Journal of Global Business and Social Entrepreneurship (GBSE)
Vol. 4: No. 11 (May 2018) page 151-157 | www.gbse.com.my | eISSN : 24621714

A REVIEW OF CLEAN ENERGY TECHNOLOGY SOURCES FOR CO_2 EMISSION REDUCTION STRATEGY IN TRANSPORTATION SECTOR

M.H. Norhidayah [1]
W.S.W.A. Najmuddin [2]

Abstract: *Rapid development for socio-economy has led to higher energy demand globally. Increasing in energy consumption that relies on fossil fuel bring to higher air pollution and contribute to climate change. As transportation supports the socio-economic growth, it is also one of the major contributors of carbon dioxide (CO_2) emission. This paper reviews the role of clean energy sources as an alternative to reduce the level of CO_2 emission in transportation sector. The potential of this clean energy also explains as an option to the energy crisis solutions. Clean energy technology able to provides non-dependency on the fossil fuel, fulfill the energy demand in future and protect the environment. This paper also suggests by decarbonizing the current energy sources in the transportation sector influence a positive strategy in mitigating CO_2 emission as well as reducing global warming.*

Keywords: Clean Energy, CO_2 Emission, Greenhouse gases emission, Transport sector.

Introduction

Transportation plays a major role in developing socio-economy, building of community and enhancing quality of human life and environment. Growth rates of socio-economic activities, along with improvement of human living, strongly influenced global energy demand and efficient transportation system. While the need of transportation sector is vital to industrialization of developing nations and enhancing community living, it also brings to significant impact to the environment, threat to global warming issue as well as risking a human health. Every year about 35 billion metric tons of carbon dioxide emitted into the atmosphere due to human activities, primarily from energy use (IEA, 2017). Increased population rates and economic development, simultaneously will increase the GHG emission from the mobility usage.

Mainly, vehicles consume fossil fuel as their energy source to move from one place to another. The majority of GHG emissions come from the vehicle resulting from the combustion of petroleum-based products in internal combustion engines (ICE). Combustion of fossil fuel includes coal, diesel fuel, gasoline, oil, and natural gas for electricity

[1] Muamalat Department, Kolej Antarabangsa Sultan Ismail Petra, P.O Box 68, Nilam Puri, 15730 Kota Bharu, Kelantan, Malaysia, Tel: +60129486300 E-mail: norhidayah169@gmail.com.
[2] DRB-HICOM University of Automotive Malaysia, DRB-HICOM Automotive Complex, Lot 1449, PT 2204, Peramu Jaya Industrial Area, 26607 Pekan, Pahang, Malaysia, Tel: +60199575313 E-mail: wan160876@yahoo.com.

production, heating, transportation, and industry have caused major air pollution (US EPA, 2015). In recent years, many studies are carried out which is subjected to the health effects of air pollution (Perera, 2017 and Landrigan, 2017). According to World Health Organization (WHO) reports, air pollution is the primary cause to the environmental health risk with about 3.7 million deaths were attributable to ambient air pollution in 2012. Although fossil fuel plays a key role in global energy demand, being the dominant source of energy, it also brings negative impact to the environment.

Addressing this critical global issue, an international environmental treaty called United Nations Framework Convention on Climate Change (UNFCC) adopted in 1992 with the objective to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system (UN, 1992). In 1997, the Kyoto Protocol was established for developed countries to reduce their greenhouse gas emissions in the period of 2008 to 2012. Then, in 2010, Cancun agreements concluded to key steps forward in capturing plans to reduce greenhouse gas emissions and to help developing nations protect themselves from climate impacts and build their own sustainable futures. The Paris Agreement adopted in 2015, builds upon the Convention to with central aims to keep the global average temperature rise below two degrees below 2.0 °C which is relative to the pre-industrial level.

This paper is organized in several sections. Section 2 represents study from previous literature encompasses the current scenarios of CO_2 emission and transportation as focused-sector in reducing climate change. The alternative energy technology from clean sources is described in Section 3. Section 4 discusses the main strategy involved for CO_2 reduction for world sustainability. Section 5 presents the conclusion of this paper.

