



The impact of offshore wind farms on beach recreation demand

DOI:

[10.1016/j.marpol.2017.03.019](https://doi.org/10.1016/j.marpol.2017.03.019)

Document Version

Accepted author manuscript

[Link to publication record in Manchester Research Explorer](#)

Citation for published version (APA):

Voltaire, L., Loureiro, M. L., Knudsen, C., & Nunes, P. A. L. D. (2017). The impact of offshore wind farms on beach recreation demand: Policy intake from an economic study on the Catalan coast. *Marine Policy*, 81, 116-123. <https://doi.org/10.1016/j.marpol.2017.03.019>

Published in:

Marine Policy

Citing this paper

Please note that where the full-text provided on Manchester Research Explorer is the Author Accepted Manuscript or Proof version this may differ from the final Published version. If citing, it is advised that you check and use the publisher's definitive version.

General rights

Copyright and moral rights for the publications made accessible in the Research Explorer are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Takedown policy

If you believe that this document breaches copyright please refer to the University of Manchester's Takedown Procedures [<http://man.ac.uk/04Y6Bo>] or contact uml.scholarlycommunications@manchester.ac.uk providing relevant details, so we can investigate your claim.



Abstract

Offshore wind energy development can have major economic implications because of the potential impact on coastal recreation demand – particularly for countries that are characterised by high offshore wind power potential while also being popular tourist destinations. In this context, the impact of offshore wind farm projects on beach recreation demand in Catalonia (Spain) during the 2012 summer season was examined. A combined revealed and stated preference approach, which allows joint modelling of actual and hypothetical demands, was applied. The results demonstrate a significant welfare loss up to €203 million per season. The results further show that the installation of a wind farm mainly will cause a shift in trips to Catalan beaches without wind farms, which implies that the estimated negative economic impacts will occur mostly in areas where wind farms are located. From a political economy point of view, this may call for the design and implementation of re-distributive instruments to offset the negative impacts caused by wind farms.

Keywords: Beach recreation demand, Mixed revealed and stated preference approach, Count data model, Offshore wind farms, Coastal tourism, Consumer surplus loss

JEL Code: D61, Q26, Q42

1. Introduction

As of 30 June 2016, a total of 3344 offshore wind turbines with a combined capacity of 11,538 MW were fully grid-connected in 82 wind farms across 11 European countries (EWEA, 2016). Wind power is expected to provide the largest contribution to the EU's 2020 renewable energy targets (Snieckus, 2015), but critics are concerned about the potential negative impacts of offshore wind farms on tourism activities, in particular the recreational use of beaches. Strong opposition movements in the Mediterranean region of Languedoc Roussillon (France) and Catalonia (Spain), for example, illustrate the sensitiveness of the link between coastal tourism and offshore wind farms. In Languedoc Roussillon, tourism operators protested against an invitation to tender for the construction of offshore wind turbines launched by the French government in 2011. They pointed towards the potential for such a project to alter and spoil the allure of the coast, resulting in a possible decrease in tourism revenues (Westerberg et al., 2013). Although there are currently no offshore wind farm proposals in Catalonia, that might soon change. Indeed, the Government of Catalonia recently published the Plan of Energy and Climate Change of Catalonia 2012-2020 (PECAC 2020) as part of the EU's 2020 strategy. This plan aims at installing 5153 MW of wind power by 2020 of which 570 MW will be generated by offshore wind farms. Such plan is not indifferent to the coastal regions of Catalonia. With 580 km of coastline and about 221 beaches, the region has a wide natural waterfront. According to the Catalonian Tourism Office (Direcció General de Turisme, 2012), the coastal regions of Catalonia – with about 5.2 million inhabitants – received 12.6 million visitors, with an average stay of 7.8 days. In fact, the tourism sector in Catalonia contributes 11% of the total GDP (61% of which are allocated to coastal municipalities) and 12% of the population of Catalonia is employed in this sector.

Any reduction in coastal recreation demand could lead to a significant fall in tourism revenues, causing job losses.

In this context, the purpose of this paper is to estimate the potential welfare impact on beach recreation demand caused by the installation of 570 MW offshore wind power along the Catalan coast. Different offshore wind farm scenarios are considered by varying the distance from the shore and the density of turbines (i.e. number of windmills per farm). The remainder of the paper is structured as follows. Section 2 offers a literature review related to the issue of offshore wind farms and coastal recreation demand. Section 3 provides a description of the survey design and questionnaire implementation. Section 4 presents the econometric models. Section 5 presents the estimation results. Section 6 discusses the results in policy contexts. Section 7 provides concluding remarks.

