AN ECONOMIC ASSESSMENT OF THE ELECTRIC VEHICLES' CO2 REDUCTION EFFECTS CONSIDERING WELL-TO-WHEEL EMISSION: A KOREAN CASE

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Overview

Since the Paris Agreement was signed, Korea has implemented many policies to meet its carbon emission reduction target that is 30% reduction in carbon emission by 2030 compared to BAU in 2009. Specifically, in automotive sector, Korea government has implemented various policies related to carbon emission reduction such as promotion of Hybrid Electric Vehicle(HEV) and Electric Vehicle(EV). For evaluation of environmental performance of vehicle, carbon emission amount is often measured by Well to Wheel(WTW) which is the method to assess carbon emissions from raw matarials production to use of them. However, it is important to consider the economic efficiency of environmental vehicles to meet the carbon reduction target, especially in case that government makes a plan to allocate budget. The purpose of this study is to develop an economic assessment model of environmental vehicles and evaluate the costs and benefits from the reduction effects of air pollutants using Korean empirical data. We assess economic efficiency considering the amount of carbon emission and Total Cost of Ownership(TCO) compared to Internal Combustion Engine Vehicle(ICEV) and choose the economic vehicle in each size and use. We construct EV diffusion and national energy structure scenarios according to current Korean policies and the elasticity of price for EV and compare the costs and benefits from the reduction effects of air pollutants between current and suggested policies using Korean empirical data.

Methods

The procedure and methods of the present study is as follows: First, we estimate the amount of carbon emissions of ICEV, HEV and EV based on the relevant data. Second, we develop an economic assessment model in which not only TCO but also the opportunity costs of well-to-wheel emission can be evaluated. Third, we construct EV diffusion and national energy structure scenarios and evaluate the costs and benefits from the reduction effects of air pollutants using Korean empirical data.

Results

First, we extracted the emission coefficients of ICEV, HEV and EV from the relevant literature. These coefficients were estimated by WTW which is the method to assess carbon emissions from raw matarials production to use of them. Also, we adjusted the coefficients considering each major country's power generation structure and compared them.

Second, we developed an economic assessment model with the amount of carbon emission and TCO. Especially, we suggested the best economic efficient alternative for each vehicle size and use and analysed the effects of the change of fuel prices and generation structure.

Third, we predicted the diffusion of renewable energy and electric vehicles using historical data. In the case of electric vehicles, we compared the environmental effects of current policies and our suggestions. Also, we extracted the main factors from sensitivity analysis and suggested policies for achieving the target of carbon reduction .

Conclusions

This research has evaluated the economic efficiency of the environmental vehicles which lacks in existing studies. We derived the amount of carbon emission reduction in transportation sector of Korea in 2030 and compared it to the political target. We extracted carbon emission coefficients estimated by WTW method from the literature, and suggested the economic alternative considering the amount of carbon emission and TCO. Additionally, we constructed EV diffusion and the renewable energy scenarios and evaluated the effects of air pollutants reduction.

As a result, it was found that fuel price and generation structure should be considered in the policy of EV's diffusion. The diffusion of EV was analysed to be more important than that of the renewable energy in Korea's case. In particular, the economic efficiencies between the vehicles were different, therefore different diffusion policies should be set for different vehicle types.

However, this paper lacks the consideration of efficiency improvement followed by technological progress in the future. Since the technology life cycle of EV is at the beginning point, the speed of development of technology is fast, and the economic efficiency can be changed. Moreover, in case of EV, the additional cost according to the construction of infrastructure appears. There is a need for further research considering the development of technology and the infrastructure construction cost.