could promote ecosystem creation, by operating as artificial reefs [19].

The social costs associated with the development of offshore wind farms are not fully known (e.g. there is not full understanding of its environmental impacts). However, a number of social costs that have been identified include the negative effects of wind farms on ecosystems, visual impact, tourism and noise [6,19–24]. Wind farms could negatively affect the population of marine birds, either through their collision with the turbines or due to the fact that the wind farms could operate as a barrier for their migration [23]. Noise during the construction phase as well as the dredging could cause clogging and damage to early-life stages of several species [24]. Finally, wind farms were found to have visual impact [20,21] and affect negatively to tourist attraction [22].

Other externalities that have been taken into account in the literature relate to job creation. A total of 250,000 working positions associated with offshore wind farms were opened across Europe in 2012 [25]. However, wind turbine installations can also be located in traditionally fishery areas, which would cause a loss in their catch for the local fisheries and would be facing their opposition [20]. Furthermore, an offshore wind farm could cause problems in navigation, especially in a busy area like the Aegean, where the transportation between the islands is being made mainly through maritime routes [6].

Therefore, regarding the environmental impacts of wind farms these are site specific as it is the case for the economic impacts. These environmental impacts will depend on the habitats and species that the site is supporting.

We estimate the willingness to pay (WTP) for the development of a hypothetical offshore wind farm located in the Aegean Sea, between the islands of Andros and Tinos, a remote and low populated area. We use a double bound dichotomous choice Contingent Valuation Method (CVM). Furthermore, we investigate the drivers behind respondent's WTP such as individual's base state influences and base state beliefs. This paper contributes to the existing literature in two ways: (1) providing an estimate for the willingness to pay for an offshore wind farm in a remote and low populated location (i.e. estimating the benefits of offshore wind farms in planned locations that minimise negative impacts associated with offshore wind farms); and (2) incorporating into the analysis of WTP for an offshore farm individual's stated behaviour towards the environment and individual's views on climate change and renewable energy along with socio-economic aspects. We include variables such as age groups, gender education and income levels into the analysis of WTP for an offshore farm to control for socio-economic aspects of the respondents. This is the first study, to our knowledge, that incorporates individual's behavioural aspects and views towards the environment, climate change and renewable energy on a WTP study for offshore wind farms.

2. Data and methods

2.1. Valuation processes of individuals

In the past few decades, there has been a growing literature on the development of valuation methods to value non-market goods

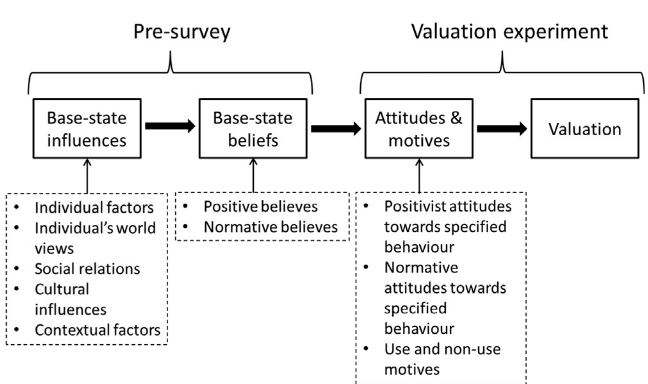

Fig. 3. The value formation process.

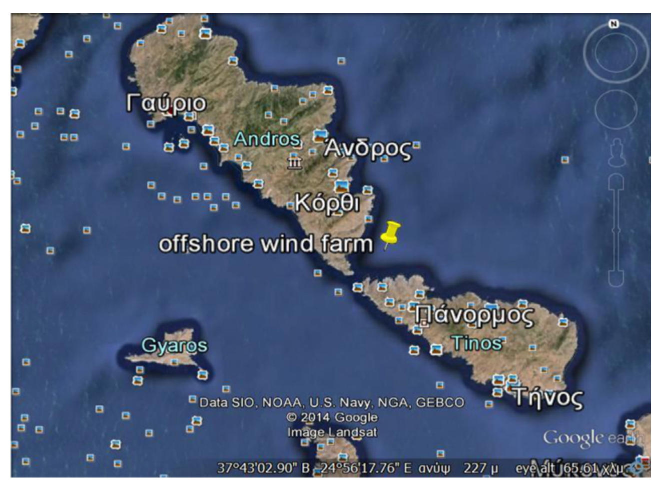

Fig. 4. Location of offshore wind farm. (Created on Google Earth.)

