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Valuating renewable microgeneration technologies in Lithuanian households: A study on willingness to pay

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ABSTRACT

Promoting clean energy requires finding the right balance among economic, social and environmental factors as the renewable energy generation technologies are often more costly than the conventional ones and imply additional requirements for their operation. Measurement of willingness to pay (WTP) can be a very useful tool for eliciting the possibilities for developing the renewables considering multiple determinants. This approach, indeed, reflects the preferences of energy consumers towards different renewable energy sources (RES) technologies and represents them in monetary terms. In this paper, we present a discrete choice experiment that was applied to gauge the WTP of individual houses owners for different RES micro generation technologies. As regards the theoretical novelty of the research, we account for willingness to share micro-generation technologies. The unlabelled discrete choice experiment has been carried out in Lithuania – a Central and Eastern European country – and thus offers a contribution to scientific discussion on the development of renewables in the region. The mixed logit model was applied in order to account for differences in tastes (preferences). Based on the results of mixed logit model, WTP was estimated for the selected RES micro generation technologies (solar photovoltaic, biomass boilers, solar thermal and micro-wind). The results show that owners of detached houses in Lithuania households are ready to pay for solar energy-based technologies (some 3300 EUR and 1363 EUR per solar panel and solar thermal installations, respectively), whereas the other two options are less desirable. As regards willingness to share, the households did not consider the latter criterion as a significant factor.

1. Introduction

The creation of sustainable economy can contribute to multiple economic, social and environmental benefits. Therefore, there have been attempts to quantify the progress towards this goal from different perspectives. Song and Wang (2018) proposed a general framework for assessing performance of the green technology implementation. Wu et al. (2017) put forward a non-parametric technique for measurement of environmental efficiency.

Promotion of renewable energy appears as one of the key components in creating the sustainable economy (Liu et al., 2016; Su et al., 2016). Decision to invest into renewable energy technology rests upon multiple factors and renders multiple effects. The principles of sustainable development should be taken into account when making decisions regarding the selection of the means for production, transportation and consumption of clean energy. For instance, Guersola et al. (2017) looked into the issues pertaining sustainability of liquefied natural gas transportation. Odewale et al. (2017) discussed the importance of the electricity sector in curbing greenhouse gas (GHG) emissions. Looking at energy consumption, the construction and maintenance of sustainable buildings is an important aspect of sustainability at the micro level. Nižetić et al. (2017) discussed the possibilities for improvement of building sustainability in the Mediterranean area, whereas Koo and Hong

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Nomenclature

i	– index for alternatives
j	– index for decision makers
P_{ij}	– probability of choosing i by j
U_{ij}	– utility of choosing i by j
V_{ij}	– representative utility of choosing i by j
ε_{ij}	– random error
$E(\bullet)$	– expected value
WTP	– estimate of willingness to pay
$\Delta W^{i\prime,i}$	– change in welfare due to switching from i to $i\prime \in i$
$\boldsymbol{\beta}$	– vector of regression coefficients
β^c	– regression coefficient associated with cost variable
$\boldsymbol{\theta}$	– vector of density function parameters

(2018) focused on the similar problematique in South Korea. The use of renewable energy technologies is necessary when constructing sustainable buildings.

Indeed, different renewable energy technologies may be considered as the most preferable means for power generation in specific location in the light of sustainability goals (Luong et al., 2012). The underlying goal, therefore, is to ensure the proper equilibrium among economic, social and environmental factors which in a medley act as guiding principles for selection of renewable energy technologies under the principles of sustainable development (Luong et al., 2012).

Yet another facet underlying the choice of sustainable energy technologies is the balance among public and private interests. At the individual level, strong correlation between environmental attitude and ecological behavior intention has been established. Also, economic factors play an important role when making decisions on installation of the energy generation technologies. Thus, it is important to understand the attitudes of energy consumers and the resulting behavior (Ek, 2005; Stigka et al., 2014; Infante and Smirnova, 2016). When it comes to democratic societies, the planning and decision-making process rest upon not only expert opinions, but public feelings and perceptions as well, see Stigka et al. (2014). Accordingly, behaving as a rational individual may conflict with the common good and prevent the efficient use of public resources. Anyways, citizens anticipate not only description of the current situation within the confines of the environment–energy–climate nexus, but also certain guidelines for improvements (Zografakis et al., 2010).

