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論　文　の　要　旨
Abstract of thesis

With the development of economy and urbanization, the number of vehicle ownership in China is continuing to increase. Most recently, much attention has been paid to the energy consumption and environmental issues caused by the rapid growth of vehicle ownership. As proposed, the development of battery electric vehicles (BEVs) and hydrogen fuel cell vehicles (HFCVs) is of great significance from the perspective of energy security and environmental quality improvement. For this purpose, life cycle analysis can comprehensively evaluate the energy consumption and pollutants emission from BEVs and HFCVs. In this study, the author conducted a well-to-well (WTW) analysis focusing on the upstream fuel production (i.e. vehicle fuel life cycle analysis) and estimated the energy consumption, greenhouse gases (GHGs) emission and air pollutants emission, including volatile organic compounds (VOCs), carbon monoxide (CO), nitrogen oxide (NO_x), sulfur oxide (SO_x), and particulate matter ($PM_{2.5}$ and PM_{10}) from individual BEV and HFCV under the current (2017) and near future (2030) situations in China. In addition, the impact of the development of BEVs and HFCVs on the energy consumption and emissions of GHGs and air pollutants in the future was first evaluated in this study.

This dissertation is divided into 5 chapters. In Chapter 1, The author addressed the current energy and environmental problems in transportation sector. After a summary of literature review on life cycle analysis of BEV and HFCV, the author discussed the global development status of BEV and HFCV, and the up-to-date plans on their deployment in China. Then the author arrived at the research objectives, research questions, and thesis structure. In Chapter 2, the author conducted a WTW analysis of individual BEV charged by gird mix electricity for the current (2017) and near future (2030) scenarios. The GHGs, regulated emissions, and energy usage in Transportation Model was applied to simulate the

WTW results which were compared with the current gasoline-fueled internal combustion engine vehicle (gasoline-ICEV). Results show that BEV could not only achieve significant reductions in terms of fossil fuel consumption (by 52%), especially petroleum consumption (by 99%), but also reduce the WTW emissions of GHGs (by 39%), CO (92%) and VOCs (81%). However, in terms of NO_x, SO_x, PM_{10} and $PM_{2.5}$, BEV could emit more from the WTW analysis under both current and future situations. In Chapter 3, the author compared the fossil fuel consumption and emissions of GHGs and air pollutants from HFCV through various hydrogen production pathways under the current (2017) and near future (2030) situations in China. Results show that the fossil fuel energy saving and emission reductions of GHGs and air pollutants vary significantly among the hydrogen fuel production pathways. HFCV is found to reduce fossil fuel consumption by 11-92%, compared with gasoline-ICEV in 2017. Regarding GHGs emission, HFCV based on water electrolysis using the renewable electricity exhibits the best performance with the lowest performance for the on-site water electrolysis using grid electricity. Remarkably, HFCV based on all H_2 production pathways can achieve a significant reduction in the emissions of WTW-based VOCs and CO, compared with gasoline-ICEV. In Chapter 4, the author established a bottom-up model to assess the impacts of the development of BEVs and HFCVs on the energy consumption, emissions of GHGs and air pollutants from light-duty passenger vehicle (LDPV) fleet in the future (2017-2040). Results show that the total LDPV stock would increase from 182 million in 2017 to 492 million in 2040. After a comparison of the energy consumption and GHGs emission among the three typical scenarios reflecting the deployment of BEVs and HFCVs, the author pointed out that the accelerated development of BEVs and HFCVs may help China achieve the goal of carbon emission peak before 2030. Finally, in Chapter 5, the author summarized the major conclusions, and proposed the future research directions.

審　査　の　要　旨

Abstract of assessment result

To reduce the environmental pressures caused by the rapid growth of light-duty passenger vehicles (LDPVs) in China, battery electric vehicles (BEVs) and hydrogen fuel cell vehicles (HFCVs) are developed very fast under the government's acceleration policies and incentives. Thus, more attention has been paid to the energy consumption and pollutants emission in the process of upstream fuel production for BEVs and HFCVs. In this study, the author conducted a well-to-well (WTW) analysis to estimate the energy consumption, GHGs emission and air pollutants emission from individual BEV and HFCV in China under the current (2017) and near future (2030) situations. In addition, the energy consumption, GHGs and air pollutants emissions from the LDPVs were compared among three typical scenarios, which reflect the impact of BEVs and HFCs development on the whole LDPV fleet in the context of China. This research is the first report on the impact of BEVs and HFCVs development on the future energy consumption and emissions of GHG and air pollutants in China. In order to make the results more meaningful to practice, more in-depth discussion and comparison are still necessary on the economic aspect regarding energy efficiency between the current research and previous studies.

The final examination committee conducted a meeting as a final examination on 22 July 2020. The applicant provided an overview of the dissertation, addressed questions and comments raised during Q & A session. All of the committee members reached a final decision that the applicant has passed the final examination.

Therefore, the final examination committee approved that the applicant is qualified to be awarded the degree of Doctor of Philosophy in Environmental Studies.