Table 1
Statements evaluated by respondents.

	Statement
1	Climate change is currently occurring (*positive belief*)
2	Climate change is posing a serious threat to the environment (*positive believe*)
3	Climate change is occurring due to human impact on the environment (*positive believe*)
4	Climate change is occurring due to natural causes (*positive belief*)
5	Climate change should be one of the top priorities in the global policy agenda (*normative belief*)
6	Climate change should be one of the top priorities in the Greek policy agenda (*normative believe*)
7	I believe I will be affected by the impacts of climate change (*positive believe*)
8	Renewable energy sources are important for the mitigation of climate change (*positive belief*)
9	Wind farms produce renewable energy efficiently (*positive belief*)
10	Wind farms are an important source of renewable energy (*positive belief*)
11	Wind farms are helping to reduce the impact of climate change (*positive believe*)

and services as well as on the applications of such methods to a broad spectrum of environmental goods and services. Such applications of existing valuation methods are useful for policy making and project evaluation (e.g. environmental cost–benefit analysis). These valuation methods are based on individual's preferences which can be derived indirectly, through consumption behaviour, or directly, by stating their WTP for an environmental improvement or Willingness to Accept (WTA) compensation for environmental deterioration.

We use a CVM, a stated preference technique, where people are asked to express their WTP contingent to a hypothetical scenario [26]. CVM has been used for the valuation of renewable energy projects and their acceptability by the society [27-29]. Regarding valuation of wind farms in Greece, two economic valuations of an onshore wind farm in Rhodes and South Evia were conducted by [30,31].

The use of CVM studies to estimate the WTP for green electricity in particular and to protect natural resources in general focuses mainly on the individual behaviour (individual's WTP) and less on the process of such behaviour [33,34]. Consideration of such processes can be dated back to the work by Fishbein and Ajzen [34,35]. We use a simplified adaptation of the conceptual model for the valuation process presented in Bateman et al. [33] (Fig. 3). In particular we take into account base-state influences and base-state beliefs in our analysis by using information obtained through the survey. These base state influences and beliefs help to shape individual's attitudes and motives which ultimately determine the individual's behaviour (individual's WTP).

2.2. The questionnaire

A total of 141 respondents completed an on-line questionnaire which was used to collect data in a convenience sample of Greek residents (older than 18 years of age). The questionnaire consisted of three sections. The first section included questions regarding respondent's base state influence (i.e. such as individual's world views, individual's environmental behaviour individual factors such as income level and education level) as well as respondent's base state beliefs, which are beliefs regarding consequences of specific behaviour. Regarding individual's base-state influences environmental behaviour respondents were asked about how frequently they use public transport and how frequently they recycle. These aspects were included in our analysis along with socio-economic factors as elements within base-state influences. Regarding base state beliefs we included here statements regarding believes towards climate change and renewable energy sources and wind farms (positive and normative believes). Thus, respondents were also asked to evaluate on a scale from 1 (agree) to 3 (disagree) 11 statements, 7 of them regarding their views on climate change and 4 regarding their views of renewable energy and wind farms (Table 1). The information obtained from the evaluation of statements was used to group participants by their base-state beliefs regarding renewable energy and wind farms using cluster analysis. It is hypothesised that prior beliefs on renewable energy, wind farms and climate change may influence individual's willingness to pay for an offshore wind farm. It is therefore hypothesised that individuals who have positive views on renewable energy, wind farms and show concern about the consequents of climate change will be more willing to pay for offshore wind farm development.