Literature Review

GHG emissions are mostly related to energy use which involved a variety of economic and social activities. Other than methane (CH_4) and nitrous oxide (N_2O), carbon dioxide (CO_2) emission is dramatically increasing over the past decades. As data are shown in IEA, (2017), energy consumption represents the largest source of emissions with about 68% out of others entities. Within the energy use, CO_2 dominates as the largest shares of global anthropogenic GHG with 90% compare to CH_4, 9% follow by N_2O, 1%. The rising trend in CO_2 emission is caused by the higher global energy demand of fossil fuel. Additionally, according to the Emission Database for Global Atmospheric Research in 2011, global CO_2 emission is equal to 33.4 billion tonnes which is 48% higher than two decades ago (EDGAR, 2011 and Leung et al., 2014). CO_2 intensity will growth to as much as 600 to 1550 ppm by year 2030, with estimated increment of 25 to 90% over the year 2000 level if neglecting the policies of climate change mitigation (Nakicenovic et al., 2000).

Excessive use and heavily reliance on fossil fuels by far create much faster threat of world climate change. In spite of the potential energy source, fossil fuels also bring a negative impact by emitting GHG emissions, CO_2. According to IEA (2017), world transportation sector is responsible for 24% of global CO_2 emissions and its growth rate keeps rising than any other energy-related sector. Figure 1 shows the portion of world CO_2 emissions from fuel combustion by sector in 2015. In the past two decades, mobility sector has observed a significant global growth in terms of energy use in all transport modes,

vehicle possession, passenger and freight activity. Mobility encompasses of different modes of transportation such as rail, road, aviation and marine.

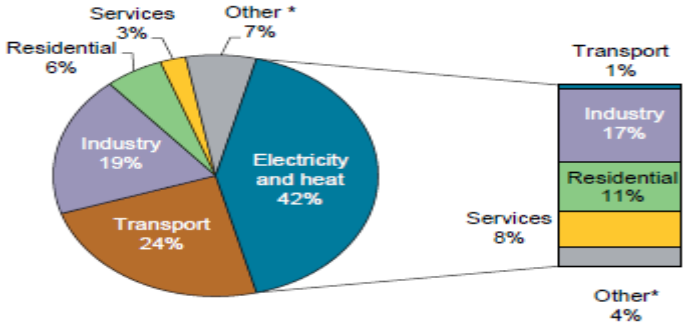

Figure 1: World CO_2 emissions from fuel combustion by sector in 2015 (International Energy Agency (IEA), 2017).

Road transport accounts of 85.71% of total passengers which is a prominent mode in transportation network (Masjuki et al., 2004). In 2015, road transport is a dominant source for three-quarters of transport emissions with about 68% increment since 1990 as shown in Figure 2.

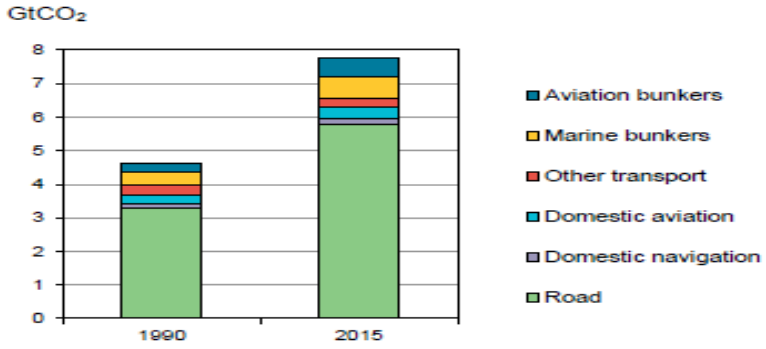

Figure 2: CO_2 emissions from transport, 1990-2015 (International Energy Agency, 2017).

Within road transportation sector, light-duty vehicles such as motorcycles, cars, vans and trucks contribute 66% which is the largest consumer of oil follow by 34% of heavy-duty vehicles includes heavy trucks, lorry and buses. Therefore, the major reduction of CO_2 emission should be achieved in road transportation via strategic plan and implementation.

CLEAN ENERGY TECHNOLOGY SOURCES

In order to protect secure long-term sustainability for humankind, academics, policy-makers, industry leaders and civil society acknowledged that economic growth and human wellbeing need to be decoupled from escalating resource use and negative environmental impacts (Schandl et al., 2016). Various countries are considered and adopted several different approaches to mitigate the CO_2 emissions which includes improve energy efficiency and promote energy conservation, increase usage of low carbon fuels, including natural gas, hydrogen or nuclear power, CO_2 capture and storage (CCS), deploy renewable energy, such

as solar, wind, hydropower and bioenergy and apply geoengineering approaches, e.g. afforestation and reforestation (Leung et al., 2014). Thus, a clean energy technology source is a promising decision to reduce global CO_2 emissions. Consuming more fuel-efficient technology such as EVs can reduce fuel consumption and the emissions level compare to a conventional fuel technology (Mustapa and Bekhet, 2016).