2. Literature review

Previous studies have explored the impact on social welfare of offshore wind energy development (e.g., Ladenburg and Dubgaard, 2007; Ladenburg, 2008; Lilley et al., 2010; Krueger et al., 2011; Landry et al., 2012; Westerberg et al., 2013). These studies have mostly considered offshore windfarms in northern Europe, United Kingdom and United States where marine turbine projects have been highly encouraged as part of the countries' energy policies. To the best of our knowledge, only three of these studies have focused on coastal tourism and recreation (Lilley et al., 2010; Landry et al., 2012; Westerberg et al., 2013). Lilley et al. (2010) use the contingent behaviour (CB) method to look at changes in the number of planned trips in response to an offshore wind farm project in Delaware. They find that one quarter of the tourists would choose another beach if an offshore wind farm was installed 10km from the coast. Landry et al. (2012) investigate the impact of coastal wind turbines on

local coastal tourism and recreation for residents of the northeastern coastal counties in North Carolina. Data using combined Travel Cost and Contingent Behaviour methods to measure the impact of coastal wind farms on the economic value of beach visits was collected via telephone interviews. The TC method relies on data from observed behaviour to estimate recreation demand for a given site (Smith and Desvovages, 1985). The authors also implement an online choice experiment (CE) to evaluate the influence of the location of turbines on beach site selection. Their results conclude that wind turbines located in close proximity to the coast (one mile offshore) induce significant disutility to beach visitors. More recently, Westerberg et al. (2013) conducted a CE to explore preferences amongst tourists for wind turbines at different distances from the shore in the Languedoc Roussillon (France). The authors find that respondents have negative preferences for an offshore wind farm located 5km from the coast. Apart from the attributes of the turbines (i.e., density and distance from the shore), respondents' characteristics (e.g., age, income, experience with turbines) and the existence of substitute sites are found to influence preferences for and attitudes towards offshore wind farms.

This study builds on the work by Landry et al. (2012) and Westerberg et al. (2013). First, it combines TC and CB data. By combining both methods it is possible to estimate the change in recreation demand (the recreational economic use value) that might occur with changes in attributes of the good. This is particularly relevant to policy makers who require information on historical consumer demand and potential future demands to improve their basis for decision. Second, the study also explores (among other factors) the influence of the density and location of wind turbines on beach visitation, whereas this issue is ignored in the study by Landry et al. (2012). Furthermore, Landry et al. (2012) focusses on local coastal residents, whereas the target population of this study is coastal tourists who use commercial

accommodation (hotels, rented houses/apartments, camp sites). This choice is motivated by at least two factors. Firstly, tourists who use non-commercial accommodations (especially those who reside with relatives and friends), are often also motivated by the objective of visiting friends and family, and the beach trip might even be an incidental consumption. Secondly, and more importantly, tourists who use commercial accommodation create greater economic impact compared to other beachgoers (residents and tourists who use non-commercial accommodation) as they spend money on transport, meals and accommodation.

3. Survey design and implementation

3.1. Survey sites

The 221 beaches along the coast of Catalonia were classified according to a set of parameters including, *inter alia*, municipality/location, beach surface, water quality/visibility, and surrounding environment (ranging from urban to natural). The combination of these elements allowed selecting a sample of beaches that are representative of the entire Catalan coastline. A total of eight beaches were chosen. Each of these beaches has a different profile, and is therefore likely to attract different users or consumers of beach recreation activities – see Table 1.

In the absence of information on the profile of beach users in Catalonia, we shall use this beach sampling strategy to guarantee the representativeness of our sample.

(Table 1 about here)

3.2. Data collection

Data for this study was collected during the 2012 summer season by the use of a questionnaire consisting of about 20 questions (for a detailed description, see Nunes et al., 2015). In terms of beach trip behaviour, respondents were asked both revealed and stated preference questions related to trips taken to the beach where they were surveyed. Specifically, they were first asked about the number of trips taken during the 2011 summer season. Next, they were asked about the number of trips for the 2012 summer season. This referred to trips already taken during this season, including the trip taken on the day of the survey, and trips planned for the rest of the season. At this stage, the contingent scenario was introduced. Two attributes pertaining to the offshore wind farm were identified: distance from the shore and density of turbines, with each attribute containing two levels. The combination of attributes and levels yielded four scenarios ($2^1 \times 2^1 = 4$) (see Table 2). Each respondent randomly received one of the four scenarios. In order to mitigate a likely heterogeneity bias in interpreting the attribute levels, each scenario was illustrated with the help of photo simulation scenarios – see Figure 1 for an example.

