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Highlighting of the Factors and Policies Affecting CO_2 Emissions Level in Malaysian Transportation Sector

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***Abstract*—**Global CO_2 emission and increasing fuel consumption to meet energy demand has become a threat in recent decades. Effort to reduce the CO_2 emission is now a matter of priority in most countries of the world including Malaysia. Transportation has been identified as the most intensive sector of carbon-based fuels and achievement of the voluntary target to meet 40% carbon intensity reduction set at the 15th Conference of the Parties (COP15) means that the emission from the transport sector must be reduced accordingly. This posed a great challenge to Malaysia and effort has to be made to embrace suitable and appropriate energy policy for sustainable energy and emission reduction of this sector. The focus of this paper is to analyze the trends of Malaysia's energy consumption and emission of four different transport sub-sectors (road, rail, aviation and maritime). Underlying factors influencing the growth of energy consumption and emission trends are discussed. Besides, technology status towards energy efficiency in transportation sub-sectors is presented. By reviewing the existing policies and trends of energy used, the paper highlights prospective policy options towards achieving emission reduction in the transportation sector.

***Keywords*—**CO_2 Emission, Energy policy, Fuel consumption, Transportation sector, Malaysia.

I. Introduction

CLIMATE change has emerged as the most challenging environmental problem in recent decades. The world CO_2 emission has increased rapidly over the years as a result of ever increasing energy consumption. The increasing CO_2 emission has led to significant changes in temperature and precipitation patterns as well as causes serious environmental consequences such as increased frequency of floods, storms, droughts, rising sea level and global temperatures [17], [25]. Therefore, significant reduction in CO_2 emission is needed to avoid these disastrous consequences.

Many countries including Malaysia have played active roles in the effort to reduce CO_2 emissions by supporting the national mitigation actions and intergovernmental mechanisms particularly the United Nations Framework Convention on Climate Change (UNFCCC), a non-binding agreement aimed at reducing the CO_2 emission. There are 195 parties including developed and developing countries agreed on the framework convention on climate change. Since 1995, the parties to the convention met annually in Conference of Parties (COP) to assess progress in dealing with emission and climate change.

At the 15th COP (COP15) in 2009, Malaysia has pledged her commitment by agreeing to a conditional voluntary target of 40% reduction in carbon intensity by 2020 from a 2005 baseline. However, this target is subject to the availability of technology and financial assistance from Annex 1 countries.

The challenge is to balance the reduction in CO_2 emission target with the need for the country to progress as energy is vital in economic and social development. In developing countries like Malaysia where the sources of energy are mainly from fossil fuels, it is noticeably apparent that as these countries progress, the demand for energy will also increase, which directly resulted to an increase in the CO_2 emission. Fig. 1 shows that the trend of CO_2 emission in Malaysia is in line with the GDP growth. The increased of CO_2 emission are due to the rapid economic development and industrialization over the last decades that requires extensive used on fossil fuels to meet the growing of energy demand.

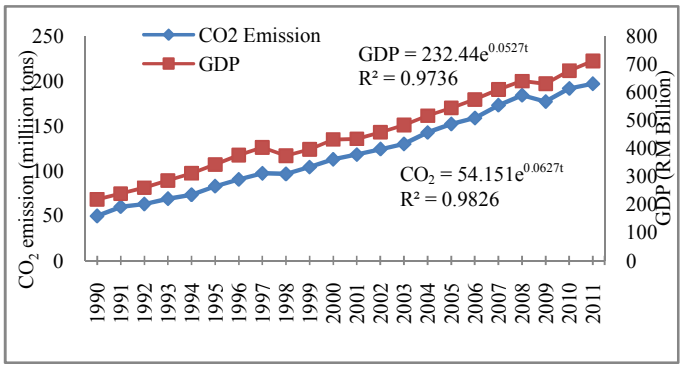

Fig. 1 The trend of CO_2 emission and GDP in Malaysia (1990-2011) [29], [18]