Recently, several technologies are emerged in the transportation sector concentrated in producing low and zero emission from a clean energy source. These technologies are known as battery electric (BEV), plug-in hybrid electric (PHEV), and fuel cell electric (FCEV) vehicles. Many research involved in this particular technology, thus, it shows the ability of this technology to reduce CO_2 emission and global warming. Currently, three main types of electric vehicles have been tested to the production stage of the manufacturing process (Al-Alawi and Bradley, 2013). There are includes hybrid electric vehicles (HEVs), the plug-in electric vehicles (PHEVs) and the full electric vehicles (FEVs). HEVs and PHEVs have a similar operating method with two combination modes of electric and internal combustion engine whereas for FEVs, an electric mode in all operation. Therefore, EV can be categorized in terms of low emission encompasses HEV and PHEV; and FEV as in zero-emission category.

As aforementioned, EV appears to be most influence clean emission of transport with over 750 thousand sales worldwide in 2016. Since 2010, the electric car supply has been growing and exceeded the 2 million-vehicle level in 2016 (IEA, 2017). Until now, BEVs has been constantly upfront of the plug-in hybrid electric vehicles (PHEVs). The world's largest electric car market in 2015 is China followed by the United States, Netherlands and Norway. Together, these countries share about 70% of electric cars sold globally (IEA, 2016). Asian market indicates the highest sales of BEVs in 2012, particularly in Japan and China. The number of countries with a market share of electric cars is increasing from 2014 to 2015 from 3% to 6% accordingly. Meanwhile, FCVs have the lowest market share with only 450 passengers on the road worldwide (OECD, 2012 and IEA, 2012). A recent report exploring the various application of hydrogen affirms its significant implications towards electricity generation, cooking food, fuel for automobiles, hydrogen-powered industries, jet planes, hydrogen village and on the top for all our domestic energy requirements (Jain, 2009).

HEV, the most accepted EVs can reduce minor CO_2 emission, as they are combined with fossil fuels. Higher CO_2 reduction could be reached with BEVs and FCVs. These two types of technologies have zero tank-to-wheel (TTW) emissions but their factual ability in contributing reduction of GHG emissions can only be estimated by addressing the whole energy supply chain analysis (Ajanovic, 2015). As for FCV, hydrogen can offer an alternative of energy carrier for transport sector due to its higher gravimetric energy density, abundantly available elements in the combined form on the planet and its oxidation process produce water which does not harm to the environment.

CO_2 EMISSION REDUCTION STRATEGY

Generally, several studies have considered mitigation alternatives for CO_2 emissions reduction. The need for radical mitigation measures is proposed such as using alternative technologies, increasing energy efficiency, reducing transport and eliminating fuel subsidies to attain substantial CO_2 emissions reductions in the transportation sector. It is important that

selected options have to be reliable and feasible without neglecting the economic growth for sustainable development. Overall, this CO_2 emission reduction strategy concentrates on the implementation of clean energy source involve EV and FCV.

In order to reduce the GHG emission, a comprehensible strategy needs to initiate, in total to meet the global consensus involving environmental issue. The policy such as Renewable Energy Directive is established for the production and promotion of energy from renewable sources in the European Union (EU). By 2020 at least 10% of transport fuels in all EU countries must come from renewable sources. In the year 2009, National Policy on Climate Change (NPCC) and National Green Technology Policy (NGTP) have been certified by Malaysia's government based on the fundamental strategy to ensure climate resilient development in fulfilling national aspirations for sustainability.

Various countries have adopted direct subsidies, tax exemptions and other non-fiscal incentives to boost the sale of electric-drive vehicles. To date, substantial of electric-drive vehicle policy is California's Zero Emission Vehicle (ZEV) program, which insists the manufacturers to meet an increasing share of vehicle sales with PHEV, BEV, and FCEV technologies. The ZEV technologies are able to mitigate climate and health impacts of transportation by replacing conventional technologies with zero-tailpipe-emission. Apart from that, a multi-government policy forum known as The Electric Vehicles Initiative (EVI) is established in 2009 under the Clean Energy Ministerial (CEM) which devoted to accelerating the deployment of EVs globally (CEM, 2017). Collectively, EVI is an effective platform for the exchange of information, action and communication about EVs and can assist via informing policymakers and the public about EV deployment.

