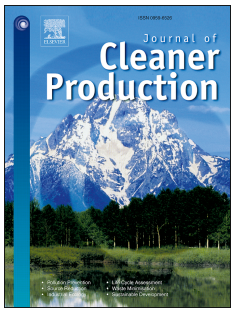
Accepted Manuscript



Life cycle assessment of a polymer electrolyte membrane fuel cell system for passenger vehicles

Sara Evangelisti, Carla Tagliaferri, Dan J.L. Brett, Paola Lettieri

PII: S0959-6526(16)32021-2

DOI: 10.1016/j.jclepro.2016.11.159

Reference: JCLP 8548

To appear in: *Journal of Cleaner Production*

Received Date: 26 May 2016

Revised Date: 24 November 2016

Accepted Date: 25 November 2016

Please cite this article as: Evangelisti S, Tagliaferri C, Brett DJL, Lettieri P, Life cycle assessment of a polymer electrolyte membrane fuel cell system for passenger vehicles, *Journal of Cleaner Production* (2016), doi: 10.1016/j.jclepro.2016.11.159.

Life cycle assessment of a polymer electrolyte membrane fuel cell system for passenger vehicles

*Sara Evangelisti, Carla Tagliaferri, Dan J. L. Brett, Paola Lettieri**

Chemical Engineering Department, University College London, Torrington Place, London WC1E 7JE, UK

**corresponding author*: Department of Chemical Engineering, UCL, Torrington Place, Roberts Building, Room 312, London WC1E 7JE, UK. Tel.: +44 (0) 20 7679 7867; fax: +44 (0) 20 7383 2348. Email: p.lettieri@ucl.ac.uk

Abstract

In moving towards a more sustainable society, hydrogen fueled polymer electrolyte membrane (PEM) fuel cell technology is seen as a great opportunity to reduce the environmental impact of the transport sector. However, decision makers have the challenge of understanding the real environmental consequences of producing fuel cell vehicles (FCVs) compared to alternative green cars, such as battery electric vehicles (BEVs) and more conventional internal combustion engine vehicles (ICEVs). In this work, we presented a comprehensive life cycle assessment (LCA) of a FCV focused on its manufacturing phase and compared with the production of a BEV and an ICEV. For the manufacturing phase, the FCV inventories started from the catalyst layer to the glider, including the hydrogen tank. A sensitivity analysis on some of the key components of the fuel cell stack and the FC system (such as balance-of-plant and hydrogen tank) was carried out to account for different assumptions on materials and inventory models. The production process of the fuel cell vehicle showed a higher environmental impact compared to the production of the other two vehicles power sources. This is mainly due to the hydrogen tank and the fuel cell stack. However, by combining the results of the sensitivity analysis for each component - a best-case scenario showed that there is the potential for a 25% reduction in the climate change impact category for the FCV compared to a baseline FCV scenario. Reducing the environmental impact associated with the manufacture of fuel cell vehicles represents an important challenge. The entire life cycle has also been considered and the manufacturing, use and disposal of FCV, electric vehicle and conventional diesel vehicle were compared. Overall, the ICEV showed the highest GWP and this was mainly due to the use phase and the fossil carbon emissions associated to the use of diesel.

Keywords: fuel cell vehicles; life cycle assessment; manufacturing; catalyst; PEM; hydrogen tank

1. Introduction

The urgency of tackling climate change is pushing policy makers and industrial sectors to investigate new technologies for the reduction of emissions and fuel consumption, especially in the transport sector. In the EU,