According to statistical data, transportation is the highest emitting sector of CO_2 emission after the electricity sector in every country in the world. The transportation sector currently contributed to about 23% of global CO_2 emission and without concerted effort to control the rising trend of fossil fuel usage, it is projected that the CO_2 emission will increase by 50% in 2030 and more than 80% in 2050 [18]. Similarly in Malaysia, the energy demand particularly fossil fuel in transportation sector is expected to grow and increase rapidly in the coming years, which will result in an increase in the CO_2 emission. Fig. 2 depicts the projected trend of CO_2 emission by sector in Malaysia. The CO_2 emission shows an increasing trend at 6%

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per annum from 54 Mt CO_2 in 1990 to 235 Mt CO_2 in 2030 with largest emitting sector from electricity generation at 33%, followed by transportation sector at 24%, Industrial Sector at 21% and remaining from other sectors [11].

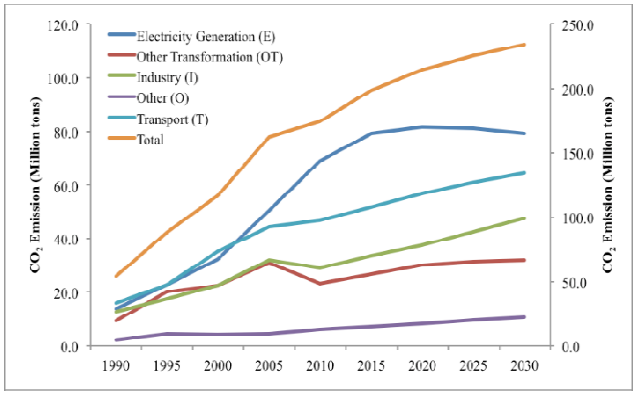

Fig. 2 Trend of CO_2 emission by sector in Malaysia (1990 – 2030) [11]

Despite the long standing concerns about fossil dependence and rising concern about climate change, until today, the transportation sector's reliance on fossil fuel has not decrease overtime [43]. This posed a great challenge to Malaysia, as it is still dependent on imported energy for transportation sector [38]. It is evident that transport is important in contributing to reducing levels of CO_2 emission. As transportation is the most intensive sector of carbon-based fuels, the achievement of the voluntary target to meet 40% carbon intensity reduction set at the COP15 means that the emission from the transport sector must be reduced accordingly.

A concerted effort has to be made to embrace suitable and appropriate energy policy for sustainable energy demand and CO_2 emission reduction [16], [42]. A strategy to reduce dependency on fossil energy sources is needed and this could be achieved by applying energy saving program that focused on renewable energy and fuel efficient technologies [18]. A number of investigations have been conducted to examine effective policy measures to reduce emission and achieve the CO_2 emission reduction target [12], [40], [6], [49]. For example, [39] evaluated a range of policies in the transportation sector in United Kingdom to assess the effectiveness of combined policies to achieve emission reduction target. Similarly, in a quest to reduce the CO_2 emission, [24] analyzed the impact of transport fuel tax to accelerate the introduction of fuel efficient vehicle technologies in the transportation sector of Sweden.

It can be seen that many countries began to attach utmost importance to explore the effective policy measures in transportation sector towards reducing the CO_2 emission. Consequently, this paper is focused on analyzing the trend of energy demand and emission of four different transport sub-sectors such as road, rail, aviation and maritime in Malaysia and highlights several policy options towards reducing emission.

The paper is structured as follows: Section II describes the development and trend analysis of energy demand and emission in the transportation sub sectors followed by policy analysis related to the transportation in Section III. Section IV discussed the Malaysian transportation technology. Key factors influencing the growth of energy consumption and emission trends are highlighted in Section V. Finally, the policy and strategic options for energy and emission reduction are outlined in Section VI before concluding remarks.

