CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

Owing to the significant growth of the population, transportation, and the basic industry sectors, the demand for fossil fuel continues to increase (Asif & Muneer, 2007). Its growth began as the Industrial Revolution in Europe took off in the 18th century since vast quantities of fossil fuel were used to power the economy. However, based on the report, it is becoming a global problem as crude oil stock is depleting and its price is increasing. Therefore, significant environmental problems can be seen as the consumption of fossil fuel increases. Based on a BP Statistical Review of World Energy in June 2014, the global primary energy consumption in 2013 accelerated by approximately 2.3% over 2012 despite stagnant global economic growth. Moreover, the consumption and production of all fuels increased, reaching record levels for every fuel type except nuclear power. Global consumption rose more rapidly than the production of each type of fossil fuel. In 2013, the data suggests that growth in global carbon dioxide (CO_2) emissions from energy use also accelerated, although it remained below average (BP, 2014).

On the other hand, global energy consumption will rise by 37% by 2040, whereas crude oil consumption is expected to rise from the current 90 million barrels a day to 104 million barrels a day. However, demand for oil will plateau by 2040 according to the International Energy Agency (IEA) in its latest World Energy Outlook released on November 12, 2014, in London. Interestingly, the report also stated that the global supply of crude oil, other liquid hydrocarbons, and biofuels is expected to be

sufficient to meet world demand for liquid fuel for at least the next 25 years. However, there is substantial uncertainty about the levels of future liquid fuel supply and demand. After the oil crises in the 1970s and 1980s, much of the debate about world oil markets focused on the limitations of supply (Birol, 2014).

According to Malaysia Energy Commission 2014, the total primary energy supply in Malaysia increased by 5.9% in 2012 compared to 3.2% during 2011. The production of crude oil growth was motivated by a 2.8% increase from 28,325 kilotonnes of oil equivalent (ktoe) in 2011 to 29,115 ktoe in 2012. Accordingly, the final energy consumption in 2012 also increased by 7.5%, which is 46,711 ktoe compared to 4.8% in 2011. The transportation sector provided the highest energy demand, which contributed 36.8%, followed by the industrial sector at 29.8%, the non-energy sector at 16.0%, the residential and commercial sectors at 15.1%, and the agriculture sector at 2.3%. Furthermore, in 2012, the total final energy consumption of petroleum products increased by 3.4%, with the major increases coming from kerosene and fuel oil. Final consumption of kerosene increased by 100.1%, whereas the final consumption of fuel oil increased by 85.5%. In a nutshell, petrol and diesel are the largest contributors to the total consumption of petroleum products with 36.2% and 35.6%, respectively, as illustrated in Figure 1.1 (Energy Commission, 2014).

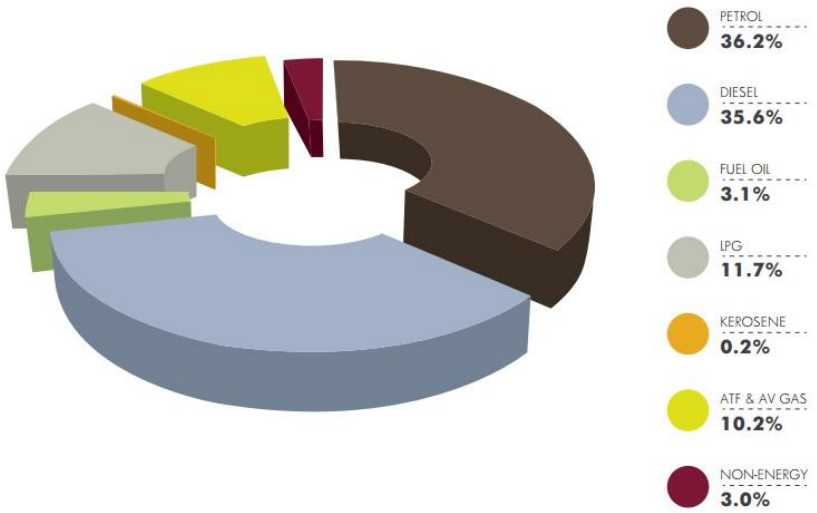

Figure 1.1: Final consumption of petroleum products

Source: Energy Commission (2014)

One of the main contributors to air pollution is the diesel engine. However, diesel engines are attractive power units used widely in many fields because of their great advantages over gasoline engines such as lower fuel consumption, lower carbon monoxide emissions, better torque characteristics, and higher reliability (Heywood, 1988; Stone, 1999). These characteristics make diesel engines the main contributor to total petroleum consumption. In contrast, owing to its lean-burning nature and high temperatures and pressures in the combustion process, diesel engines are the main contributors to air pollution for a large amount of emissions, especially particulates and nitrogen oxides (NOx) (Heywood, 1988). However, the trade-off trend between NOx and particulate matter (PM) in diesel combustion is not yet completely solved. One of the solutions identified by many researchers is to replace diesel fuel with an alternative fuel. Many agree that this solution can solve the problem of diesel emissions and also reduce dependence on crude oil. Thus, controlling these emissions is one of the most important aspects of modern air quality management.

Biodiesel is increasingly used as an alternative fuel and is becoming important owing to environmental and energy concerns. Besides, the Ministry of Plantation Industries and Commodities of Malaysia (MPIC, 2014) implement the B7 programme for the subsidized sector beginning in November 2014. B7 involves the blending of 7% palm biodiesel with 93% petroleum diesel. The implementation of the B7 programme would consume 575,000 tonnes of biodiesel, which would contribute towards a savings of 667.6 million litter of diesel a year (MPIC, 2014). Biodiesel, which is considered to be a low-carbon fuel, can be blended with different proportions and directly used in diesel engines without modification. In fact, it has been found that engines fuelled by biodiesel run successfully for longer durations. Moreover, the performance and emissions characteristics are also quite comparable to those of petroleum-based diesel fuel (Gopal et al., 2014).

Research has shown that diesel engines fuelled with palm oil could decrease the emissions produced in terms of smoke, PM, hydrocarbon, sulphur oxide, and carbon monoxide (Kumar & Chauhan, 2013; Lapuerta et al., 2008). However, there are growing concerns surrounding the negative impact of PM emissions from diesel engines on human health and the environment. Moreover, since the great smog of 1952 in