In the second section respondents were informed about renewable energy and wind farms as well as the CO_2 and water savings associated with energy being produced by wind farms. They were also informed about the potential construction of the construction of an offshore wind farm in Greece is at the location shown in Fig. 4. Participants were presented with the hypothetical scenario of constructing the offshore wind farm in the determined location and were asked for their WTP question for such development taking place: "A possible site for the construction of an offshore wind farm in Greece is at the location below (showing Fig. 4) … *The wind farm will be located between the islands of Andros and Tinos, with a 2.75 km and 4.1 km distance from the shore respectively. It will have a total capacity of 100 MW, which equals to the electricity needed for 40.000 homes. From the generation of the renewable electricity, 160.000 ton of CO_2 emissions will be avoided and 70–210 million gallons of water will be saved. Renewable energy is currently more costly than that from fossil fuels. Therefore consumers are asked to pay a fixed special levy every two months, through their electricity bill. Are you willing to pay X€?*".

We selected the location of the hypothetical offshore farm site based on wind speed and level of tourism development in the area. In order to minimise negative externalities associated with the development of an offshore wind farm a suitable site was considered to be one located in an area with an average high speed throughout the year and with minimal visual impact. We identified 4 islands (Andros, Tinos, Mykonos, Evia which are located in the Aegean Sea and Crete) using a wind atlas by [12]. The chosen location is between the islands of Andros and Tinos, with a 2.75 km and 4.1 km distance from the shore respectively (Fig. 4). The site is

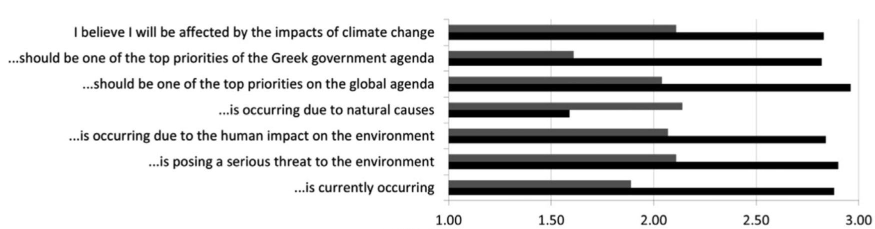

Fig. 5. Average evaluation score given to beliefs on climate change by cluster.

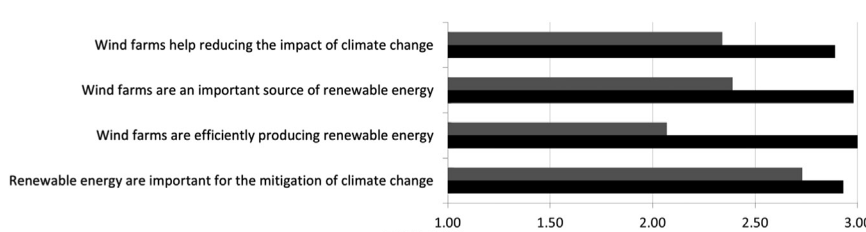

Fig. 6. Average evaluation score given to beliefs on renewable energy and wind farms by cluster.

located in a remote area, where both islands are not densely populated (i.e. low visual and noise impact) nor ferry routes pass through that passage. However, the location of the hypothetical wind farm is near a wildlife shelter on the island of Andros, which may raise concerns regarding possible damage to the local fauna.

We use a double bounded dichotomous choice format to ask participants for their WTP. Thus, participants were asked whether they would be WTP for an initial bid X€. If the respondent answered "yes" ("no"), she would be asked whether she would be WTP a higher (lower) amount. The initial bids (€10, €15, €20) were randomly distributed with follow-ups increasing (€15, €20, €25) or decreasing (€5, €10, €15) accordingly.[2] The true WTP is between the lowest amount the respondent declined (upper bound) and the highest amount they accepted (lower bound). Consequently, the respondent's true WTP is not directly observable by the researcher. Finally, the third section included socioeconomic and demographic questions such as age, gender, education level and income (i.e. base-state influences, individual factors).