II. Overview of the Transportation Sector

A. The Trend of Transportation Demand

Malaysia has experienced tremendous economic success in the last three decades, which has caused substantial urbanization. It is believed that the rapid expansion of urbanization growth coupled with population growth has increased the demand for transport services and travel, which correspondingly increased the energy consumption in Malaysia. The demand for transportation sector covers for road, rail, aviation and maritime transportation. Currently, data on transport demand in Malaysia is still lacking except for rail transportation sector. In order to analyze the freight and passenger traffic growth trends, the travel demand of the road and aviation sector was estimated.

The estimated demand for the passenger and freight movement in terms of billion passenger kilometers (BPKM) and billion tone kilometers (BTKM) is provided in Figs. 3 and 4 respectively which have witnessed a dominance of road transport sector, both in passenger and freight movement.

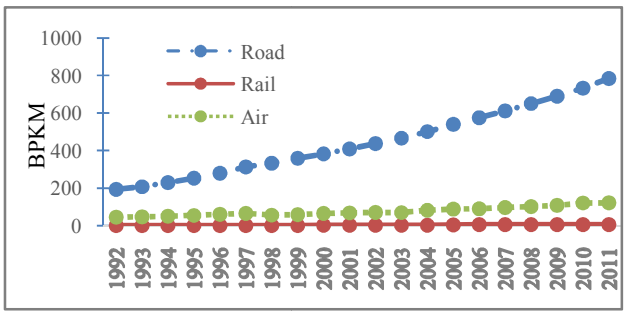

Fig. 3 Inter-modal shares in transport sector for passenger movement (1992-2011)

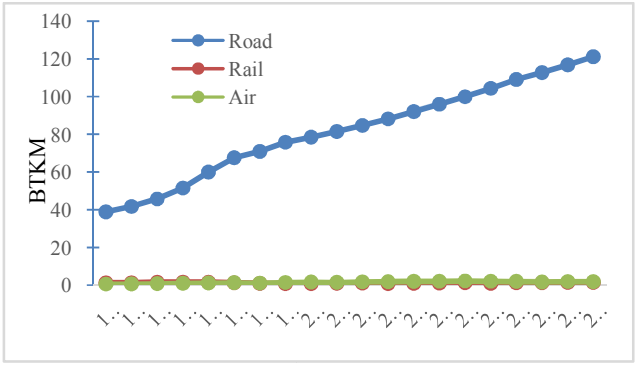

Fig. 4 Inter-modal shares in transport sector for freight movement (1992-2011)

1. Road Sector

The travel demand for road sector was estimated based on vehicle statistics, vehicle utilization levels and occupancy/load factors in Malaysia [14]. In general the travel demand for passenger movement was estimated as follows;

$$Demand\ Travel_t^v = Number\ of\ Vehicle_t^v \times Mileage_t^v \times Occupancy_t^v \quad (1)$$

And the travel demand for freight movement was estimated as follows;

$$Demand\ Travel_t^v = Number\ of\ Vehicle_t^v \times Mileage_t^v \times Load\ Factor_t^v \quad (2)$$

where, t, in the year t and v, type of vehicles.

From Figs. 3 and 4, it shows that the share of road sector has continuously increased over the past two decades in both passenger and freight movement. As indicated in Fig. 5, motor cars had the highest share of about 60% in total road transport passenger activities in 2011, followed by motorcycles (23%) and buses (16%). It can be observed that the public modes have minimal share in passenger transport. The current trend of growth in transport activities by private passenger modes raises concerns with regard to the increasing demand for fuels. It is predicted that the vehicle population which has increased by 8% per annum from 1990 to 2011, will continuously grow in the future. Utilizing public transportation is one of the most effective options to ensure less energy intensive growth of road transport sector in Malaysia. Currently, the usage of public transportation in Malaysia is about 16% and considered the lowest compared to other countries in Asia [16]. Thus, greater effort needs to be made to promote the utilization of public transportation as one of the strategies to reduce emission in Malaysia.

