INTERNATIONAL JOURNAL OF HYDROGEN ENERGY 42 (2017) 25695–25734

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/he

Developments of electric cars and fuel cell hydrogen electric cars

Tabbi Wilberforce [a], Zaki El-Hassan [a,*], F.N. Khatib [a], Ahmed Al Makky [a], Ahmad Baroutaji [b], James G. Carton [c], Abdul G. Olabi [a]

[a] Institute of Engineering and Energy Technologies, University of the West of Scotland, UK
[b] School of Engineering, Faculty of Science and Engineering, University of Wolverhampton, UK
[c] School of Mechanical & Manufacturing Engineering, Dublin City University, Dublin, Ireland

ARTICLE INFO

Article history:
Received 31 January 2017
Received in revised form
7 July 2017
Accepted 9 July 2017
Available online 31 August 2017

Keywords:
Electric cars
PEM fuel cell
Internal combustion engine
Hybrid cars
Plug – In hybrid cars
Battery electric vehicles

ABSTRACT

The world continues to strive in the search for clean power sources to run the millions of different vehicles on the road on daily basis as they are the main contributors to toxic emissions releases from internal combustion engines to the atmosphere. These toxic emissions contribute to climate change and air pollution and impact negatively on people's health. Fuel cell devices are gradually replacing the internal combustion engines in the transport industry. Some notable challenges of the PEMFC technology are discussed in this paper. High costs, low durability and hydrogen storage problems are some of the major obstacles being examined in this investigation.

The paper explores the latest advances in electric cars technology and their design specifications. The study also compares the characteristics and the technologies of the three types of electric cars now available in the market.

© 2017 Hydrogen Energy Publications LLC. Published by Elsevier Ltd. All rights reserved.

Introduction

A sustainable high quality of life is the basic driver for providing a clean, safe, reliable and secure energy supplies around the world. In order for human activities to co-exist with a sustainable environment, energy supply systems must provide some societal needs at affordable prices but at the same time they must not impact negatively on the environment. These systems need to mitigate the effects of climate change, reduce toxic pollutants and be in place to replace the diminishing reserves of oil. The implication of an energy system not being able to meet these requirements is an adverse effect on the environment, on the economy and on public health. Plans should be far advanced to promote more efficient use of energy and energy supply from a growing proportion of carbon free sources [1]. The impacts of climate change cannot be underestimated as they are irreversible. The world cannot take chances on this crucial decision, hence, the need for ideal emissions free future based on sustainable energy. One of the most promising ways to make this goal a reality is the usage of cleanly produced electricity from non-fossil fuels such hydrogen using fuel cells technology. Hydrogen is not considered a primary source of energy like coal and gas. It is a potential for clean energy but it is currently mainly produced using existing

* Corresponding author.
E-mail address: zaki.el-hassan@uws.ac.uk (Z. El-Hassan).
http://dx.doi.org/10.1016/j.ijhydene.2017.07.054
0360-3199/© 2017 Hydrogen Energy Publications LLC. Published by Elsevier Ltd. All rights reserved.

energy systems that are based on different conventional primary energy carriers and sources.

Renewable energy will be one of the most important sources for the future production of hydrogen, even more than in the present. Regenerative hydrogen and hydrogen produced from nuclear sources and fossil based energy conversion systems with capture and safe storage (sequestration) of CO_2 emissions are almost completely carbon free energy pathways. Scientist all over the world are researching the use of renewable energy systems in the transport industry due to the continuing depletion of crude oil based energy resources and their impact on the environment which is accelerating climate change as a result of the continued burning of fossil fuels. Emissions from fuel cells are extremely low hence the increased interest in their use and increased efforts by scientists and researchers across the globe to improve their efficiency and reduce their costs.