A supportive policy shall be adopted to enable market growth in clean energy source vehicles attractable to consumers, reduce risks for related investors and encourage automakers to develop EV business streams industry on a huge scale. As such, policy to support mechanism shall be introduced to encourage a research and development of innovative clean technologies, aims and regulations, subsidies and incentives in terms of financial and other mechanisms to increase the value proposition of EVs.

Conclusion

Apart from fulfilling local energy consumption, clean energy sources bring the potential to provide energy resource with low or almost zero emissions to the atmosphere. Effective implementation of global green environment policy among world nations has created a positive impact on CO_2 emission. However, EVs and FCV still hold a long path before reaching a full deployment scales capable of making a significant development of reducing global oil demand and greenhouse gas (GHG) emissions. Research, development and supportive policy lead to continuous improvements and higher market penetration respectively. Immense concentration by global automakers and researcher higher attraction to clean energy technologies currently, confirm that this tendency of development will continue, narrowing the cost competitiveness gap between EVs and conventional internal combustion engines (ICEs). Therefore, the transformation of the energy and transportation sector will play a crucial role in accomplishing this, as both sectors are the major contributor to global climate change. However, with the technology transition to clean energy sources definitely, it brings to a cleaner and more secure of energy in the future.

References

Perera, F. (2017). Pollution from Fossil-Fuel Combustion is the Leading Environmental Threat to Global Pediatric Health and Equity: Solutions Exist. International journal of environmental research and public health, 15(1), 16.

Landrigan, P. J. (2017). Air pollution and health. The Lancet Public Health, 2(1), e4-e5.

IEA. CO_2 Emissions from Fuel Combustion—2016 Edition—Key CO_2 Emissions Trends. 2016. Available online: https://www.iea.org/publications/freepublications/publication/co2-emissions-fromfuel-combustion---2016-edition---excerpt---key-trends.html (accessed on 12 September 2017).

US Environmental Protection Agency. Greenhouse Gas Emissions, 2015. Available online: https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions (accessed on 12 October 2017).

United Nations (UN), 1992. http://unfccc.int/essential_background/convention/items/6036.php

Emission database for global atmospheric research (EDGAR), European Commission. http://edgar.jrc.ec.europa.eu/overview.php?v; CO2ts1990-2011.

Nakicenovic, N., Alcamo, J., Grubler, A., Riahi, K., Roehrl, R. A., Rogner, H. H., & Victor, N. (2000). Special Report on Emissions Scenarios (SRES), A Special Report of Working Group III of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Masjuki HH, Karim MR, Mahlia TMI. Energy use in the transportation sector of Malaysia. Economic planning unit of the Prime Minister's Department. Kuala Lumpur: Consultancy Unit, University of Malaya; 2004.

Schandl, H., Hatfield-Dodds, S., Wiedmann, T., Geschke, A., Cai, Y., West, J., ... & Owen, A. (2016). Decoupling global environmental pressure and economic growth: Scenarios for energy use, materials use and carbon emissions. Journal of Cleaner Production, 132, 45-56.

Leung, D. Y., Caramanna, G., & Maroto-Valer, M. M. (2014). An overview of current status of carbon dioxide capture and storage technologies. Renewable and Sustainable Energy Reviews, 39, 426-443.

Mustapa, S. I., & Bekhet, H. A. (2016). Analysis of CO 2 emissions reduction in the Malaysian transportation sector: An optimisation approach. Energy Policy, 89, 171-183.

Al-Alawi, B. M., & Bradley, T. H. (2013). Review of hybrid, plug-in hybrid, and electric vehicle market modeling studies. Renewable and Sustainable Energy Reviews, 21, 190-203.

International Energy Agency (IEA), 2017. https://www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf

International Energy Agency (IEA), 2016. http://www.iea.org/publications/freepublications/publication/TrackingCleanEnergyProgress2016.pdf

The Organisation for Economic Co-operation and Development (OECD), 2012. Market Development for Green Cars.

International Energy Agency (IEA), 2012. Tracking clean energy progress. Energy Technology Perspectives 2012 excerpt as IEA input to the Clean Energy Ministerial. Paris: OECD/IEA, 2012.

Jain, I. P. (2009). Hydrogen the fuel for 21st century. International journal of hydrogen energy, 34(17), 7368-7378.

Ajanovic, A., (2015). The future of electric vehicles: prospects and impediments. Wiley Interdisciplinary Reviews: Energy and Environment, 4(6), 521-536.

Clean Energy Ministerial (CEM), (2017). "Electric vehicles initiative (EVI)", www.cleanenergyministerial.org/Our-Work/Initiatives/Electric-Vehicles.