2.3. The statistical analysis: cluster analysis and econometric model[3]

We conducted a number of cluster analyses (CA), a statistical method for identifying homogeneous groups, on the statements regarding respondent's positive and normative beliefs on climate change, renewable energy and wind farms. We use a partitioning method (*k*-means) to group participants into distinct groups according to their views. As a result of CA we obtained 2 groups (CC1 and CC2) regarding respondents' beliefs on climate change and another 2 groups (RE1 and RE2) regarding respondents' beliefs on renewable energy and wind farms. These clusters were incorporated into the econometric model as explanatory variables to investigate the effect of respondent's views on climate change and renewable energy on their WTP for an offshore wind farm. Finally, we included as explanatory variables age groups, gender education and income levels.

According to the random utility model [32,36], the unobserved WTP, following a linear function, is given by

$$\mathrm{WTP}_i = c + x_i' \beta + \varepsilon_i$$

where c is the constant term, x_i is the vector of explanatory variables, β is the vector of the coefficients, ε_i is the error term, where $\varepsilon_i \sim (0, \sigma)$ and $i = 1, 2, 3, \ldots, n$ are the respondents. The lower and the upper bound for each respondent i are denoted by B_i^L, B_i^U respectively. Then, the probability of the WTP_i being between B_i^L and B_i^U is given by

$$\Pr\{\mathrm{WTP}i \subseteq (B_i^L, B_i^U)\} = \Phi(Z_i^L) - \Phi(Z_i^U)$$

where Z_i is the standard normal random variable and Φ is denoted as the standard normal cumulative distribution function (cdf), with $Z_i^U = \frac{B_i^U - c - x_i' \beta}{\sigma}$ and $Z_i^L = \frac{B_i^L - c - x_i' \beta}{\sigma}$. The model is estimated, using interval regression, by maximising the log-likelihood function for the responses which is given as follows:

$$\log\ L = \sum_{i=1}^{n} \log\ [\Phi(Z_i^L) - \Phi(Z_i^U)]$$

We use as explanatory variables for WTP respondent's stated base-state influences, their environmental behaviour regarding recycling and frequency of use of public transport; clusters derived from cluster analyses on respondent's positive and normative beliefs on climate change, renewable energy and wind farms (base-state beliefs); base state age, gender, level of education and income. Regarding recycling behaviour a dummy variable (recycle) behaviour was created taking a value of 1 if the respondent recycles constantly or often and 0 if the respondent recycles rarely or never. Another dummy variable (public transport) was created taking a value of 1 if the respondent uses public transport always or often and 0 if the respondent uses public transportation rarely or never.

3. Results and discussion

As highlighted above CA was conducted on respondents' evaluation of statements regarding their positive and normative beliefs on climate change, renewable energy and wind farms. These statements and the average score by cluster are shown in Figs. 5 and 6. Two clusters per group of statements were obtained. Respondents were classified into two distinct groups regarding their beliefs on climate change. In the first group (CC1) there were those respondents who believe climate change is happening and it is happening due to the human impact on the environment and it should be on the global and Greek government agenda as a top priority; they also believe they will be affected by impacts of climate change. The second group (CC2) was formed by respondents who were less certain about whether climate change is currently happening and their possible causes than respondents belonging to CC1; those who tend to disagree that climate change should be one of the top Greek government agenda and are uncertain about whether they will be affected by it.

Two groups of respondents were also classified according to respondent's beliefs on renewable energy and wind farms (RE1 and RE2). Although respondents from both groups agreed that renewable energy is important for the mitigation of climate change, respondents belonging to cluster RE1 were more certain about wind farms being an important source of renewable energy which produces energy in an efficient way and can help reducing the impact of climate change. Clustering respondents according to their views on climate change, renewable energy and wind farms serve to incorporate these aspects into the analysis of willingness to pay for an offshore farm.

Table 1 and Table 2 present the descriptive statistics of the sample and the results of the interval regression. Regarding respondents' environmental behaviour Table 2 shows that 82.3% of respondents recycle and 52.5% use public transport often or always. Taking into consideration respondents views on climate change 79.7% of respondents belong to cluster CC1, i.e. cluster formed by respondents who agreed that climate change will affect them and should be on both global and Greek policy agenda since it is happening due to the human impact on the environment whereas 20.3% belong to cluster CC2, i.e. cluster formed by respondents who were more sceptical about climate change is occurring or affecting them and disagreed that it should be on the Greek policy agenda. Regarding respondents views on renewable

Table 2
Descriptive statistics.