(Table 2 and Figure 1 about here)

After being presented with a scenario, respondents were asked to indicate how they expected that their beach trip behaviour would change during the next 12 months if an offshore wind farm was built at the beach where they were surveyed. A single choice list of responses was proposed: (1) I would come more to this beach; (2) No change at all, I would return to this beach; (3) No change at all, I would return to this beach but not get into the water; (4) I would not come so often; (5) I would not come to this beach. If respondents

chose option (1) or (4), they were asked to indicate, in percentage terms, how many more or less trips they would take during the next summer season. The percentage stated was multiplied by the number of trips for 2012, resulting in the increase or decrease in the number of trips as a response to the offshore wind farm scenario. This outcome was then added to or subtracted from the number of trips for 2012 to obtain the number of planned trips under the contingent scenario. If respondents chose option (2) or (3), the number of trips under the contingent scenario was considered to be the same as the number of self-reported trips in 2012 under status-quo conditions. If option (5) was chosen, it was assumed that respondents would make no trips at all. In this case, a follow-up question asked whether they would go to a different beach in Catalonia, a non-beach location in Catalonia, a beach outside Catalonia, stay at home, or do something else. Thus, each respondent in the data set provided three trip responses: (1) revealed trips for the 2011 summer season; (2) mixed revealed – stated trips for the 2012 summer season under beach status-quo conditions; (3) stated trips for the next summer season under survey-described offshore wind farm conditions.

The questionnaire also contained information about trip costs. Trip costs include not only the TCs but also all expenses required to make a trip possible (e.g. food, accommodation and equipment costs) (Parsons, 2003). There are two broad categories of approaches for estimating the TCs (Parsons, 2003). The first approach involves calculating the TCs borne by the respondents to reach a site by the use of information gathered on distance travelled from the respondents' place of residence to the site. The second approach asks the respondents directly about their TCs. Respondent-reported costs are considered to be more likely than researcher-estimated costs to accurately reflect the costs that affect trip choice

(Randall, 1994). Therefore, also given our target population, it was considered more appropriate to apply the second approach. Similar to Prayaga et al. (2010), respondents were asked to report their TCs as well as all expenditures related to a day trip to the beach. These included the TC from the place of residence to the Catalan coast, TC from the accommodation in Catalonia to the beach, accommodation costs, meal costs, equipment costs and other costs related to beach recreation for the day of the survey.

The questionnaire was administered in Catalan, Spanish and English via face-to-face interviews by two teams of trained enumerators covering the 4 southern and the 4 northern studied beaches, respectively. The interviews were conducted in two distinct time frames, from 10:00 to 14:00 and from 15:00 to 19:00. The interviews were carried out during both weekdays and weekends from 14 June to 15 September 2012. Only adult beach users (18 years of age or over) were surveyed. They were approached using the itinerary method, which approximates a random sample: enumerators took the shoreline as a reference line and walked ten meters straight ahead between each respondent. The ten meters were walked along the shoreline or from the shoreline towards inland. Interviews were only carried out with beach users placed in the fringe between the shoreline and, when possible, the first 30 meters of the shore, which is considered the useful beach surface (Sardá et al., 2009). Beachgoers were mainly approached while sunbathing, stepping out of the sea, or walking along the shoreline. Interviewers were identified with a badge and they were in charge of introducing the aim of the study as well as the estimated duration of the survey (approximately 20 min).

4. Econometric model specifications

Trip responses of respondents can be classified into two categories. The first one refers to whether or not their recreation demand would change in the future if an offshore wind farm was installed in the beach where they were surveyed. This type of response is modelled through a Probit model. The second one refers to the number of trips taken to the beach in question under current and offshore wind farm conditions. Given the nonnegative integer nature of the dependent variable (number of trips), count models from the Poisson family are suited for this type of data. Similar to Eiswerth et al. (2000), a Pooled Poisson revealed/contingent trip behaviour model is adopted. Revealed and stated trips to all surveyed beaches are combined in a single-site equation, as in Englin and Cameron (1996), Englin et al. (1997) and Hanley et al. (2003). The model is specified as follows:

$$r_i = f(tc_i, y_i, z_i, bc_i, RP_i, OWF_i, RP_i \times tc_i, MRP_i \times tc_i, OWF_i \times tc_i) = f(x_i) \quad (1)$$

where individuals are indexed i ; r is the number of revealed and stated trips; tc is the travel expenses; y is the household income; z is a vector of socioeconomic and demographic characteristics; bc is a dummy variable indicating the beach where the respondent was surveyed; RP is a dummy variable indicating the revealed trips for the 2011 summer season; MRP is a dummy variable indicating the mixed revealed and stated trips for 2012; OWF is a dummy variable indicating the stated trips under the offshore wind farm scenario. $RP \times tc$, $MRP \times tc$ and $OWF \times tc$ are interactions between the travel expenses and revealed, mixed revealed/stated and stated trips dummy variables, respectively. In Appendix A, an additional specification is estimated containing interaction terms between the beach variable and the

eight beaches. Only one cross-product is significant, and thus, Section 5 will be devoted to explaining the results of equation (1).