The selection of the most preferable renewable energy technologies requires considering multiple criteria measured in different dimensions. Indeed, societies need not only assessment of sustainability of renewable energy technologies, but also assessment of the trade-offs existing among alternative sources in order to choose the most preferable one (Kosenius and Ollikainen, 2013). Even though there has been an increase in public awareness of the adverse environmental effects caused by the consumption of fossil fuels (Stigka et al., 2014), making socially optimal renewable energy investments requires taking into consideration possible external costs and benefits associated with renewables (Bergmann et al., 2006). What is more, some benefits and costs of renewables and their technology do not have monetary values. Therefore, different economic valuation techniques have been developed to evaluate them (Menegaki, 2008). Quantitative approaches are needed to guide societies in understanding the environmental impacts and especially, facilitating multi-dimensional comparisons among different kinds of energy sources and between different types of renewables (Kosenius and Ollikainen, 2013).

WTP is considered as a means of capturing public preferences for climate strategies, especially in relatively localized settings (Johnson et al., 2010). Installation and operation costs, environmental attitudes, income, education and political views all shape the patterns of WTP (Johnson et al., 2010). More specifically, willingness to pay (WTP) indicated "the financial contribution people are willing to make" in order to reach certain objectives (Stigka et al., 2014). In our case, we focus on the features of different renewable energy technologies and monetary appraisal thereof.

Even though WTP is a measure that aggregates multiple attributes describing different alternatives for energy generation and offers a single value for each alternative, it should be interpreted with certain caution. More specifically, the premium the energy customers are willing to pay for environmentally friendly energy, should not be directly interpreted as a monetary sum consumers are actually willing to pay but rather as a relative value attached to each alternative (i.e. energy source) described in terms of combinations of attributes or outcomes (Wood et al., 1995). Household satisfaction with renewable energy (as measured by the resulting WTP) has significant impact on the effectiveness of public policies aiming at promotion of renewable energy sources (Georgescu and Herman, 2014; Lungu et al., 2014). According to Lungu et al. (2014), such policies are highly needed as renewable energy use is in an early stage, which implies relatively high installation and operation costs. This might exert negative influence on the consumer behavior. On the other hand, consumers are becoming more environmentally conscious and, thus, willing to pay a higher price for green energy. The latter trend, indeed, is likely to encourage utilization of RES (Ek, 2005). Large scale implementation of renewables will allow reducing the costs of renewable energy technologies (Menegaki, 2008). Therefore, WTP is affected by social and technological developments and, in turn, can be used to shape the behavior of society via the use of public support.

There is a need to expand the knowledge of WTP for renewables prevailing in different contexts, especially consumers' attitudes towards green energy as well as information about the foundations of these attitudes (Ek, 2005). In many cases, results of studies on WTP vary within wide intervals which, according to Kraeusel and Möst (2012), is the result of different methodologies and intermittent preferences of customers (Kraeusel and Möst, 2012). Notably, even though much of existing research generally supports conclusion that consumers are willing to pay extra for renewable energy (Akcura, 2015; Bigerna and Polinori, 2014; Borchers et al., 2007; Nomura and Akai, 2004), zero WTP or negative WTP may also exist.

The global energy system has worked on the basis that supply must follow demand. Consumers – businesses and households – have been passive users of power, paying to use what they want when they want, whilst electricity supply has adapted to ensure the lights stay on. This has created inefficient systems adjusted for periods of peak demand. In the last decade, technological development caused proliferation of sharing economy business models that offered significant reshaping of the established industries within rather short time period. The manifestations of sharing economy include Airbnb, Uber etc. Being a consumer-led phenomenon, sharing economy allows exploiting excess capacity within the existing systems. In energy systems, the principles of the sharing economy can be applied for extracting mutual benefits of the owners of the microgeneration facilities. In the energy sector, the promoting of the principles of the sharing economy allows for gains in energy efficiency and demand response flexibility. These goals can be implemented by installing distributed generation facilities (e.g. roof top solar) and distributed storage (e.g. batteries,