	Mean	Standard deviation
Recycle (yes=1; no=0)	0.823	0.383
Public transport (yes=1; no=0)	0.525	0.501
Climate change (CC1)	0.797	0.404
Renewable (RE1)	0.686	0.466
Age_26–50	0.574	0.496
Age_51+	0.333	0.473
Gender (female)	0.507	0.502
Education (B.Sc.)	0.411	0.494
Education (M.Sc./Ph.D.)	0.461	0.500
Income (1000–2000€)	0.347	0.478
Income (> 2000€)	0.270	0.445

[2] The options for the value of the bid amounts were based on an earlier piloting questionnaire.

[3] Cluster and econometric analysis was conducted using Stata Statistical Software: Release 12. College Station, TX: StataCorp LP.

Table 3
Interval regression results: mean and z-statistic of parameter estimates.

	Mean	z-Statistic
Constant	−0.395	−0.05
Recycle (yes=1; no=0)	6.864*	1.81
Public transport (yes=1; no=0)	1.347	0.45
Climate change (CC1)	8.876**	2.42
Renewable (RE1)	7.409**	2.35
Age_26–50	3.248	0.58
Age_51+	0.894	0.15
Gender (female)	5.346*	1.72
Education (B.Sc.)	8.823*	1.81
Education (M.Sc./Ph.D.)	8.299*	1.73
Income (1000–2000€)	−1.576	−0.46
Income (>2000€)	−0.100	−0.02
Log-likelihood	−142.235	
n	141	

* Statistically significant at the 0.10 level of significance.
** at 0.05-level.

Table 4
Mean and median WTP (€) for offshore wind farm.

	Mean	Median
WTP (€)	20.37	21.56

energy and wind farms in particular 68.6% of respondents were grouped into the RE1 cluster, i.e. cluster formed by respondents who agreed more that wind farms are an important source of producing renewable energy and contribute to reducing the impact of climate change, whereas 31.4% are of respondents belonging to the RE2 cluster were less certain about whether wind farms are an important source of producing renewable energy and contribute to reducing the impact of climate change.

Results show that *base state beliefs* are important determinants of individual's WTP for the development of the off-shore wind farm. More specifically it was estimated that respondents belonging to cluster CC1 and RE1 were WTP 8.88€ and €7.41 more than respondents belonging to cluster CC2 and RE2, respectively. Respondents who believed they will be affected by climate change; that climate change is happening due to the human impact and that climate change should be on the global and government agendas as a top priority were WTP higher amounts than respondents who are uncertain about whether climate change is currently happening. The former were found to be willing to pay 7.41€ more than the latter. The views that respondents have on renewable energy and wind farms in particular, i.e. their base state beliefs, determine their WTP. Thus, respondents who think of wind farms as an important source of renewable energy which produces energy in an efficient way helping to reduce the impact of climate change are WTP more than those who are more uncertain about these aspects. Individuals' level of education was found to be a determinant in their WTP with those with higher level of education WTP (B.Sc., M.Sc., Ph.D.) being WTP 8–9€ more than respondents with lower levels of education. This is in concordance with the previous literature which also found positive relation between level of education and willingness to pay for wind farms [37]. We found that age and income level were not determining WTP. Finally, female in the sample were WTP 5.35€ more than male for the offshore wind farm.

We also found evidence that *base state influences* such as respondent's (pre-survey) behaviour towards the environment may determine respondents WTP (Table 3). Respondents who showed a positive environmental behaviour such as recycling were WTP more than those who do not recycle. However, other environmental behaviour such as the regular use of public transport was not found to be related to the WTP for the development of an offshore wind farm. Although the coefficient associated with respondents using public transport often or always was positive indicating a positive correlation between individual's frequency of use of public transport and individual's WTP this was not found to be statistically significant ($p > 0.05$).