The probability function of the Poisson model is given by:

$$f(r_i|x_i) = \frac{e^{-\lambda_i} \lambda_i^{r_i}}{r_i!} \quad (2)$$

with a mean parameter specified as an exponential link function, which is assumed to be a function of explanatory variables, x_i , as described in (1):

$$\lambda_i = \exp(x_i \beta) \quad (3)$$

β is the vector of parameters to be estimated. The exponential form ensures that λ_i , the number of reported trips in the current summer season, is nonnegative. Welfare is expressed in terms of consumer surplus (CS) and calculated per-trip and per-season basis, respectively, as:

$$CS = -\frac{1}{\beta_{tc}} \quad \text{and} \quad CS = -\frac{\hat{\lambda}}{\beta_{tc}} \quad (4)$$

The seasonal surplus loss resulting from the installation of an offshore wind farm is given by:

$$\Delta CS = \frac{\hat{\lambda}^* - \hat{\lambda}}{\beta_{tc}} \quad (5)$$

where $\hat{\lambda}^*$ is the expected number of trips for the following summer season under the offshore wind farm conditions.

5. Estimation results

5.1 Univariate analysis of the joint travel cost and contingent behaviour method

A total of 641 beach users (both residents and tourists) completed the questionnaire. Of this number, approximately 23% were tourists using commercial accommodation. Table 3 provides the descriptive statistic review for this segment of tourists (our target population). In terms of demographic and socio-economic characteristics, 53.8% are non-local tourists (they do not live in Catalonia). Almost as many men (49.7%) as women (50.3%) are surveyed. The average age is 40.37 years, with an average midpoint of household income brackets of nearly €5000 per month (the most frequent income class was €2000 – €3000 (24.8%) followed by €3000 – €4000 (20.0%). They are generally highly educated with 59.4% having obtained a university degree. The average household size is 3.13 persons.

(Table 3 about here)

The total expense per beach trip per person for the 2012 summer season is calculated as follows:

$$\text{Trip cost} = \frac{T_{cost} + E_{cost} + L \times (A_{cost} + M_{cost} + t_{Ccost})}{NBtrip_{2012}} \quad (6)$$

where T_{cost} is the sum of TCs per person for all trips from the respondent's place of residence to the Catalonian coast and back; E_{cost} is the total equipment costs related to beach activities; L is the length of stay; A_{cost} is the daily cost of accommodation per person;

M_{cost} is the daily cost of meals per person; t_{ccost} is the TC per person from the accommodation in Catalonia to the beach; and $NBtrip_{2012}$ is the number of trips for the 2012 summer season.

An implicit assumption underlying the above definition of trip cost is that all reported expenses are incurred exclusively for beach recreation purposes i.e., there is no multi-purpose problem. This problem does not seem to apply for local tourists (people who live in Catalonia and spend their holidays in another Catalan city) because their average stay is 12.34 days and the average number of trips reported for the 2012 summer season is 14, corresponding to a trip/length-of-stay ratio of 1.13. The Wilcoxon rank-sum test shows that the difference between these two values is not significant ($Z = -1.206$; $p \leq 0.228$). The results thus suggest that local tourists go to the beach once a day during their stay. The trip/length-of-stay ratio for non-domestic tourists, however, is 0.59 ($Z = -5.558$; $p \leq 0.000$) suggesting that beach recreation is not the sole purpose of their visit to Catalonia, and therefore their trip costs cannot be fully allocated to the beach trip. To date, there is no standard approach to deal with the issue of multiple-purpose trips in the TC method (see Martínez-Espiñeira and Amoako-Tuffour, 2009). In this study, the trip/length-of-stay ratio is taken as a proxy for the degree of importance attached to beach recreation by the non-local tourists when deciding on their holiday destination by multiplying trip costs by 0.59.

