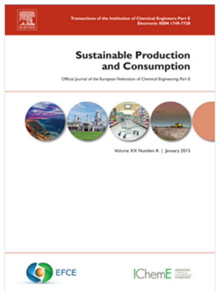
Accepted Manuscript



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PII: S2352-5509(18)30142-8
DOI: https://doi.org/10.1016/j.spc.2018.08.007
Reference: SPC 163

To appear in: *Sustainable Production and Consumption*

Received date : 9 April 2018
Revised date : 18 August 2018
Accepted date : 25 August 2018

Please cite this article as: Elliot T., McLaren S.J., Sims R., Potential environmental impacts of electric bicycles replacing other transport modes in Wellington, New Zealand. *Sustainable Production and Consumption* (2018), https://doi.org/10.1016/j.spc.2018.08.007

Potential environmental impacts of electric bicycles replacing other transport modes in Wellington, New Zealand

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Abstract

Transport contributed 26% of New Zealand's direct greenhouse gas (GHG) emissions in 2014 (MFE, 2017). In the same year private car journeys made up 79% of trips nationally and 71% of trips in the capital city Wellington (MOT, 2017b). Electric bicycles (E-bikes) present an opportunity to reduce those emissions. A life cycle assessment approach was used to estimate the environmental impacts of a greater uptake of E-bikes that would displace the use of family size cars powered by petrol or diesel engines. The potential life cycle impacts for the E-bike were found to be favourable compared to the car for most impact categories, including GHG emissions. This was largely due to the approximately 80% share of renewable electricity generation in New Zealand. This electricity mix also meant that the E-bike's environmental impacts during use were small compared with those related to its production and disposal. The environmental impacts were evaluated for recharging the battery at for four different times of day, representing different average electricity generation mixes. This was found to have very little influence on the environmental performance of the E-bike.
The environmental impacts of people switching from other transport modes to E-bikes were calculated for four different user groups in Wellington, New Zealand. These four groups had different transport preferences that were defined with respect to their barriers to cycling: Safe Cyclists, Likely Cyclists, Recreational Cyclists, and Hesitant Cyclists. The groups provided the basis for developing scenarios representing city-wide mode switches from car, bus, train and walking - to use of E-bikes. The Safe Cyclists scenario performed best for 9 of the 15 impact categories. This suggests the desirability of focusing on specific user-groups and their needs in order to change transport behaviours. In particular, in this case it implies a need to prioritise cyclist safety in transport planning (such as providing separate infrastructure for E-bikes).

Keywords: Electric bicycles, E-bikes, life-cycle assessment, transport, urban planning

1. Introduction

Increasing demand for mobility is constrained by the need to curtail global greenhouse gas (GHG) emissions. This has motivated the investigation of alternative urban transport planning options and their associated climate-related consequences. One such option is greater uptake of electric mobility including use of electric cars, buses and bicycles. However, there is a need to understand the trade-offs that may emerge, especially with respect to the environmental effects, both direct and embodied, of increasing electricity demand associated with electric mobility. New Zealand has an electricity mix with a high proportion of renewables and so could potentially benefit from higher levels of electric mobility displacing more traditional fossil fuel-based transportation modes (EA, 2018). However, the degree to which this is feasible and how much it would reduce New Zealand's GHG emissions is currently unknown.

In 2015 New Zealand was responsible for less than 0.1% of global greenhouse gas (GHG) emissions (UNFCCC, 2017a; UNFCCC, 2017b). However, these emissions increased from 1990 to 2015 at an average rate of 0.9% per annum which was a higher rate than most other developed countries (UNFCCC, 2017b). On a per capita basis, New Zealand was 1.7 times the global average in 1990 and by 2012 this had increased to 2.53 times the global average (UNFCCC, 2017a; UNFCCC, 2017b). The largest single source of this increase was road transport (MFE, 2017).

New Zealand has a political and ethical duty as a participant in the global community to contribute to the reduction of environmental impacts including climate change. New Zealand has committed to combatting climate change locally and globally through the United Nations Convention on Climate Change (UNFCCC), Kyoto Protocol, and the Paris Agreement (MFE, 2017). Of the 56.4 mega-tonnes CO_2-equivalent emitted by New Zealand in 2015, 32.5 mega-tonnes (41%) were energy-related emissions and, of this, road transport was the largest source of emissions (13.3 mega-tonnes, 41% of the energy-related emissions) (MFE, 2017). This large contribution made by transport emissions presents an opportunity to reduce national emissions by targeting passenger road transport emissions. One way this could be done is by shifting transport from more energy-intensive modes such as cars to less intensive modes such as electric bicycles (hereafter E-bikes) (Rietveld & Daniel, 2004).

Cycling is promoted as an environmentally and socially responsible mode of passenger transport (Massink, 2011). Government policies and citizen participation both play important roles in increasing the cycling mode share of transport (Dill & McNeil, 2013; Ruan et al, 2013; Sagaris, 2015; Simons et al, 2014; Zhou et al, 2013; Weinert et al, 2007). In order to be effective, government policies need to focus on both decreasing the external costs of cycling and increasing the external costs of less desired competing modes such as light passenger vehicles (Rietveld & Daniel, 2004).