Low-carbon Energy in Scooter Applications

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Overview

According to the CO_2 emissions of fuel combustion statistics published by the Ministry of Economic Affairs in 2015, which pointed out that the total CO_2 emissions in 2014 (excluding electricity consumption emissions) increased by1.93 million tonnes compared with the emission in 2013. Moreover, annual CO_2 emission growth rate from 1995 to 2014 was 3.52%. In which, the transport sector is third-largest source of CO_2 emissions in Taiwan and comparing with the emissions of 2013, the emissions in 2014 grew by 1.34%. Furthermore, according to the National Greenhouse Gas Inventories Report (2015) in Taiwan, by 2013 the share of CO_2 emissions from transport, in descending order, are road transport (97.72%), maritime transport (1.36%), air transport (0.69 %), and rail transport (0.24%). Therefore, it is necessary to reduce the CO_2 emissions from the road transport sector to avoid environmental degradation.

In general, there are two ways to solve the emission problems from the transport sector. One is to control the number of vehicles on the road. The other one is the use of alternative energy in transportation, in other words, using low-carbon energy instead of the natural diesel and other high-carbon energy to reduce the GHG emissions in the transport sector. With the view of this, this paper will apply ISO/TS 14067: 2013 with carbon footprint (CF) model to evaluate the carbon footprint of internal combustion engine (ICE) scooter and other three alternative energy-based scooter, including liquefied natural gas (LNG) scooter, hydrogen scooter and electric scooter.

The paper is organised as follows: After the introduction the second section explains the models, including carbon emission model, carbon footprint model, and cost-benefit analysis respectively. In section three we describe the results. In the final section conclusion and policy implications are derived.

Methods

This paper refers to *ISO/TS 14067:2013* using life cycle analysis (LCA) with carbon emission model and carbon footprint model to evaluate the carbon footprints of an internal combustion engine (ICE) scooter and three other scooters using different forms of energy, liquefied natural gas (LNG), hydrogen and electricity. And then its uses cost-benefit analysis to evaluate which costs and benefits are based on the three different energy-based scooter's life cycle carbon reduction and incremental cost comparing it with ICE scooter to explore which energy-based scooter has the best development potential.

Results

The results reveal that the following

First, the ICE scooter has the highest carbon footprint over its life cycle, at 0.1418 $kgCO_2$,e /km. In contrast, the hydrogen scooter has the lowest carbon footprint at 0.0169 $kgCO_2$,e/km.

Second, the total life cycle costs, in descending order, are those for the hydrogen scooter ($19,477.71), electric scooter ($6,991.64), ICE scooter ($6,811.60) and LNG scooter ($4,978.61).

Third, the LNG scooter has the best cost-benefit value.

Conclusions

While in terms of environmental benefits, the hydrogen scooter has the most potential for development, although it does not have economic benefits. Therefore, if hydrogen scooter could store hydrogen in normal temperature and pressure. And also have more better techniques in manufacturing to reduce the fixed cost in the future, which the fixed cost was similar with the ICE scooter, the hydrogen scooter would have more development potential. Thus, in view of the environmental benefits, this paper suggests that hydrogen-based energy should be used more widely in public transportation.

This paper also suggested that future research can continue to explore the direction which include: (1) in the future, the research subject can consider the transportation type which emits more emission such as buses, vehicles and trucks, we believe from the viewpoint of cost-benefit, the hydrogen scooter will have the best development potential. (2) when exploring the carbon footprint of different energy-based transport, the life cycle boundary can be set the fuel life cycle (FLC) and vehicle life cycle (VLC), and further apply more detailed data of scooter manufacturing for footprint calculation, then it will be more conducive for related authorities to set the green transport policy.