All scenarios combined, 51% of respondents state that they would not change their trip behaviour if an offshore wind farm was built at the beach where they were surveyed, 12.4% say they would visit the beach less and 36.6% say they would take no trips at all. Of these 36.6%, 88.7% state they would visit a different beach in Catalonia and 11.3% would prefer to

visit a beach outside Catalonia. None of the respondents report an increase in intended beach visits. Due to the small number of observations for the modality "I would not come so often", this modality is pooled with "I would not come to this beach", resulting in a single modality "change in trip behaviour" (63.5%). Looking at each scenario separately, 34.2% of respondents predict a change in their beach trip behaviour for the scenario Low/Far. This proportion increases by about 14%-points under the scenarios Low/Near and High/Far and by 29%-points under the scenario High/Near.

Mean revealed and stated trips are summarized in Table 4. The average number of trips for the 2012 summer season increases by 42% relative to the average number of trips for 2011, mainly because 64.1% of respondents did not take any trip in 2011. The Wilcoxon rank-sum test indicates that the difference is significant ($Z = -6.225$; $p \leq 0.000$). However, when performing the test on only repeat beach users, i.e. respondents who have taken at least one trip in both 2011 and 2012 summer seasons, the results indicate no significant difference ($Z = -0.32$; $p \leq 0.744$). Assuming no change in respondents' income, this finding can be seen as evidence of the absence of hypothetical bias in the trip data (Whitehead et al., 2000): revealed trips for 2011 are identical to mixed revealed/stated trips for 2012 under similar benefit and cost conditions. With all offshore scenarios combined, the number of planned trips decreases by 37% relative to the number of trips in the 2012 summer season. The difference is significant ($Z = -7.361$; $p \leq 0.000$), suggesting that the installation of an offshore wind farm is likely to result in a significant decrease in the demand for beach recreation. Differences in the mean number of trips across scenarios are tested through the Mann-Whitney test. The null hypothesis of equality is rejected in several cases.

(Table 4 about here)

5.2 Multivariate regression analysis

Results of the Probit model are presented in Table 5. The dependent variable takes the value 1 if the respondents report a change in trip behaviour under offshore wind farm conditions and 0 otherwise. The likelihood of changing trip behaviour depends on the distance from the shore and/or the density of turbines, as reflected by the significance of parameters for scenario variables. The effect of High/Near indicates that the installation of an offshore wind farm characterised by both a high density of turbines and close distance from the shore increases the likelihood of reducing the trip frequency, as compared with a low density offshore wind farm far from the shore (the base category). The positive sign of the parameter for High/Far suggests that for two scenarios where wind farms are located far from the shore (i.e., High/Far and Low/Far), increasing the density of turbines leads to an increase in the likelihood of reducing the trip frequency. The parameter for High/Near is significantly different from the parameter for Low/Near [$\chi^2 (1df) = 4.21; p \leq 0.038$], which suggests that for two scenarios where the wind farms are located near the shore, increasing the density of turbines leads to an increase in the likelihood of reducing the trip frequency. However, the null hypothesis of equality of parameters cannot be rejected for High/Near and High/Far [$\chi^2 (1df) = 1.92; p \leq 0.166$] and for High/Far and Low/Near [$\chi^2 (1df) = 0.54; p \leq 0.461$].

The likelihood of changing trip behaviour is also influenced by other beach characteristics including for example the surrounding environment evidenced by the fact that at least one of the associated coefficients is significantly different from zero. Bearing in mind that Castell and Golfet beaches (the base category) are labelled "natural" beaches (see Table 1), the negative sign of parameters for beach variables indicate that respondents would be less

likely to reduce their trip frequency if an offshore wind farm was built at an urban or mixed urban/natural beach.

(Table 5 about here)

Table 6 contains the results of two specified pooled Poisson models. The first specification includes a "composite" scenario variable, OWF, which refers to all scenarios combined (Model 1). The second specification includes dummy variables that denote each offshore wind farm scenario separately (Model 2). Similar to Simões et al. (2013), regression disturbances are clustered at the individual level to control for a possible correlation between trip responses for the same respondent.

(Table 6 about here)

Both models provide somewhat similar results in terms of both sign and magnitude of parameter estimates. The trip cost parameter is negative and significant, which enables estimation of CS. The negative and significant sign of the OWF parameter indicates a downward shift of the demand function under wind farm scenarios. However, the shift in demand differs across scenarios as at least one parameter for scenario variables is significant. The negative sign of the High/Near parameter suggests that the implementation of the High/Near scenario is likely to result in a lower number of trips, as compared to the Low/Far scenario. A similar pattern is true for the scenario High/Far, which means that for the two scenarios where wind farms are located far from the shore, increasing the density of turbines leads to a significant fall in the demand for beach trips. Differences in parameters

for High/Near vs Low/Near and High/Far vs Low/Near are found to be significant ($[\chi^2 (1df) = 3.43; p \leq 0.064]$ and $[\chi^2 (1df) = 11.96; p \leq 0.000]$ respectively), suggesting that the demand for trips differs across these scenarios.

