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Keio University

Thesis Abstract

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Thesis Title

Sustainability Analysis of Alternative Fuel Vehicles by using Life Cycle Analysis and Optimisation

Thesis Summary

In recent years, there has been an increasing interest in alternative fuel vehicles (AFVs), such as electric vehicles (EVs), fuel cell vehicles (FCVs) and compressed natural gas (CNG) vehicles, as a promising option for mitigating global warming and reducing energy consumption. Most studies in this area have been conducted on only a few types of powertrains, e.g. EVs and gasoline vehicles; to fill this gap, this study will cover FCVs, CNGs, hybrid electric vehicles, diesel hybrid electric vehicles and liquefied petroleum gas (LPG) vehicles. Moreover, most of the papers focus on the use phase of those vehicles and disregard the manufacturing part, which is energy and emission intensive. The indirect effects of emissions production include severe health problems such as chronic asthma or even mortality. Automakers and policy makers need to investigate the lifecycle emissions of vehicles in different regions. It is crucial to decide if governments should invite EV production into their country, or whether it would be more appropriate to import vehicles.

This research is novel because it includes energy security aspects, uses multiple scenario analysis, and investigates FCVs and various stages of AFV’s lifecycle in different regions. The objective of the thesis is to systematically assess the sustainability of AFVs. Firstly, the economic pillar of sustainability is being investigated by carrying out optimisation. The optimal AFV portfolio, based on different scenarios to sustain energy security in light of gas and petroleum restrictions until 2030, is being calculated. Secondly, environmental and social pillar of sustainability is explored. Life cycle analysis (LCA) has been applied to this research in order to quantify greenhouse gas (GHG) and non-GHG emissions and health impacts of air pollution connected with AFVs.

Overall, this research will help automakers and policymakers recognise investment possibilities and it provides numerical findings for multiple stakeholders such as governments, energy, and automotive companies.