We found that 70.2% of respondents were willing to pay the first proposed bid and 53.2% of respondents accepted to pay the second proposed bid. Of the respondents who were willing to pay the first proposed bid 70.7% were willing to pay a higher bid whereas of the 29.8% that refuse to pay the first bid 11.9% were willing to pay a lower amount. Table 4 illustrates the estimated mean and median WTP given the explanatory variables. Respondents would be WTP a premium of 20.37€ in their bi-monthly electricity bill for a 100 MW wind farm located in between the islands of Andros and Tinos. This represents the 0.7% of their average monthly income, a figure that is within the range of estimates found in previous studies on WTP for renewable energy. The mean WTP for renewable energy varies between 4.60€[4] and 29.19€[5] per two months [28-31,38]. More specifically in Greece, the mean WTP for a wind power farm in Rhodes (Greece) was estimated to be 8.86€ per two months [30] and the mean WTP per two months in South Evia (Greece) was estimated to be 16.13€. Compared with this estimate our WTP results are relatively high, in particular regarding results for the Rhodes island. However, two aspects must be beared in mind: (1) whereas respondents in this study were asked for their WTP for an offshore wind farm located in a low populated and remote area, between Andros and Tinos (24 people per km^2 and 44 people per km^2 in Andros and Tinos respectively) the wind power farm located in Rhodes is in a relatively highly populated area (2757 per km^2); and (2) whereas our respondents were Greek residents (i.e. not local residents from Andros and Tinos) who would not be affected by the negative externalities associated with the offshore wind farm, the sampling frame of the Rhodes project included local individuals who would be affected by the negative externalities associated with wind farms (e.g. visual impact, noise pollution). Therefore, we would expect higher (lower) individual WTP if negative effects associated with wind farms are not (are) present. Previous research has estimated household WTP for offshore wind farms in Denmark being located at long distances from the coast. On this point, locating the wind farms far from the coast minimises their visual and noise impact [21]. It was found that Danish households were WTP between 46 and 122€ per year for wind farms to be located 12 km and 50 km offshore, respectively, as opposed to having offshore farms at a 8 km distance [21]. Our results show individual's WTP for an offshore wind farm that minimises its negative effects (i.e. a relatively small population may be affected – visual and noise impact) from individuals that will not suffer negative impacts. Regarding this point, previous research has not found support for not in my backyard hypothesis [39,40], however research has focused on individual attitudes towards wind power rather than on the willingness to pay for it. Thus, although respondents living nearby wind power installations may be as likely to have positive attitudes and views towards wind power as people leaving far from wind power stations they may be willing to pay different amounts. Such differences in their willingness to pay are possible and they would reflect the negative effects of wind electricity generation (e.g. visual and noise impact).

[4] Mean WTP of 18.5 Chinese yuan, exchange rate 8 Chinese yuan/euro [28].
[5] Mean WTP of 2000 Japanese Yen, exchange rate 137 yen/euro [29].

Regarding WTP estimates for particular groups of respondents we found that those who recycle and belong to CC1 and RE1, with a female with a B.Sc. level of education and belonging to the 26–50 age group would be WTP 38.60€ every two months compared to 15.45€ which would be the amount that those a female between 26 and 50 years old who do not recycle and do not belong to CC1 nor RE1, with a B.Sc. level of education would be WTP.

4. Conclusion

We have used a double bounded dichotomous choice Contingent Valuation Method to (1) estimate the willingness to pay for an offshore wind farm located in a low density populated remote area in Greece and (2) investigating the influence of a number of behavioural aspects and views along with socio-economic factors on respondents' willingness to pay.

We found evidence that the development of offshore wind farms in Greece in areas where negative externalities are minimised have public support. Offshore wind energy development was found to be generally supported, especially by highly educated individuals, a result commonly found in the literature [30]. More specifically, 73.7% of respondents were willing to pay some amount for the offshore wind farm proposed. Hence, there is support for their development as a way to combat potential impacts of climate change. Such development of offshore wind farms would be in line with European Union targets regarding reducing GHG emissions. However, the promotion of offshore wind farms and/or any policy support for the development of offshore wind farm projects is more likely to be backed by the public if offshore farms are located where negative impacts are minimised.