Beach variables turn out significant in both models, which means that the effect of wind farms on recreation demand is influenced by different types of beach environment. This finding implies that overall visual impact may vary depending on the field-of view of the proposed projects, which is not only related to the distance from the turbines to the beach, but also to other morphological related characteristics (open-sea beaches for example allow for an ampler visual spectrum than closed and semi-closed beaches). Furthermore, recreational activities are also affected by the beaches' morphological types.

In terms of control variables used to consider the various elicitation situations, the RP dummy variable shifts the intercept significantly downwards, suggesting that the number of revealed trips is significantly lower than the number of mixed revealed and stated trips under the same status quo beach conditions. As noted earlier, this is due to the fact that 64.1% of the respondents surveyed in 2012 did not take any trips during the 2011 summer season. When estimating the model with only repeat beach users (those respondents who have taken at least one trip in each summer season), the results indicate that there is no statistically significant difference (see Appendix B). In other words, they suggest that the trip data do not suffer from hypothetical bias (Whitehead et al., 2000).

As for socio-demographic variables, the parameter for age is positive and significant, indicating a direct relationship between beach recreation demand and age. An explanation could be that older people have a higher propensity to enjoy this activity compared to teenagers. The relationship between income and beach recreation, although negative and

significant, is extremely small. Other empirical studies found similar results (e.g., Landry et al., 2012).

Conditional expectations and welfare estimates are summarized in Table 7. The CS per-person for the 2012 summer season (our baseline) is about €96 per beach trip. This is of the same order of magnitude as that of Landry et al. (2012), namely \$113 per beach trip or €100 (June 2015 exchange rate). Multiplying this value by the estimated number of average predicted trips yields the CS per-person for the 2012 summer season of about 942€. If an offshore wind farm was installed, seasonal CS is estimated to be reduced by about 36% relative to the baseline CS in 2012, suggesting a significant loss in welfare. However, as suggested by the results reported in Table 7 (Model 2), the welfare loss would be lower than 36% under the Low/Near scenario or higher than 36% under the High/Far scenario.

(Table 7 about here)

6. Policy uptake of the current study

According to the Catalan Government, 263.7 million trips were made to Catalan beaches in 2012 by all types of beach recreationalists including residents, local tourists, non-local tourists and excursionists (see Catalunya Turística en Xifres, 2012). Bearing in mind that the architecture of the sample design aims at guaranteeing regional representativeness of beach users in Catalonia, it is possible to estimate the total expected welfare loss associated with the generation of 570 MW offshore wind power as planned by the Government of Catalonia to be generated by offshore wind farms by 2020 (Government of Catalonia, 2011).

Based on our survey data for the 2012 summer season, it is known that: (1) the average number of adults in a beach recreation party is 2.44; (2) the average number of trips

reported by any individual respondent is 25; and (3) 23% of the respondents made use of commercial accommodation. Combining these survey statistics with the beach trip data reported by the Catalan Government, it can be inferred that there are 994,278 adult tourist beach recreationalists who use commercial accommodation during their stay in Catalonia $(263,700,000 \div 2.44 \div 25 \times 0.23)^1$. In order to estimate the total expected welfare loss associated with the generation of 570 MW offshore wind power the percentage of the target group that will be affected by such installation needs to be estimated.

In this context, the proportion of the 580 km Catalonian coastline that will be impacted by the installation of 570 MW offshore wind power is estimated. Visual impact is dependent upon a wide range of variables (e.g. distance to the coastline, size of the wind farm, size and colour of turbines and weather conditions). Distance to the coastline, however, is a key variable that can be used to define visual significance thresholds. According to the literature, wind farms are a major focus of visual attention at distances up to 13 km and moderately noticeable at distances up to 24 km (see Wratten et al. 2005). Wind farms installed more than 24 km from the coastline will only have possible minor visual effects.