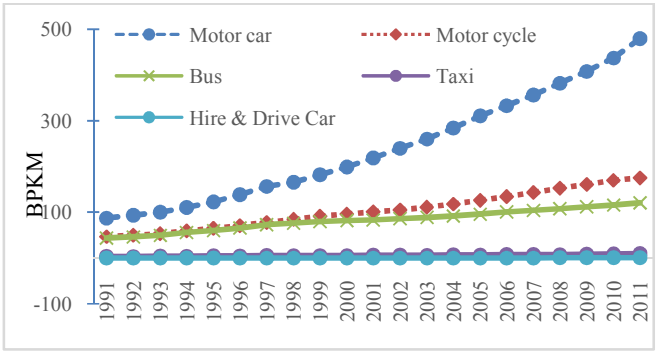

Fig. 5 Mode-wise growth in passenger transport activities in road sector (1991-2011)

2. Rail Sector

The growth in railway track length in Malaysia has been quite slow for the last twenty years as compared to the growth of road network. The track length increased at an average annual growth rate of about 1% from 1989 to 2009. However, there has been a sudden increase of about 1200 kilometres in the rail track length in 2010 which shows the increasing recognition given by government to increase the rail capacity in the country [26]. Rail transport passengers and freight movement from year 1992 to 2011 are shown in Fig. 6. In terms of passenger kilometres movement, there was a 4% annual decline in rail passenger kilometres from 1990 to 2003. However, after 2003 there was an upward trend and the railways experienced a growth rate of about 7% per annum from 2003 to 2011. Similarly, in the last two decades, there were wide fluctuations in the freight movement by railways.

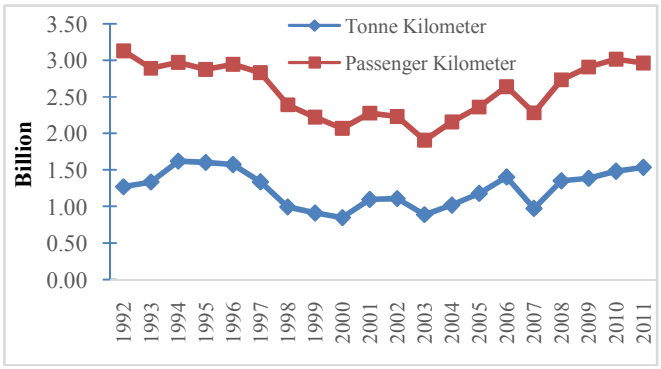

Fig. 6 Passenger and freight transport activities in rail sector (1991-2011) [34]

3. Aviation Sector

The main aviation transportation in Malaysia includes commercial airlines and freight carriers. Due to the lack of data, the travel demand for passenger and freight for aviation sector was estimated based on assumption adapted from [34] and [47]. In general the travel demand for passenger movement was estimated as follows;

$$Demand\ Travel_t = Total\ passenger_t \times Average\ distance\ travel(2065km) \quad (3)$$

And the travel demand for freight movement was estimated as follows;

$$Demand\ Travel_t = Total\ freight_t \times Average\ distance\ travel(2065km) \quad (4)$$

In Fig. 7, it can be seen that Malaysia experienced a steady growth in the freight movement by air transport from 1991 to 2006 but there was a decline after the year 2006 to 2009. On the whole, the freight movement by the air transport sector tripled from 0.588 billion to 1.85 billion during 1991 to 2011. The air passenger kilometres also increased steadily from 41 billion in 1991 to 133 billion in 2011.

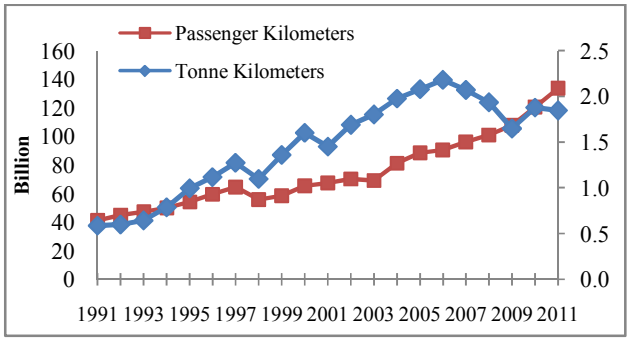

Fig. 7 Growth in freight and passenger movement by air transport (1991 to 2011)

4. Maritime Sector

The freight movement by the maritime sector increased by 8% per annum from 113 million tons in 1998 to 495 million tons in 2011 (Fig. 8). There was a steady growth in the freight movement in the maritime sector in Malaysia except in 1997 and 2009 because of the South East Asian crisis and the global recession, respectively.

