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Dynamic properties of the preferences for renewable energy sources – A wind power experience-based approach

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ABSTRACT

Based on a Danish survey including respondents with on-shore viewshed experience and varying degrees of off-shore viewshed experience, it is estimated how the different types of wind power experience influence the preferences for wind power, biomass energy and solar energy development in Denmark. The preference relations indicate that on-shore viewshed experience reduces preferences for wind power by 6% and increases preferences for biomass and solar energy solutions relative to wind power by nearly 5%. In contrast, off-shore viewshed experience increases preferences for wind power relative to biomass energy by 24%. However, the effect is dependent on the type of off-shore wind farm experience. Thus, experience of near-shore wind farms can reduce the preferences for wind power. The results also suggest that wind turbines in the viewshed influence the relative preferences between solar energy and biomass energy.

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1. Introduction

The transition to a low carbon economy is dependent on the mix of RES (Renewable Energy Sources) chosen and the flexibility of the existing energy network in terms of coping with the challenges of the higher variability of energy generation from RES [1–3]. The cost of transition is an important factor when choosing among different low carbon paths and RES mixes. Such costs typically include investments, generations, grid costs etc. [3–5]. However, from a welfare economic point of view, the external (social) costs of RES, such as disamenities, pollution, loss of biodiversity, etc., should be included in the analysis [3,5,6]. An example of this can be seen in Garcia et al. [7], in which the dynamic cost of Hybrid Energy Solutions is estimated. The external cost is modelled in a relatively simple manner (as also stated by the authors) and is limited to take into account the cost of CO_2 emissions associated with conventional brown energy. A similar approach has been applied in Cosentino et al. [4]. However, as stated in the preferences literature, the external costs of RES depend on the type of RES and can hardly be explained by a unit price for CO_2. This is illustrated in Hong et al. [8], who include the external cost of nuclear energy from radiation.

Preferences for RES and the mitigation of their external costs have received considerable attention in the literature on energy economics. Generally, the literature indicates that people have the strongest preferences for solar energy and wind power [9–13]. Interestingly, a new study by Ribeiro et al. [13] finds that acceptance of solar energy, wind power, biomass power and hydropower is dependent on the experience people have with the different RES. These results are in line with the finding that preferences for RES are influenced (both positively and negatively) by people's knowledge of RES [11,14,15]. However, a limitation of Ribeiro et al. [13] is that they do not test the effects of living in an area with the jth RES on the acceptance of other RES ($\neq j$th). The effects from experience of RES on the preferences for other RES have only been explored in a few studies, and so far no significant effect has been identified. This is despite the important implications an experience-driven feedback mechanism on relative preferences would have for an efficient deployment of RES and the associated costs paths. If preferences for different RES vary according to people's experience and/or their spatial interrelation with RES, the RES-specific preferences – and particularly the relative preferences – among different RES would be dynamic in experience and spatial dimensions, as commonly found in, for instance, environmental economics studies [16–19]. Based on the two papers [20,21] published in Energy, I will try to exemplify my arguments. Cohen et al.

Abbreviations: RES, renewable energy sources; CVM, contingent valuation method; CE, choice experiments; WTP, willingness to pay.

