Can hydrogen be a clean fuel source for sustainable road freight transport in South Africa

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Background

Climate change is becoming a rapidly growing concern worldwide. On the 12th of December 2015, nearly every nation on Earth committed to being climate-neutral by 2050 through the Paris Agreement. The goal is to become completely free of greenhouse gas emissions to limit global warming to less than 2°C-1.5°C (United Nations/Framework Convention on Climate Change, 2015). The leading cause of global warming has been scientifically understood to be the human expansion of the "greenhouse effect." During this greenhouse effect, greenhouse gases in the atmosphere prevent heat from escaping resulting in increased atmospheric temperatures which cause disastrous events such as droughts, storms, and heat waves (National Aeronautics and Space Administration, 2021). Of the greenhouse gases, carbon dioxide is particularly dangerous due to its high atmospheric concentration and heat-trapping ability (Makan & Heyns, 2018).

The mobility of energy over the last century has primarily stemmed from refined crude oil, either petrol or diesel, which emits carbon dioxide as a by-product of extracting energy from its combustion. Road transportation accounts for around 25% of the total world energy-related carbon dioxide emissions as of 2007 resulting in it accounting for 74% of the total carbon dioxide emissions from transport (Terblanche, 2019). The road freight industry emits roughly 14% of carbon dioxide at global and European Union levels making it among the greatest contributors to greenhouse gas emissions (Makan & Heyns, 2018). Additionally, road freight transportation accounts for around 7% of the total world energy-related carbon dioxide emissions (Kaack, Vaishnav, Morgan, *et al.*, 2018).

Scope

For road freight transport were to be made more sustainable, the methods by which the energy is mobilised need to be addressed such that non-carbon-dioxide-emitting measures can be implemented. The irony herein is that many of the emerging energy mobility methods do not produce carbon dioxide as a by-product of combustion but might still require carbon-dioxide-emitting feedstocks such as

electricity generated from coal, crude oil, and natural gas. The focus of this study is centred around scenarios for hydrogen production and integration into the road freight transport sector such that the impacts it may have in reducing carbon dioxide emissions from this sector can be assessed approaching 2050 with an emphasis on informed decision-making relating to such emerging technologies.

Questions

1. Will preparing for competing alternative energy mobility technologies inhibit or assist hydrogen-fuelled road freight technology?
2. What are the necessary circumstances that hydrogen-fuelled road freight technology require to achieve its aims?
3. What pathways should be taken to integrate hydrogen technology into the road freight transport sector, if any?

Objectives

- Explain how hydrogen technology can improve the sustainability of road freight transport.
- Introduce emerging technologies relating to the generation and utilisation of hydrogen in the road freight transport sector.
- Propose an implementation pathway from the generation of hydrogen to its distribution, and finally, its utilisation in the road freight transport sector.

Method

A systematic review is conducted to estimate the energy required, in the form of hydrogen, to meet the South African road freight truck transport demands by 2050 using estimated road freight truck growths (Ahjum, Merven, Stone, *et al.*, 2018). The amount of renewable energy required to produce this amount of hydrogen can then be determined and a feasibility assessment conducted. This assessment will provide the necessary constraints upon which an argument can be made for or against strictly focusing on hydrogen-fuelled road freight transport. The renewable energy requirements will provide an indication of the infrastructure necessary to supplement this demand, which will form the basis of an implementation pathway. The maturity of technologies with appropriate current technology readiness levels are determined and their impacts assessed along the proposed implementation pathway to provide a more accurate strategy for hydrogen generation, distribution, and utilisation within the road freight transport sector.

Significance

Climate change is an important topic, but a highly contentious one. The effects of climate change are slow to reveal themselves, which complicates the process of accurately determining the correct course of action based on the current data. Counter arguments and alternative approaches will always be made and are frequently valid. The foresight required to estimate future events in the range of thirty years makes arguing for competing alternative energy technologies nearly subjective in nature. Although all models are wrong, useful ones should be created urgently to guide informed decision-making on this global scale challenge. The most significant agreement between the various pathways for alternative energy implementation appears to be that decisions are required as soon as possible, because the effects of delayed decision-making can be counter-productive to the common goal of significantly reducing carbon dioxide emissions by 2050.

References

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