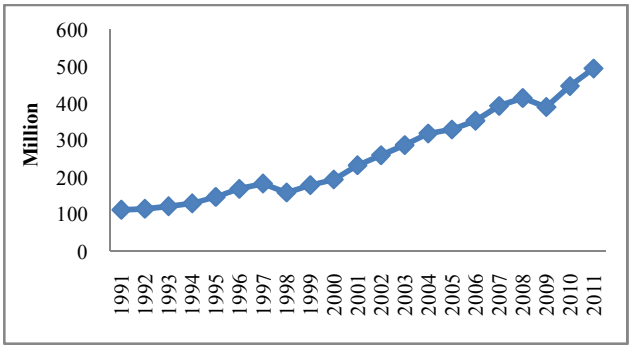

Fig. 8 Growth in maritime freight movement (1991-2011)

B. The Trend ofTransportation Energy Consumption and Emission

1. Energy Consumption

In Malaysia, the energy consumption has increased over the years to meet the social and rapid economic activities. As indicated in Table I, the energy used has increased at 5.9% annually from 13.2 million tons of equivalent (Mtoe) in 1990 to 43.3 Mtoe in 2011. The transportation appeared as the leading energy consuming sector, surpassing the industrial sector in 2011. The rapid growth of road vehicles and private cars as well as decrease in passenger occupancy per vehicle had contributed in continuing growth of energy consumption in this sector [19], [20].

TABLE I
ENERGY CONSUMPTION BY TRANSPORTATION SECTOR (1991-2011) [29]

Sector	1990(Mtoe)	Share (%)	2011(Mtoe)	Share (%)
Transport	5.4	40.8	17.0	39.3
Industry	5.8	44.5	12.1	27.8
Residential & Commercial	1.6	12.5	6.9	15.9
Agriculture	0	0	0.9	2.1
Non energy Use	0.3	2.3	6.4	14.8
Total	13.2	100.0	43.3	100.0

The transportation sector is the most energy intensive sectors in the country and relies primarily on petroleum products. The total energy consumption has increased at an annual growth rate of 5.2% from 7.8 Mtoe in 1995 to 17.0 Mtoe in 2011. Fig. 9 shows the trend of fuel consumption in the transportation sector for the (1995- 2011) period. It can be seen that in 2011, petrol and diesel accounted about 83% of total energy consumption, followed by Aviation Turbine Fuel (ATF) at 15% and natural gas at 2%. The share of electricity and fuel oil is marginal, which both constituted about 0.2% of the total energy consumption. The marginal share of biodiesel can be seen in the year 2011. Over the years, it can be seen that the uptake of natural gas has increased. The increase of natural gas usage in the transportation sector is due to the promotion of natural gas as an alternative energy resource by the government.

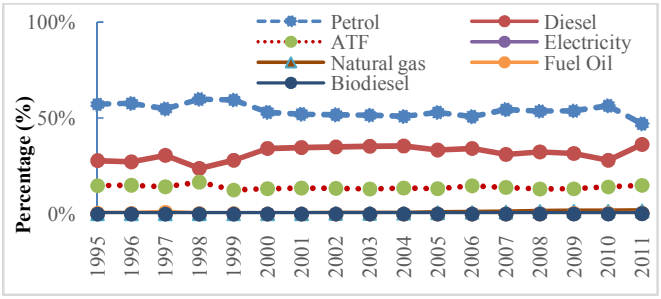

Fig. 9 Energy consumption by type of fuel in transportation sector (1995-2011)