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Nomenclature

Preference: measure of the extent to which a renewable energy source should be used
Relative preference: measure of the extent to which one type of renewable energy source should be used relative to another type of renewable energy source
Viewshed: all locations visible from a view source, for my purposes a residence
On-shore wind turbine/farm: wind turbine/farm located on shore/on land
Off-shore wind farm: wind farm located at sea
Near-shore wind farm: off-shore wind farm located relatively close to the coast
Far-shore wind farm: off-shore wind farm located relatively far from the coast
$Preference_{ij:}$ respondent *i*'s preference for the *j*th RES
$Preference_{ijk:}$ respondent *I*'s relative preference for the *j*th and *k*th RES
X: vector of socio-demographic characteristics of respondent *i*
Nysted: dummy variable controlling for whether respondent *i* is in the Nysted sample or not
Horns Rev: dummy variable controlling for whether respondent *i* is in the Horns Rev sample or not
Viewshed Onshore: dummy variable controlling for if respondent *i* has an onshore wind farm in the viewshed or not
Viewshed Offshore: dummy variable controlling for if respondent *i* has an offshore wind farm in the viewshed or not
Viewshed Offshore_NY: dummy variable controlling for if respondent *i* in the Nysted sample has an offshore wind farm in the viewshed or not
Viewshed Offshore_HR: dummy variable controlling for if respondent *i* in the Horns Rev sample has an offshore wind farm in the viewshed or not
β: the estimated impact from the socio-demographic variables of respondent *i* on preferences for the *j*th RES or the relative preferences for the *j*th and the *k*th RES
γ: the estimated impact from respondent *i* in the Nysted sample on preferences for the *j*th RES or the relative preferences for the *j*th and the *k*th RES
μ: the estimated impact from respondent *i* in the Horns Rev sample on preferences for the *j*th RES or the relative preferences for the *j*th and the *k*th RES
δ: the estimated impact from respondent *i* having an onshore wind farms in the viewshed on preferences for the *j*th RES or the relative preferences for the *j*th and the *k*th RES
θ: the estimated impact from respondent *i* having an offshore wind farms in the viewshed on preferences for the *j*th RES or the relative preferences for the *j*th and the *k*th RES
υ: the estimated impact from respondent *i* in the Nysted sample having an offshore wind farms in the viewshed on preferences for the *j*th RES or the relative preferences for the *j*th and the *k*th RES
τ: the estimated impact from respondent *i* in the Horns Rev sample and having an offshore wind farms in the viewshed on preferences for the *j*th RES or the relative preferences for the *j*th and the *k*th RES
ε: the idiosyncratic error term related to respondent *i*'s estimated preferences for the *j*th RES or the relative preferences for the *j*th and the *k*th RES

[20] discuss the acceptance literature associated with wind power, pylons and pump hydro-storage. In their paper, acceptance for the three landscape infrastructures mentioned above is assumed to be independent of the existing level of the infrastructures in the landscape. As found by Ribeiro et al. [13], it seems a fair assumption that the acceptance of additional hydro-storage capacity is conditional on the existing capacity. What about the relative acceptance, though? People living in areas with hydro-storage facilities might have a higher/lower level of acceptance for an additional hydro-storage facility relative to additional wind turbines. In the other example, Ladenburg et al. [21], the acceptance of wind power, relative to the number of wind turbines in the area people live in, is estimated and a significant negative relation is found. If the lower level of acceptance among people who see numerous wind turbines daily increases their acceptance for other RES, the relation between existing RES facilities and acceptance of new ones cannot be analysed separately for each RES, but must be analysed jointly.

In the present article, two novel measures of experience of wind turbines are used to test the potential effect that wind power experience can have on the preferences for wind power and, most importantly, the preferences for solar energy and biomass energy. First of all, I use information on whether or not people have on-shore or off-shore wind turbines in their viewshed. So far, the literature has only tested on-shore viewshed effects. Secondly, two samples, in which the respondents have significantly different experiences with the visual impacts from large off-shore wind farms, are included in the analysis of preferences for wind power, solar energy and biomass energy. This unique design feature makes it possible to test whether systematic variations in the visual disamenities from off-shore wind farms influence preferences for wind power and particularly other RES.

The paper is structured as follows. First, the relevant studies are reviewed, in order to define the analytical framework of the study. This is followed by a description of the study, the sample and the results. Finally, a discussion and a conclusion are provided.

2. Review of the literature and analytical setup

Preference studies for RES have employed different types of data, frameworks and econometric analyses. Some of the literature analyses the preferences for a single type of RES, such as biomass [22,23], biomass ethanol [24], on-shore wind power [25] and off-shore wind power [26]. Preferences for green electricity in general [27–29] and for an increase in the renewable share of the energy mix [15,30–32] have also been estimated. Generally, the studies find significant positive preferences for RES and a price premium/willingness to pay for a greater share of RES.

Most policies focus on a mix of different sources of renewable energy with different current and expected future generation costs profiles [33]. In order to be able to take into account the differences in these costs profiles, and in order to identify efficient RES deployment schemes, the relevant economic question is what the relative preferences are for the various types of renewable energy sources. In the subsequent section, a brief review of the existing literature will be given. The review is divided into three parts, presenting the studies that elaborate on the relation between

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