Previous research found developing wind farms to be economically viable with similar support rates as the ones we present here. Our estimates for the willingness to pay for an offshore farm are higher than previous research on the willingness to pay for onshore farms in Greece [30,31]. It was found that residents were willing to pay a premium in their bi-monthly electric bill of €8.86 [30] and €16.13 [31] for the sole purpose of the construction of the wind farm. Our mean WTP estimate is €20.37 which differs approximately between 4€ and 11€ from previous estimates. However, this might partly reflect some of the costs associated with locating wind farms in sites that do not minimise the negative externalities associated with such installations (e.g. visual and noise impact).

Previous studies have analysed people's WTP for wind farms and renewable installations but this is the first study, to the best of our knowledge, which examines how behavioural aspects and views towards the environment, climate change and renewable energy affect individual's willingness to pay for offshore wind farms. We found that individual's behaviour and views towards environment, climate change and renewable energy are determinants of their WTP for the offshore wind farm. We found that respondents are WTP 20€ in their bi-monthly electricity bill with more environmentally conscious respondents being willing to pay almost 40€ and least environmentally conscious approximately 15€. This is important from a public policy aspect. Policies aiming at promoting “green energies” such as energy produced from off-shore wind farms may be more likely to succeed if the population is environmentally conscious. Therefore informative/educational activities/programmes in which potential effects of climate change and renewable energy are explained are likely to have an impact on the support for the development of “green energy”.

References

[1] Fuss S, Daniel JA, Johansson J, Szolgayova M. Obersteiner impact of climate policy uncertainty on the adoption of electricity generating technologies. Energy Policy 2009;37:733–43.

[2] Georgakellos DA. Impact of a possible environmental externalities internalisation on energy prices: the case of the greenhouse gases from the Greek electricity sector. Energy Econ 2010;32:202–9.

[3] Eurostat. Renewable energy in the EU28 March 2014. 〈http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/8-10032014-AP/EN/8-10032014-AP-EN.PDF〉.

[4] Kottari M. Energy fact sheet. Energy brains. Greece; 2014.〈http://www.energybrains.org/docs/EFS/EnergyBrains_EFS_Greece_MK_2014.pdf〉.

[5] YPEKA. Law 3851/2010. YPEKA (Ministry of Environment, Energy and Climate Change); 2010. 〈http://www.ypeka.gr/LinkClick.aspx?fileticket=qtiW90JJLYs%3d&tabid=37〉.

[6] Snyder BK. Ecological and economic cost–benefit analysis of offshore wind energy. Renew Energy 2009;34:1567–78.

[7] Keyaerts N, Delarue E, Rombauts Y, D'haeseleer W. Impact of unpredictable renewables on gas-balancing design in Europe. Appl Energy 2014;119:266–77.

[8] GWEC. Global Installed Wind Power Capacity. Global Wind Energy Council 2013. 〈http://www.gwec.net/wp-content/uploads/2014/04/5_17-1_global-installed-wind-power-capacity_regional-distribution.jpg〉.

[9] EWEA. The EU wind energy sector skills gap. EWEA 2013. 〈http://www.ewea.org/publications/reports/workers-wanted/〉.

[10] EWEA. The European offshore industry – key trends and statistics 2014. A report by the European Wind Energy Association. 2015.

[11] European Environment Agency. Europe's onshore and offshore wind energy potential. An assessment of environmental and economic constraints. Technical report no. 6/2009; 2009. p. 90.

[12] Kotroni V, Lagouvardos K, Lykoudis S. High-resolution model-based wind atlas for Greece. Renew Sustain Energy Rev 2014;30:479–89.

[13] Pryor SC, Barthelmie RJ. Climate change impacts on wind energy: a review. Renew Sustain Energy Rev 2010;14:430–7.

[14] Perveen R, Kishor N, Mohanty SR. Off-shore wind farm development: present status and challenges. Renew Sustain Energy Rev 2014;29:780–92.

[15] EWEA. The economics of wind energy. EWEA; 2009.

[16] Makarieva AM, Gorshkov VG, Bai-Lian L. Energy budget of the biosphere and civilization: rethinking environmental security of global renewable and non-renewable resources. Ecol Complex 2008;5:281–8.

[17] Esteban MD, Diez JJ, López JS, Negro V. Why offshore wind energy? Renew Energy 2011;36:444–50.

