Evaluating the GHG Reduction Potential through the Adoption of Electrified Kei Vehicles in Japan

Topic: Industrial policies
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To achieve the goal of carbon neutrality in Japan, there is an increasing expectation for further promotion of electrified vehicles, and numerous empirical studies on Life Cycle Assessment (LCA) for electrified vehicles have been conducted. It is important to note that when forecasting life-cycle CO2 emissions from electrified vehicles, researchers make assumptions about the lifetime mileage of electrified vehicles and the future electricity generation mix of a country. Therefore, there is uncertainty in both the lifetime mileage of electrified vehicles and the future electricity generation mix in previous studies. In addition, although the Japanese car market is characterized by mini passenger vehicles with an engine displacement of 660cc and below, commonly known as "Kei passenger vehicles," previous studies did not estimate the greenhouse gas (GHG) emissions reduction potential of promoting electrified Kei vehicles.

In this study, we make an environmentally-extended input-output table, taking into account the specific passenger vehicles technologies of electric vehicles (BEV(O)), hybrid vehicles (HV(O)), plug-in hybrid vehicles (PHV(O)), fuel cell vehicles (FCV(O)), and internal combustion engine vehicles (ICE(O)). And Kei vehicles also include electrified Kei passenger vehicles (BEV(K)) and Kei vehicles with internal combustion engines (ICE(K)). More specifically, this table reflects the different body structures of electric vehicles. For example, electrified vehicle sectors (BEV(O) and BEV(K)) eliminates the need for an engine compared to the combustion engine sector, while considering an increase in batteries and other electric machines. In addition, the electricity generation sector is further detailed with a focus on non-fossil generations such as renewable energy and nuclear power.

Next, we evaluate the life-cycle GHG emissions associated with the vehicle life-cycle, from manufacturing to disposal, assuming a wide range of electricity generation mixes. Scenario analyses are conducted to further evaluate the GHG reduction potential of introducing electric vehicles in two cases: decarbonizing the power supply and promoting the electrification of passenger cars. As for the power supply, three scenarios are presented, Case I (based on 2015 data), Case II (Japanese government's 2030 target as indicated by the Ministry of Economy, Trade and Industry in Japan), and Case III (zero emissions projected for 2050 by IEA). Additionally, four car electrification cases were examined: Case A (2015 sales figures with 35.9% kei passenger cars and others), Case B (100% BEV(O) sales), Case C (a mix of 64.1% BEV(O) and 35.9% BEV(K)), and Case D (100% BEV(K) sales). Assumptions included a car's lifetime mileage and differing energy efficiencies based on various factors. Disposal costs were estimated using actual recycling fees from leading car manufacturers.

Moreover, the overall objective of this study is to analyze the cost-effectiveness analysis based on scenario-specific marginal cost curves. The economic costs of BEV(K) are expected to be lower than those of BEV(O) , HV(O), PHV(O), FCV(O), and ICE(O) with lower greenhouse gas emissions. Finally, this study obtains policy implications based on these findings.