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Valuing the visual impact of wind farms: An application in South Evia, Greece

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ABSTRACT

This study presents an application of the Contingent Valuation Method (CVM) for valuing the landscape externalities associated with the large-scale exploitation of wind power at the local level. The survey was undertaken in South Evia, Greece, which is a region with rich wind energy potential and a considerable number of wind farms in operation during the period of the study. The results showed that 57% of the households are not willing to contribute financially in order to implement interventions to mitigate the visual impact of wind farms. The mean willingness to pay per household to avoid the visual impact attributed to the installation of new wind farms in the area in question was estimated at €41.6/year taking into account all households of the sample. This estimate is relatively lower compared to the results of other relevant studies. As shown by a meta-analysis developed based on these studies, this is mainly attributed to the great recession in Greece and the reduced available income of households.

Contents

1. Introduction

It is widely recognized that combating the negative effects of climate change constitutes one of the most significant challenges faced by the global community. The key role of renewables and particularly of wind power in tackling climate change has been acknowledged by several major studies completed recently [1,2]. In the European Union promotion of renewable energy sources and energy efficiency as well as the strengthening, expanding and improving the functioning of the emission trading system are the main pillars of the European policy to combat climate change. In this context, significant investments in new wind farms are included in almost all National Renewable Energy Action Plans undertaken by Member States in the Scope of Directive 2009/28/EC. Also, Pacala and Socolow [3] identified wind power as one of the key 15 technologies to solve the carbon and climate problem for the next half-century.

Even though wind energy is a pollution-free and infinitely sustainable form of energy, there is considerable concern over some environmental effects resulting from wind power development (see

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Nomenclature

CV	Contingent Valuation
CVM	Contingent Valuation Method
Q_i	quantitative and/or qualitative characteristics of the respondent i
RES	Renewable energy sources
S_i	socio-economic characteristics of respondent i
WTA	willingness to accept
WTP	willingness to pay
Y_i	the annual income of respondent i
ZTV	Zone of Theoretical Visibility

for example [4] as well as [5] for a comprehensive review). Criticism focuses primarily on the visual impact due to the installation of wind turbines and transmission lines, which results in the deterioration of the landscape and may harm the associated economic activities, namely tourism, real estate, etc. It is also worth mentioning that relevant concerns initiated reactions against wind energy that intensified in recent years as the number of installed wind farms and the size of turbines increased: nowadays the most common types of turbines have a nominal capacity of 2–3 MW, a tower height of 70–90 m and diameter blades of around 45 m. However, there are also cases where the local communities are positive towards the development of large wind farms [6,7].

The analysis of the visual impact associated with wind farms development presents significant methodological difficulties as it depends on turbine and site characteristics as well as on the level of exposure received by visual receptors. Several studies agree that the visual impact in a specific area increases with the size and number of wind turbines [8–10]. However, it is not clear whether a low number of large turbines is preferable to many smaller wind turbines or vice versa (for example Tsoutsos et al. [8] and Brusa and Lanfranconi [11] lead to contradictory results). The visual impact attributed to wind farms decreases with distance from dwellings or from the sea-coast in case of off-shore wind farms [12–16]. The materials and the color of wind turbines also affect the visual impact caused, which increases if the turbines contrast with the background [16]. In addition, the arrangement of wind turbines in the farm area as well as the spacing between them could also affect the overall human perception of annoyance, as can ground morphology, existence of neighboring buildings, vegetation and climatic conditions [11,16,17]. Last, as the perception of visual impacts is subjective it is also influenced by psychological factors. Individuals with a negative attitude towards wind energy are expected to find the visual impact less tolerable [18].

Several approaches can be implemented, independently or in combination, for analyzing and assessing the visual impact of wind farms. The most commonly used among them comprise [19,20,8,21]: (i) the Zone of Theoretical Visibility (ZTV) approach, which defines the land area from which a wind farm can be totally or partially visible (as the visual impact decreases with the distance, different zones of theoretical visibility can be defined representing different levels of visual burden); (ii) the estimation of appropriately designed indices, which incorporate specific parameters (e.g., population in the neighboring areas, number of wind turbines) influencing the visual impact of wind farms; (iii) field surveys and evaluation of the future changes in the landscape through photomontage, video-montages, etc; and (iv) monetization of the visual impact on the basis of appropriate environmental valuation techniques.

This paper aims at valuing the visual impact and the aesthetic degradation of the landscape associated with the large-scale wind power development at the local level by exploiting techniques of environmental economics. Attributing monetary values to environmental impacts associated with power generation technologies was widely used during the last two decades in the European Union and constitutes a powerful tool to comparatively evaluate alternative energy projects and technologies. Focusing on wind energy, environmental valuation techniques have been used for quantifying both the environmental benefits [22–24] and costs [25,26,13,27] associated with this specific power generation technology. This study presents an application of the Contingent Valuation Method (CVM) for valuing the landscape externalities attributed to wind farms installed in a Greek island, namely Evia. The implementation of the method was supported by a survey of the residents of the area in question, through the completion of an appropriately designed questionnaire with personal interviews. It should be noted that on the south side of the island of Evia, where the survey was undertaken, a significant number of wind farms are under operation (with a total installed capacity of 83.9 MW), while several new projects are planned. So the residents can evaluate the environmental impacts of wind farms on the basis of their own experiences. The findings of the analysis are comparatively evaluated with the results of similar studies conducted internationally, with a view to highlight the significance and the key parameters influencing the externality in question.

The structure of this paper is as follows: Section 2 presents a literature review of studies valuing the visual impact of wind farms. Section 3 describes the CVM used in this paper. Section 4 focuses on the application of the method, providing information on the study area, the design of the questionnaire, the survey undertaken, etc. Section 5 presents the selection of the appropriate econometric models and the basic results of the analysis. Finally, in Section 6, the main findings of the study are summarized and conclusions are drawn.

2. Review and meta-analysis of valuation studies

There is a growing number of studies, mainly in developed countries, aiming at valuing the visual impact and aesthetic degradation of the landscape caused by wind farms development. In this Section a review of this literature is given, with a view to undertake a meta-analysis, which may be used to easily approximate landscape externalities attributed to specific wind energy projects through benefits transfer.

2.1. Valuation techniques used

Various environmental valuation techniques have been used for monetizing the landscape externalities of wind farms, namely Contingent Valuation [28–30], Conjoint Analysis and particularly Choice Experiments [12,14,25,26,31,32], Hedonic Pricing [33,34], and Benefits Transfer [13].

The majority of the studies reviewed, exploiting either Contingent Valuation or Conjoint Analysis, estimate people's willingness to pay (WTP) for avoiding (e.g., through the exploitation of alternative energy sources) or eliminating (e.g., through the installation of wind farms in question in relatively isolated areas) the visual disamenities attributed to wind farms, while a rather limited number of studies (see for example [10,29]) focus on the willingness to accept (WTA) compensation for installing the wind farms in a specific area. Hedonic Pricing techniques usually explore the relationship between house prices and their proximity to wind