The heavy reliance of transport sector on petroleum products is a worrying trend for the future in terms of its energy security and emission contribution [1], [4], [26]. It was found that the share of petroleum products will remain highest in the span of 2010 to 2020 whereby almost 100% of the private cars are fuelled by petrol, while about 74% of commercial vehicles such as busses and lorries consumed by diesel [50]. Although Malaysia is an oil producer, it is still reliant on imported oil to satisfy the demand in transportation sector. Consequently, the development of renewable energy policies and technologies towards introduction of alternative fuels like hydrogen, ethanol and biodiesel will reduce the dependence on imported fuel sources and emissions contribution [44]. The introduction of National Biofuel Policy in 2006 is a commendable initiative by the government to reduce dependency of fossil fuels by increasing the use of biofuel such as biodiesel in the country.

Fig. 10 shows the proportion of energy consumption in different transportation sectors of road, rail, aviation and maritime in Malaysia for the (1980-2011) period. The proportion of energy consumption in road transport has slightly decreasedparticularly shifted to other means of transportation namely aviation, maritime and rail sector.

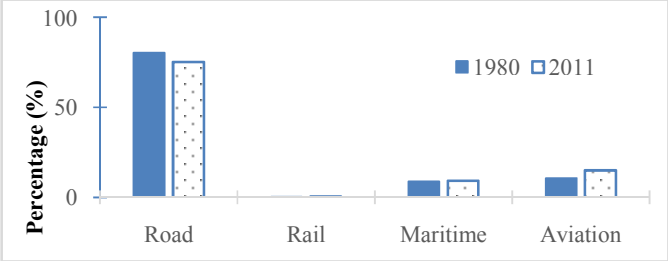

Fig. 10 Energy consumption by type of sub sector in transportation sector (1995-2011)

2. Emission in Transportation Sector

Undoubtedly, the increasing energy demand and heavily reliant on fossil fuels in the transportation will increase the CO_2 emission level in Malaysia. In this paper, the annual CO_2 emission level in Malaysia for transport sector is calculated. For this, the energy consumption by type of fuel and modes of transportation were used and the potential CO_2 emission impact or emission factor by different types of fuel was collected as shown in Table II.

TABLE II
POTENTIAL EMISSION IMPACT BY TYPE OF FUEL FOR TRANSPORTATION SECTOR [51], [52]

Fuel Type	CO_2 Emission Factor (kg/GJ)
Petrol	72.79
Diesel	73.99
ATF	72.00
Natural Gas	53.90
Electricity	196.00
Fuel Oil	78.00

The CO_2emission was calculated using the following equation [16]:

$$E_t^m = CF_f^t \times \sum_f^m FC_{t,f} \times EF_f \quad (5)$$

where, E, CO_2 Emission; CF, conversion factor (1 toe = 41.868 GJ); FC, Fuel consumption; EF, Emission Factor; m, mode of transportation; f, fuel type; t, in the year t.

The annual emission of each transportation modes has been estimated (5) and the result is depicted in Table III.

Table III shows the CO_2 emissions had increased steadily over the past 17 years. It is revealed that the CO_2 emissions in 2011 are more than double from 1995 with annual growth rate of 4.7%. Reference [11] projected the CO_2 emission from transport sector will increase to reach about 63 million tons in 2035.