[18] Lu X, McElroy MB, Nielsen CP, Chen X, Huang J. Optimal integration of offshore wind power for a steadier, environmentally friendlier, supply of electricity in China. Energy Policy 2013;62:131–8.

[19] Wilhelmsson D, Malm T, Ohman MC. The influence of offshore windpower on demersal fish. J Mar Sci 2006;79:775–84.

[20] O'Keeffe A, Haggett C. An investigation into the potential barriers facing the development of offshore wind energy in Scotland: case study – Firth of Forth offshore wind farm. Renew Sustain Energy Rev 2012;16:3711–21.

[21] Ladenburg J, Dubgaard A. Willingness to pay for reduced visual disamenities from offshore wind farms in Denmark. Energy Policy 2007;35:4059–71.

[22] Westerberg V, Jacobsen JB, Lifran R. The case for offshore wind farms, artificial reefs and sustainable tourism in the French mediterranean. Tour Manag 2013;34:172–83.

[23] Winiarski KJ, Miller DL, Paton PWC, McWilliams SR. A spatial conservation prioritization approach for protecting marine birds given proposed offshore wind energy development. Biol Conserv 2014;169:79–88.

[24] Hammar L, Wikström A, Molander S. Assessing ecological risks of offshore wind power on Kattegat cod. Renew Energy 2014;66:414–24.

[25] EWEA. Wind in power: 2013 European statistics. European Wind Energy Association; 2014. 〈http://www.ewea.org/fileadmin/files/library/publications/statistics/EWEA_Annual_Statistics_2013.pdf〉.

[26] Perman R, Ma Y, McGilvray J, Common M. Natural resource and environmental economics 2001. Pearson Education Limited.

[27] Stigka EK, Paravantis JA, Mihalakakou GK. Social acceptance of renewable energy sources: a review of contingent valuation applications. Renew Sustain Energy Rev 2014;32:100–6.

[28] Guo X, Liu H, Mao X, Jin J, Chen D, Cheng S. Willingness to pay for renewable electricity: a contingent valuation study in Beijing, China. Energy Policy 2014;68:340–8.

[29] Nomura N, Akai M. Willingness to pay for green electricity in Japan as estimated through contingent valuation method. Appl Energy 2004;78:453–63.

[30] Koundouri P, Kountouris Y, Remoundou K. Valuing a wind farm construction: a contingent valuation study in Greece. Energy Policy 2009;37:1939–44.

[31] Mirasgedis S, Tourkolias C, Tzovla E, Diakoulaki D. Valuing the visual impact of wind farms: an application in South Evia, Greece. Renew Sustain Energy Rev 2014;39:296–311.

[32] Greene W. Econometric analysis. Boston, Mass/ London: Pearson; 2012.

[33] Bateman IJ, Lovett AA, Brainard JS. Applied environmental economics: a GIS approach to cost–benefit analysis. New York: Cambridge University Press; 2005.

[34] Fishbein M, Ajzen I. Belief, attitude, intention, and behavior: an introduction to theory and research. Mass: Addison-Wesley, Reading; 1975.

[35] Ajzen I, Fishbein M. Attitude-behaviour relations: a theoretical analysis and review of empirical research. Psychol Bull 1977;84:888–918.

[36] Shen J. Understanding the determinants of consumers' willingness to pay for eco-labeled products: an empirical analysis of the China environmental label. J Serv Sci Manag 2012;5:87–94.
[37] Zarnikau J. Consumer demand for "green" power and energy efficiency. Energy Policy 2003;31:1661–72.
[38] Zografakis N, Sifaki E, Pagalou M, Nikitaki G, Psarakis V, Tsagarakis KP. Assessment of public acceptance and willingness to pay for renewable energy sources in Crete. Renew Sustain Energy Rev 2010;14:1088–95.
[39] Ek K. Public and private attitudes towards "green" electricity: the case of Swedish power. Energy Policy 2005;33:1677–89.
[40] Wolsink M. Wind power and the NIMBY-myth: institutional capacity and the limited significance of public support. Renew Energy 2000;21:46–64.