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Implementation of biofuels in Malaysian transportation sector towards sustainable development: A case study of international cooperation between Malaysia and Japan

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ABSTRACT

Modern transportation nowadays has evolved into an important economic activity for human civilisation. Even though various alternative energy solutions have been put forward to reduce the dependency on fossil fuels, biofuels remain one of the few options which are capable of replacing the roles of fossil fuels in transportation sector without suffering from major economic losses. Malaysia with a huge supply of palm oil for biofuels production is intended to implement mandatory biodiesel blends in its transportation sector in 2011 in order to achieve its carbon reduction commitment towards a more sustainable development. This implementation was originally targeted to start in 2009 but had to be postponed due to several obstacles such as expensive cost, lack of sufficient infrastructure and low public demand. On the other hand, Japan is also trying to fulfil its carbon reduction obligation as outlined under Kyoto Protocol with the usage of biofuels to replace fossil fuels in the transportation sector. However, it lacks sufficient biofuels supply to support its high transportation energy demand. In this case study, the mutual cooperation between Malaysia and Japan in the implementation of biofuels in transportation sector will be studied and analysed in order to overcome the challenges presented in both countries. It is hope to ascertain potential cooperation opportunities amongst those two countries to promote biofuels energy as Malaysia is rich in natural resources whilst Japan has the relevant expertise and technology. It is believed that the strengths from one country can help to cover for the weaknesses from the other and vice versa via closer bilateral partnership which will be extremely crucial when dealing with global energy issues. Ultimately, it is hope that this case study will enable both Malaysian and Japanese government to achieve their renewable energy target in domestic transportation sector.

Contents

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1. Introduction

One of the most pressing global concerns in this century is none other than the issue of global warming. The dawn of the industrial revolution in Europe on the 18th century marked the beginning of huge emissions of carbon dioxide (CO_2) gases to the open atmosphere due to anthropogenic activities. Rapid accumulation of free CO_2 gases in our atmosphere will eventually lead to irreversible drastic climate change to our ecology. Over the years, several global climate talks had been conducted by United Nations and participated by more than 200 countries around the world [1]. Even though intense discussions and serious debates are still on-going at the moment, it is obvious that major carbon reduction scheme will be imminent in the near future to transform into low carbon society. Transportation sector accounted for almost 16% of the total global CO_2 emissions from man-made activities, just behind electricity generation and industry sector from manufacturing and construction [2]. A recent study regarding the influence of anthropogenic activities towards climate change had also proven that transportation sector would be the highest potential contributor to atmospheric warming in the near decades [3]. With regards to this, reducing net greenhouse gas (GHG) emissions in transportation has become one of the top priorities to achieve sustainable development.

Over the years, ample of alternative fuels such as biofuels, solar and fuel cell had been proposed to reduce the usage of non-renewable energy in transportation. Unfortunately, most of the renewable sources required radical technologies and revamping of the whole transportation energy supply system [4]. The changes might take more than several decades to be carried out and maybe even longer time to stabilise. In view of the critical time frame to address the increasing GHG emissions in transportation, biofuels remain as one of the most promising substitutions to replace fossil fuels in the transition phase towards cleaner transportation energy sources. Malaysia is one of the staunchest supporters in the Asia region to push for the implementation of biofuels in its transportation system. Regrettably, its progress is still far from success since it has encountered numerous problems along the way. Malaysia enjoys plentiful of natural resources to provide continuous supply for biofuels but lacks adequate skilled workforce and advanced technology [5]. As the whole world is gearing towards the implementation of biofuels in transportation sector, it is vital for Malaysia to identify the impending and subsequent challenges in order to stay at the forefront of sustainable development. In this context, Japan can serve as a perfect role model and ideal comparative case for Malaysia. As one of the most developed countries in Asia, Japan was able to reform its transportation industry with great success such as the introduction of 'Shinkansen' (bullet train) and hybrid vehicle [6]. Moreover, Japan possesses a rich pool of skilled workers and state-of-the-art green energy processing technology. Unfortunately, it does not have sufficient cost-effective supply of raw materials to cater for the biofuels demand for its transportation sector [7]. Therefore, in this case study, experience and government policies from both countries in revamping their transportation sector were studied extensively. Comparisons of scenario were made where appropriate and adapted to overcome the challenges in several key factors for the implementation of biofuels in their own respective native country. It was also hope that this review could pinpoint several opportunities for deeper cooperation amongst the two countries in order to achieve a win-win situation. Subsequently, the success based upon this symbiotical relationship may be able to serve as an example for other countries to emulate towards achieving the global quest for sustainable development in transportation sector.

2. Biofuels in transportation

In general, the term biofuel is used to represent all the liquid and gaseous transportation fuels derived predominantly from biomass [8]. Examples of biofuels include biodiesel, bioethanol, biomethanol, biohydrogen and bio-oil. Currently, biodiesel and bioethanol are the two most promising biofuels being projected to replace conventional fossil fuels in transportation. Biodiesel or fatty acid methyl ester (FAME) is normally synthesised through transesterification of vegetable oils with methanol and the aid of appropriate catalysts. It can be used to replace mineral diesel in compression-ignition (CI) engine which has almost similar properties without requiring any major engines modifications. Commercial production of biodiesel has been well established and is available to be purchased as turn-key plants in many countries [5]. On the other hand, bioethanol is suitable to replace the usage of gasoline in petrol engine. Conventional bioethanol is produced from the fermentation of simple sugar or starch crops. Its large-scale production has been well proven and demonstrated successfully in Brazil [9]. However, it competes with food sources for human consumption which renders it susceptible to criticisms. Another alternative raw material for bioethanol production is using inedible food sources mainly lignocellulosic material such as forest and agricultural biomass waste. However, additional pretreatment steps are normally required which will increase the overall production cost. Process optimisation is still being researched intensively at pilot plant scale in order to find a more cost-effective production method for mass commercialisation [10]. In this case study, biofuels for transportation in Malaysia and Japan will focus mainly on biodiesel produced from palm oil and Jatropha whilst bioethanol will be synthesised from lignocellulosic biomass. For Japan, majority of its source of biofuels is expected to be imported from Malaysia. Part of its demand for bioethanol will be fulfilled from its own agricultural and wood waste as well.

3. Malaysia vs Japan

Malaysia is a South East Asia country with total land area spans across 328,657 km^2 and inhibited with a population of more than 28 million people. After gaining independence from the British in 1957, Malaysia has successfully diversified its economy from natural resources and agricultural exportations to multi-sector output encompassing manufacturing, services and tourism. It is now one of the leading developing countries in the world with the aim to achieve the status of developed country by the year 2020. Malaysia enjoys a tropical climate with constant rainfalls throughout the year. This has enabled its plantation industry to thrive with agricultural products such as palm oil, rubber, cocoa and rice. Malaysia is also a net exporter of oil and gas and has thus benefited from the higher energy price. Almost 40% of its government revenue is derived from its local oil and gas producer, Petronas [11]. Unfortunately, its oil and gas reserves are fast depleting and adjustments will have to be made to curb the increasing demand for fossil fuels.

After World War II, Japan has successfully recovered and transformed into a global economic powerhouse. It is now the second largest economy in the world just behind the US. Part of its success can be attributed to a close working relationship and cooperation between the government and its private industry. Effective government policies such as the guarantee of lifetime employment for the urban workforce had enabled the private industry to flourish. In return, the private industry had developed a strong work ethic to drive the enhancement and progress of advanced technology [12]. Since Japan is heavily dependent on imported raw materials and fuels for its manufacturing sector, its state-of-the-art technology is pivotal in preserving its economy growth. As one of the largest oil