TABLE III
TOTAL CO_2 EMISSIONS FROM TRANSPORTATION SECTOR IN MALAYSIA (TONS)

Year	CO_2 Emission
1995	23,923,654
1996	27,362,020
1997	31,211,250
1998	29,911,387
1999	34,856,822
2000	36,954,241
2001	40,214,007
2002	41,137,864
2003	43,677,614
2004	47,082,204
2005	46,746,590
2006	45,294,132
2007	47,976,559
2008	50,085,110
2009	49,187,895
2010	51,338,726
2011	52,060,646

III. TRANSPORTATION POLICIES IN MALAYSIA

Prior to 1980, Malaysian energy sector was highly dependent on crude oil to meet its energy requirement. In order to ensure energy security of the country, concerted efforts have been undertaken by the government to diversify the fuel mix from oil based sources to a mix of various conventional energy sources. In 1981, The Four Fuel Diversification Policy (FFDP) was introduced and incorporated into the Malaysian National Energy Policy in Malaysia after the occurrence of two international oil crisis and quantum leaps in prices in the year 1973 and 1979 [5], [7]. The FFDP aimed to achieve a more balanced energy mix of four fuels (oil, gas, coal and hydro), especially in the generation of electricity. The success of this policycan be seen from the fact that the crude oil in energy supply dropped from 61% in 1990 to 38% in 2008 [30]. It can also be seen that from more than 70% share of oil in the total fuel input in power stations, the share has fallen to less than 1% in 2008 and a more balanced fuel mix has been achieved [30]. It is evident that this policy has played an important role in reducing the overdependence of the economy on a single fuel.

Later in the year 2000, the Five-Fuels Policy (FFP) was implemented that introduce renewable resources such as biomass, solar, mini hydro, etc. as additional fuel resources for the power sector. The FFDP and FFP have played a catalyst role in reducing dependence of the electricity sector on oil. However, the transport sector still depends on oil as a major fuel and it is still heavily dependent on one fuel with shares of other fuels (natural gas and electricity being marginal). So far, no fuel diversification has been achieved in case of transport sector unlike electricity sector. However, due to concerned on issues relating to environment and climate change and to diversify fuel mix in transport sector, the government has promoted biofuels [33]. Since 2006, emphasis has been given on the promotion of biodiesel in the country. In 2006, in line with FFDP, the Government introduced the National Biofuel

Policy that encourages the utilisation of renewable resources i.e. biodiesel to reduce the dependency on depleting fossil fuels in the transportation sector and industry [9].

The B5 biodiesel policy (5% palm oil-based methyl ester blend in conventional diesel) has started in February 2009 and has been made compulsory in 2011. The government has announced to extend implementation of biodiesel to B10 (10% palm oil-based methyl ester blend in conventional diesel) and to facilitate the implementation of the B10 Programme, the Government will allocate an annual subsidy of RM413.6 million [32].

As Malaysia targeted to reducing the carbon emission levels, several policies has been initiated that reflect government initiatives on sustainable growth and greener solutions such as National Policy on the Environment (2002), National Urbanisation Policy (2006), National Green Technology Policies (2009) and National Climate Change Policy (2009). The policies are in the right direction but need to be strengthened and have their adoption and implementation facilitated. While other sectors have been given considerable attention, the efficient fuel use of transportation sector in particular, has a large need for focusing on the policy and institutional side.

IV. Malaysia Transportation Technology

Malaysia's fuel economy ratio is still less than other developed countries such as Japan, America and Europe. Reference [4] estimated that the average annual fuel economy ratio for road transport (measured in terms of the distance travelled per unit of fuel used in kilometres per liter (km/l)) in Malaysia has improved between 7 and 7.7 km/l from year 1987 to 1999 to 9.67 km/l in 2008. This increase is due to the technological advances of motor vehicles. Malaysia currently has no fuel economy standard and it is estimated that byimplementing a fuel economy standard for motor vehicles, about 36 million tons of CO_2emission could be reducedfrom 2010 to 2018 [16].

On the other hand, emission standards in Malaysia are not as stringent as in many other developing countries like in India, China and Thailand. Malaysia embarked on a formal emission control regime in 1997 when emission norms were first notified for petrol and diesel engine passenger cars; Euro 1 equivalent norms were introduced for vehicles with diesel and petrol engines. The introduction of these regulations marks the beginning of the catalyst based technology usage in Malaysia. Emission standards for new motor vehicles with petrol and diesel engines were upgraded to Euro 2 in January 2000. Malaysia did not have emission standards for motorcycles till 2003 although motorcycles represented more than 40% of the motor vehicle population. In moving towards cleaner fuels, Malaysia plans to implement Euro 4 for motor vehicles by 2014 [35].