Any electro-chemical device that transforms chemical energy of any fuel directly into electrical energy is called a fuel cell. One of the main characteristics of fuel cells is that the reactants are fed directly from external sources unlike batteries which store the reactants internally. The electrodes in fuel cells are also not consumed as often the case with batteries, irreversibly in a primary cell and reversibly in a secondary cell, and do not participate in the reaction. Fuel cells are already used to generate electricity in many applications including spacecraft and in stationary uses such as emergency power generators. Several research work in recent years has revealed that the transport industry is one of the main contributors to the emission of hazardous and toxic substances into the environment as they rely highly on fossil fuels and as explained earlier, they are the main reasons for the phenomena of global warming. This in effect has contributed massively to the sudden climatic changes around the globe and many of the released pollutants contribute to the depletion of the ozone layer. Due to the high demand for fossil fuel by the transport sector, there is continual diminution of fossil based resources of energy such as crude oil. The worlds total energy consumption is highly dominated by the transport industry which accounts for nearly 55% of the world energy consumption and 30.9% of carbon dioxide gas emissions according to recent research studies [1]. It was also anticipated that if no proper action is collectively taken the situation will get worse and the negative impacts on the environment and world economies will further increase. Figs. 1 and 2 from Das et al. [2] explain the levels of energy consumption by 2 sectors over the past few years. From Figs. 1 and 2 it is also possible to predict the likely events in the future if the situation is not carefully addressed. A possible solution to mitigate this challenge is the use of electric cars, a topic that is currently being investigated and explored as the alternative to the usage of fossil fuel. Electric cars are considered to be environmentally friendly and are predicted to aid in the process of reducing toxic emissions into the atmosphere. Most of the electric energy sources currently under consideration are from batteries, ultra-capacitors or fuel cells. Another advantage of using electric cars is the fact that they help in reducing operational cost compared to gas or oil powered vehicles.

It is estimated that electric vehicles cost nearly 2cents per mile while conventional petrol powered cars cost around 12 cents per mile indicating an extra 10 cent per mile needed in running a petrol powered vehicle. Recent studies have revealed that electric cars can operate within 4–8 miles per kWh energy with zero emission of greenhouse gases (GHG). The US Department of Energy also reported that internal combustion engines (ICE) vehicles normally use 15% of the total fuel energy to run the car while 75% of the energy is usefully utilized in electric vehicles [3,4]. Most electric vehicles are quite expensive due to the cost of their source of energy that accounts for almost one third of the entire cost of the car. A number of energy storage mediums in electric cars are currently being considered with the express purpose of reducing the cost relating to energy storage and utilisation.

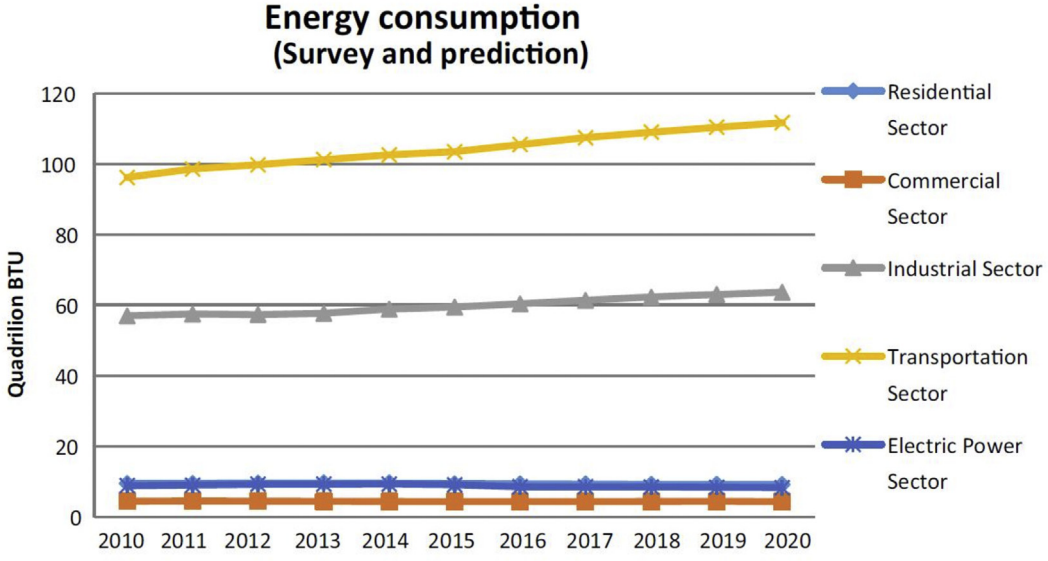

Fig. 1 – Consumption of energy in different sectors [2].

Download English Version:

https://daneshyari.com/en/article/5145666

Download Persian Version:

https://daneshyari.com/article/5145666

Daneshyari.com