In the following it is assumed that wind farms have negative visual impact if they are located no more than 24 km from the coastline. In particular, it is estimated that wind farms located 3 km, 5 km, 10 km, 15 km and 20 km away from the coastline generate a visual dis-amenity that is extended to 14.5 km, 24.1 km, 43.6 km, 37.5 km and 26.5 km of the shoreline,

¹ This may be considered a conservative figure given that more than 7.2 million visitors are classified as "coastal tourists" staying in hotels in 2011 according to an official statistics report. The term "coastal tourists" include both coastal and inland municipalities (<http://www.idescat.cat/economia/inec?tc=3&id=5410&lang=en>).

respectively.² The total impact will depend upon the number of wind farms necessary to deliver the proposed policy goal, i.e. generation of 570 MW offshore wind power by 2020. In this respect, two policy options are considered. The first refers to the ZÈFIR investment programme in which the proposed wind farms generate 70 MW (Government of Catalonia, 2011). In this scenario, approximately 8 wind farms would be necessary to generate 570 MW. The second option refers to the average size of offshore wind farms in Europe. According to the European Wind Energy Association, this figure was 337.9 MW in 2015 (see EWEA, 2015). In this scenario, approximately 2 offshore wind farms would be necessary to generate 570 MW. The combination of these two factors (distance from the shore and density of the farms) will determine how many kilometres of the shoreline that will be visually impacted by 570 MW offshore wind power installations – see Table 8.

(Table 8 about here)

At this stage, it is possible to estimate the loss of consumer surplus associated with the implementation of 570 MW offshore wind power. A range of welfare estimates depending upon (1) the density of the offshore wind farms, and (2) distance from the wind farm to the coastline are presented in Table 9. The welfare impact from visual dis-amenities on adult tourist beach recreationalists who use commercial accommodation during their stay in Catalonia caused by the implementation of 570 MW in line with the ZÈFIR investment programme ranges between €67.3 and €203 million per season.

(Table 9 about here)

² Visual impact is not a linear function of distance to the shore because wind farms that are installed close to the coastline will be far out in the periphery if seen from a distance of 24 km while wind farms that are installed far from the coastline will be visible only along a relatively short segment of the coastline.

These valuation results need, however, to be interpreted along the empirical conditions of this study. First, on-site data collection may lead to endogenous stratification because frequent users are more likely to be surveyed than less frequent users (Shaw, 1988). Our estimates are not corrected for truncation or endogenous stratification similar to Lienhoop and Ansmann (2011) and Simões et al. (2013)) and the reported welfare estimates, therefore, relate to current beach users only (Hanley et al., 2003). Second, our empirical exercise did not include non-users (Shaw, 1988). The welfare of non-users may also be affected by the installation of offshore windfarms, but the sign and magnitude of this potential change in welfare is not included in our estimates. Note that when the contingent scenario refers to an improvement in current conditions, it is likely that current non-users become users in the future. In such case, failure to account for truncation is likely to underestimate the total gains in welfare (Hanley et al., 2003). In our study, however, none of the respondents predicted an increase in trip behaviour under the contingent scenarios and an offshore wind farm is thus assumed to be an unfavourable change to current beach attributes. Under such deteriorated conditions, the probability of current non-users becoming users in the future is low, and so the additional estimated welfare loss is not likely to deviate significantly from the one estimated in this study (Simões et al., 2013).

7. Conclusions

Offshore wind farm projects gain ground in a number of European countries. Objections to such projects often relate to the potential negative impact on coastal tourism. This study investigated the potential change in beach recreation demand in Catalonia in response to the implementation of an offshore wind farm project. Our results showed that respondents would change their trip behaviour significantly if an offshore wind farm was installed,

bringing along with it a significant welfare loss to Catalonia's beach visitors estimated to range between €67.3 and €203 million per season.

Furthermore, the results showed that if 570 MW offshore wind power is to be generated along the Catalan coast, such installation will cause significant shifts in visits flows to the beach. Consequently, the annual welfare loss will not be equally distributed but rather concentrated to those areas where the wind farms are located. In this context, our findings can play a useful role in the debate on implementation of offshore wind farm projects. From a political economy point of view, the quantification of these aspects may be equally important to the quantification of welfare impacts in order to reach high-level, evidence-based, policy-relevant consensus in line with the recently adopted EU's 2020 renewable energy targets.

Acknowledgements

The authors acknowledge the European Commission for financial support under contract agreement no. 266445: *Vectors of Change in Oceans and Seas Marine Life, Impact on Economic Sectors (VECTORS)*. They would also like to thank Laia Piñol, Lola Rodríguez and Sergio Sastre for their support on data collection. Last but not the least, the authors would like to thank an anonymous reviewer for valuable comments and suggestions on an earlier version of this manuscript. The usual disclaimers apply.

