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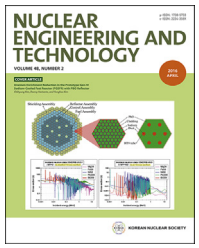

Original Article

Can Renewable Energy Replace Nuclear Power in Korea? An Economic Valuation Analysis☆

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ABSTRACT

This paper studies the feasibility of renewable energy as a substitute for nuclear and energy by considering Korean customers' willingness to pay (WTP). For this analysis, we use the contingent valuation method to estimate the WTP of renewable energy, and then estimate its value using ordered logistic regression. To replace nuclear power and fossil energy with renewable energy in Korea, an average household is willing to pay an additional 102,388 Korean Won (KRW) per month (approx. US $85). Therefore, the yearly economic value of renewable energy in Korea is about 19.3 trillion KRW (approx. US $16.1 billion). Considering that power generation with only renewable energy would cost an additional 35 trillion KRW per year, it is economically infeasible for renewable energy to be the sole method of low-carbon energy generation in Korea.

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1. Introduction

Broadly speaking, there are two types of low-carbon power generation source: renewable energy and nuclear energy. Renewable energy sources are resources that can be used to produce energy continuously, and include solar energy, wind energy, biomass energy, and geothermal energy, among others [1]. The use of renewable energy sources is growing rapidly, but renewable energy currently accounts for only about 3% of the world's primary energy consumption [2] and supplies about 14% of the total world energy demand [3]. The worldwide share of renewable energy sources is expected to increase significantly from 30% to 80% by 2100 [4].

Nuclear energy is another low-carbon power generation method that accounts for approximately 20% of world electricity [5]. From the second half of the 2000s until the

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Fukushima incident (in March 2011), nuclear power had been gaining popularity due to increasing concern over global warming as a result of the use of fossil fuels [6]. However, Fukushima altered the public perception of nuclear power, and, as such, renewable energy technologies are rapidly gaining ground, supported by global subsidies amounting to US $120 billion until 2013. Renewable energy technologies are sometimes seen as direct substitutes for existing technologies, and their benefits and costs are conceived in terms of assessment methods developed for existing technologies. Such power generation units can provide small advanced-capacity additions to existing energy systems with short lead times and more flexibility compared with large, long lead-time units, such as nuclear power stations. Therefore, the development of advanced renewable energy technologies that serve as cost-effective and environmentally responsible alternatives to conventional energy generation is necessary [7].

After the Fukushima incident, many countries vowed to strengthen their renewal energy programs. For example, the German government announced that it would eliminate nuclear energy generation and replace it with renewable energy within 10 years, cut greenhouse gas emissions by 40% by 2020 and 80% by 2050, ensure renewables contribute 80% of Germany's energy by 2050, and ensure energy consumption drops of 20% by 2020 and 50% by 2050. It even has its own word, *Energiewende*, or "Energy Transformation." However, over the past 2 years, this plan has resulted in a 47% increase in the average family's energy bill [8]. Therefore, it is feasible that the rising cost of energy and people's reluctance to pay may be the biggest barrier to renewable energy replacing nuclear power and fossil fuels.

Nuclear and renewable energy have advantages and disadvantages as alternatives to fossil fuels. Nuclear energy has the public perception of being unsafe and renewable energy has economic feasibility concerns. However, long-term strategies for achieving global warming mitigation will soon necessitate alternative energy. Further, public measures that enforce market mechanisms that induce a shift from fossil-fueled to nuclear and/or renewable electricity generation will be required [9]. Therefore, it is necessary to determine whether or not renewable energy can be a better option than nuclear power as a means of low-carbon power generation.

Recently, the estimation of social cost concerning the stability and accident risk of the energy source has been important in various academic fields [10]. Therefore, the objective of this investigation is to examine whether or not renewable energies can be an economically feasible method for replacing nuclear power and fossil fuels in Korea. In this study, we used the contingent valuation method (CVM) and measure Korean households' willingness to pay (WTP) in order to estimate the economic value of renewable energy as an alternative to nuclear and fossil energies. In the next section, we discuss the importance of energy and the current energy situation in Korea. In the "Contingent Valuation Method" section, we explain our main methodology (i.e., CVM). In the "Data and Measurement" section, we elaborate on our data and measurements, followed by our results in the "Results" section. Finally, the "Conclusion" section presents the concluding remarks.

2. The Importance of Energy

In this section, we consider the factors that affect decisions on which energies should be used. At first we considered all kinds of possible factors based on previous research. Bae [11], for example, listed six factors, namely, environment pollution, regional economy, economic resources, environment friendliness, landscape change, and electric supply and demand. The Korean Ministry of Knowledge Economy [12] discussed seven factors, namely, safety, environment pollution, regional economy, asset value, environment-friendliness, diplomatic conflict, and electric supply and demand. In addition, ethicality was quoted by Huh [13]. Combining these factors together, we have 10 factors overall, including safety, environment pollution, regional economy, asset value, economic resources, environment friendliness, diplomatic conflict, landscape change, electric supply and demand, and ethicality. Among these, asset value, environment friendliness, and landscape change were removed through our pretest, because respondents thought they were either covered by other factors or less important. Therefore, we ended up with seven factors that affect the decision of energy usages as follows. These are described in the following sections.

2.1. *Environmental pollution*

Economic growth based on the use of energy has the potential to cause environmental degradation [14]. There have been many studies regarding the relationship between economic growth and environmental pollution. In particular, Grossman and Krueger [15] and Selden and Song [16] found that economic growth was associated with environmental degradation. In its early phase, economic growth causes environmental degradation. However, environmental conditions can improve after a certain level of economic growth has occurred. In several studies, this is described as a U-shaped relationship between environmental degradation and economic growth.

2.2. *Regional economy*

Since the 1980s, the Korean government has made substantial efforts to find a site for a radioactive waste disposal facility. Those efforts failed, primarily because of protests by local residents concerned with the implications that a waste disposal plant might have on the regional economy. Among various potentially hazardous facilities, nuclear-related facilities have been considered some of the most concerning to the general public. In 2005, however, the decision was made to construct the first Korean radioactive waste disposal facility, located in Gyeongju City. The decision was made based on the results of four candidate cities' local referendums, held in November 2005. In their referendum, Gyeongju's residents demonstrated general acceptance of the site, with nearly 90% of residents voting for construction of the facility [17–20].

Development and implementation of energy projects in rural areas can create job opportunities, thereby minimizing migration toward urban areas [21]. For example, in some rural regions, the investment in renewable energy represents a significant share of gross domestic product, up to 3% in Extremadura, Spain, in 2009. According to several case

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