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Quantifying drivers' acceptance of renewable fuel standard: Results from a choice experiment in South Korea

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ABSTRACT

The production and use of renewable fuels in the transport sector are rapidly increasing. Renewable fuel standard (RFS) is a strong regulatory component and quantitative policy expected to have a significant market impact. In Korea, RFS implementation was agreed upon in July 2013 and will be enforced beginning in July 2015. Drivers' acceptance is the most important consideration for RFS introduction and sustainable implementation. This study analyzed Korean customer preferences for RFS and quantified their acceptance level according to policy design. A choice experiment was analyzed with a mixed logit model to reflect the heterogeneity of respondents' preferences. Respondents were relatively sensitive to the price increase, while other attributes had little effect on acceptance of RFS. Differences between the influences of attributes on drivers' acceptance should be considered when designing RFS implementation. Furthermore, it is recommended that the price of transportation fuels should be limited to an increase between KRW 10 and 20/liter (USD 8.879×10^{-3} and 1.776×10^{-2}/liter) to ensure high acceptance level, secure a budget for infrastructure, and achieve substantial environmental improvement.

Introduction

Renewable energy (RE) has attracted significant worldwide attention over the last few decades. In 2011, an estimated 19% of global final energy consumption was supplied with renewables (REN21, 2013). Furthermore, annual investment in new renewable capacity has dramatically increased from USD 40 billion in 2004–244 billion in 2012 (REN21, 2013). In addition to the environmental benefits, the economic effect of RE on domestic markets has been highlighted in recent years, which has motivated many countries to advocate for RE. Most countries have set mid- and long-term RE supply targets,[1] and implemented various policy tools to achieve these targets.

Most RE policies have focused on expanding renewable electricity supplies because scale and market impact of the electric power sector are greater than other sectors.[2] In recent years, however, most governments have acknowledged that policies

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[1] In 2012, the number of countries with policy targets was 138 worldwide (REN21, 2013).

[2] The primary energy consumption of the US electric power sector was 39.3 quadrillion Btu in 2011, which accounted for 40% of total primary energy consumption. The primary energy consumption of the transport sector accounts for approximately 28% while that of heating sector might be less than this ratio (EIA, 2012). Furthermore, in the case of the estimated renewable energy share of global final energy consumption, electric power generation, heat energy, and the renewable energy for transportation use accounted for 4.8%, 4.1%, and 0.8% which amounted to 9.7% modern renewables in total (REN21, 2013). From all these evidences, we can infer the relative large scale of the electric power sector.

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for promoting renewable electricity alone would be insufficient to achieve their entire RE supply target, thus generating public interest in RE supply in other sectors. In particular, the production and use of renewable fuels in the transport sector are rapidly increasing. Global production of bioethanol and biodiesel in 2000 was 17.0 and 0.8 billion liters while those in 2012 were 83.1 and 22.5 billion liters, respectively. Based on these figures, the compound annual growth rate (CAGR) of bioethanol and biodiesel was 14% and 32%, respectively. Production of these types of liquid biofuels is currently providing approximately 3% of global road transport fuels (REN21, 2013). Furthermore, policies supporting the use of renewable fuels in the transport sector have been identified at the national level in 49 countries as of early 2013 (REN21, 2013).

Among various RE policies in the transport sector,[3] the Renewable fuel standard (RFS) is expected to have a substantial market and environmental impact.[4] RFS—a mandatory minimum volume of biofuels to be used in the national transportation fuel supply (Schnepf and Yacobucci, 2013)—is a representative strong regulatory component and quantitative policy in the transport sector. Although official names differ between countries, blending mandates have been identified at the national level across 27 countries (REN21, 2013).

The US, UK, and Germany appear to be the leading countries in RFS implementation. The US enforced RFS1 from 2007 to 2010 following the Energy Policy Act of 2005, and from 2010 to the present, it has implemented RFS2, which requires the use of 36 billion gallons of biofuels annually by 2022. The UK's RTFO (Renewable Transport Fuel Obligation) has been enforced since 2008 and the German Biofuel Quota Act since 2007, with 2013 percentage standards of 5.26%, and 6.25%, respectively (Kpetro, 2013). RFS is expected to become more common worldwide.

Brief history of RFS in Korea

The Korean government seeks to supply 11% of primary energy with eligible renewable sources by 2030 (MKE, 2008). Although RE supply in the transport sector, the main focus of our research, accounted for only 2.5% (165,000 TOE) of total RE supply in 2008, it is expected to increase to 13.2% (2.31 million TOE) by 2020 (MKE, 2012).

Although there has been continuous debate regarding the need for RFS, its formal enforcement has never been achieved due to stakeholder opposition. Nevertheless, after considerable research and debate, RFS implementation was finally agreed upon in July 2013 and will be enforced beginning in July 2015 following a two-year preparatory period.

According to the bill, the oil refinery operators and petroleum export/import businesses in Korea should mix their fuels for transportation purposes with a certain percentage of renewable fuels. The current 2% ratio of bioethanol and biodiesel will increase by 0.5% every year, reaching 5% in 2020 (see Table 1). Despite the official declaration of RFS implementation, however, resistance is still prevalent among stakeholders such as fuel suppliers in the transport sector. They argue that the oil industry will bear the entire cost increase because renewable fuel in the Korean market is primarily imported from foreign countries.

However, drivers' acceptance is a more important consideration for RFS introduction and sustainable implementation than any other factor. Considering that production and distribution of renewable fuels is more costly than conventional gasoline/diesel, RFS will cause increases in transport fuel prices, which will be a burden for end-users in the long-term. Increased fuel prices will receive insufficient drivers' acceptance, which will act as a barrier to successful RFS implementation.

In this context, this study analyzed Korean customers' preferences for RFS and quantified their acceptance level. A choice experiment (CE), which collects stated preference data, was used with a mixed logit model to reflect the heterogeneity of respondents' preferences. Several policy implications to help successful implementation of RFS are suggested.

The remainder of this article is organized as follows. Focusing on RFS, a summary of previous literature on renewable fuels is provided in the next section. The early part of Section Methodology describes the mixed logit model while the latter part explains the CE survey design. Section Results and Discussion, which presents the analysis results including drivers' preferences for RFS and acceptance level forecasts with simulation, is the main section of this article. Finally, Section Conclusions concludes with a summary and provides directions for further research.

Literature review

Previous studies on renewable fuel technologies and policies were limited both quantitatively and qualitatively. As public interest in renewable fuels has increased, however, several studies—including those focusing on RFS—have been published.

A renewable fuel policy is introduced with the expectation of various environmental, economic benefits. From this perspective, several studies analyzed and forecasted the possible impacts of RFS implementation. Gallagher et al. (2003) estimated the changes in additives markets and the ethanol industry according to the demand expansion and policy scenarios related to RFS. Anderson and Coble (2010) investigated the potential impact of RFS ethanol mandates on the corn

[3] These policies generally fall into two categories: one is to impose mandatory targets, and the other is to provide subsidies to reduce the burden of the higher cost of renewable fuels. The former includes emission standards such as biofuel blend mandates (RFS) and the low carbon fuel standard (LCFS) while the latter includes production credits, capital grants, biofuel production subsidies, tax incentives, and research grants.

[4] According to the analysis of EPA (2010), US RFS2 is expected to displace about 7% of expected annual US transportation fuel consumption of petroleum-based fuel and to reduce annual GHG emissions by 138 million metric tons by 2022. It is also expected to increase annual net farm income by $13 billion and to increase the cost of food per capita by about $10 by 2022. To see more detail, refer to the analysis results of EPA (2010) or Schnepf and Yacobucci (2013).