References

- Cameron, A.C., Trivedi, P.K., 2009. *Microeconometrics Using Stata*. Stata Press College Station, TX.
- Government of Catalonia, 2011. *Plan of Energy and Climate Change 2012-2020 (Pla de l'Energia i Canvi Climàtic de Catalunya 2012-2020)*.
- Catalunya Turística en Xifres Generalitat de Catalunya Departament d'empresa i Ocupació. Direcció General de Turisme, 2012.
- Eiswerth, M.E., Englin, J., Fadali, E., Shaw, W.D., 2000. The value of water levels in water-based recreation: A pooled revealed preference/contingent behavior model. *Water Resources Research* 36, 1079-1086.
- Englin, J., Cameron, T.A., 1996. Augmenting travel cost models with contingent behavior data. *Environmental and Resource Economics* 7, 133-147.
- Englin, J., Lambert, D., Shaw, W.D., 1997. A structural equations approach to modeling consumptive recreation demand. *Journal of Environmental Economics and Management* 33, 33-43.
- European Wind Energy Association (EWEA), 2015. *The European offshore wind industry - key trends and statistics 2015*.
- European Wind Energy Association (EWEA), 2016. *The European offshore wind industry: key trends and statistics 1st half 2016*.
- Hanley, N., Bell, D., Alvarez-Farizo, B., 2003. Valuing the benefits of coastal water quality improvements using contingent and real behaviour. *Environmental and Resource Economics* 24, 273-285.

- Krueger, A.D., Parsons, G.R., Firestone, J., 2011. Valuing the visual disamenity of offshore wind projects at varying distances from the shore. *Land Economics* 87, 268-283.
- Ladenburg, J., 2008. Attitudes towards on-land and offshore wind power development in Denmark; choice of development strategy. *Renewable Energy* 33, 111-118.
- Ladenburg, J., Dubgaard, A., 2007. Willingness to pay for reduced visual disamenities from offshore wind farms in Denmark. *Energy Policy* 35, 4059-4071.
- Landry, C.E., Allen, T., Cherry, T., Whitehead, J.C., 2012. Wind turbines and coastal recreation demand. *Resource and Energy Economics* 34, 93-111.
- Lienhoop, N., Ansmann, T., 2011. Valuing water level changes in reservoirs using two stated preference approaches: An exploration of validity. *Ecological Economics* 70, 1250-1258.
- Lilley, M.B., Firestone, J., Kempton, W., 2010. The effect of wind power installations on coastal tourism. *Energies* 3, 1-22.
- Martínez-Espiñeira, R., Amoako-Tuffour, J., 2009. Multi-destination and multi-purpose trip effects in the analysis of the demand for trips to a remote recreational site. *Environmental Management* 43, 1146-1161.
- Nunes, P.A., Loureiro, M.L., Piñol, L., Sastre, S., Voltaire, L., Canepa, A., 2015. Analyzing beach recreationists' preferences for the reduction of jellyfish blooms: Economic results from a stated-choice experiment in Catalonia, Spain. *PloS one* 10, e0126681.
- Parsons, G.R., 2003. *The travel cost model, A primer on nonmarket valuation*. Springer, pp. 269-329.
- Prayaga, P., Rolfe, J., Stoeckl, N., 2010. The value of recreational fishing in the Great Barrier Reef, Australia: a pooled revealed preference and contingent behaviour model. *Marine Policy* 34, 244-251.

- Randall, A., 1994. A difficulty with the travel cost method. *Land Economics* 70, 88-96.
- Sardá, R., Mora, J., Ariza, E., Avila, C., Jimenez, J.A., 2009. Decadal shifts in beach user sand availability on the Costa Brava (Northwestern Mediterranean Coast). *Tourism Management* 30, 158-168.
- Shaw, D., 1988. On-site samples' regression: Problems of non-negative integers, truncation, and endogenous stratification. *Journal of Econometrics* 37, 211-223.
- Simões, P., Barata, E., Cruz, L., 2013. Joint estimation using revealed and stated preference data: An application using a national forest. *Journal of Forest Economics* 19, 249-266.
- Smith, V.K., Desvougues, W.H., 1985. The Generalized Travel Cost Model and Water Quality Benefits: A Reconsideration. *Southern Economic Journal* 52.
- Snieckus, D., 2015. Vestas unveils customisable 3MW platform, *Recharge*, EWEA.
- Westerberg, V., Jacobsen, J.B., Lifran, R., 2013. The case for offshore wind farms, artificial reefs and sustainable tourism in the French Mediterranean. *Tourism Management* 34, 172-183.
- Whitehead, J.C., Haab, T.C., Huang, J.-C., 2000. Measuring recreation benefits of quality improvements with revealed and stated behavior data. *Resource and Energy Economics* 22, 339-354.
- Wratten, A., Martin, S., Welstead, J., Martin, J., Myers, S., Davies, H., Hobson G., 2005. Guidance on the Assessment of the Impact of Offshore Wind Farms: Seascape and Visual Impact Report.