Clean alternative vehicle fuel technologies which have great influence on transport emission reduction have penetrated into Malaysia. For example, natural gas vehicle were used since 1991 on passenger cars and bus. Malaysia has also developed its local hybrid and electric car in 2007 and currently promoting the use of hybrid and electric vehicles to reduce energy consumption and CO_2 emission. Due to higher cost investment, the development of fuel cell and hydrogen-fuelled technologies has been relatively slow and still under extensive research and development stage [44].

Generally, in terms of energy efficiency, technology in Malaysia's transportation accentuated on the aspect of intelligent transport system, public transport management system and intelligent transport etc. The aviation sector in Malaysia for example has moving towards reducing CO_2 carbon emission and has taken commendable measures by improving efficiency through new technology of aircraft, improving operational practices and optimal flight planning, increased efficiency of the air traffic infrastructure and airport management infrastructure [27]. The maritime sector has also undertake effort to reduce CO_2 emission by introducing green practices such as fuel efficiency campaign, efficient logistics management and using efficient technology such as auto switching mechanism, tankers engine, etc. in its operation [28].

Despite existing technologies that have been applied, substantial opportunities for further efficiency improvement and energy saving through advanced technology is still a major way for Malaysia's transport sector. These technologies not only include building high technology capability, upgrade of transport equipment, infrastructure and communication but also include capacity and comprehensive transport system management. Recently, [11] and [25] are confirmed that advanced technologies and strategic policies can enable Malaysia to meet its sustainable energy and substantial amount of CO_2 emission reduction.

V. Key Factors Influencing the Growth of Energy Consumption and Emission Trends

Based on past trends analysis of transportation growth, the key factors influencing the energy consumption and emission growth in Malaysia are due to the following;

A. Rapid Growth of Motorization Level

Increasing urbanization, growing economic activities and population have resulted in higher demand of transport services in Malaysia. This is reflected in the fast pace of motorization growth in the country. The growth rate of the total number of registered motor vehicles in Malaysia has shown a very high growth rate, 8% for the (1991-2011) period, which is much faster than the total population growth rate, 2.1%, during the same period [29], [34].

B. Increasing Share of Private Modes

Motorization in Malaysia is characterized by higher growth of private vehicles i.e. motor cars and motor cycles, which have the highest share in transport vehicles registered in the country; together the two modes had a high share of about 92% of the total vehicles in 2011. While private vehicles have a high share and fast growth rate, public transport modes in Malaysia (buses, taxis and hire and drive cars) have a very small share in the total registered vehicles (about 1% only in

2011). The share of public transport has continuously declined from 34% in 1985 to 20% in 1997 and 16% in 2011 [10], [48].

C. Transport Shares Skewed towards Road Sector

There has been an increase of about four times in on-road passenger transport activities in Malaysia between 1991 and 2011. In comparison to road movement, rail movement in Malaysia has not increased significantly. The rail passenger movement has shown a declining trend till 2003, after which there has been an upward trend, mainly due to efforts of the government to promote rail movement in urban areas.

D. Largest Consumption of Energy within Transport Sector for Road Based Movement

The consumption of both petrol and diesel has been increasing rapidly with growing motorization and increasing dependence on private modes. Transport sector is heavily dependent on petroleum products, which in total account for nearly 98% of the total consumption. There is lack of diversification of fuel mix for the transport sector. One of the ways to diversify fuel mix is by promoting alternative fuel such as biofuels, bioethanol and electricity in transportation sector.

E. Lack of Adequate Policies Focusing on Fuel Diversification, Promoting Energy Efficient and Clean Use of Energy in the Transport Sector

Currently, policies on promoting energy efficient and clean use of energy in the transportation are still lacking [3]. It can be observed that the energy intensity of Malaysia is high as compared to most of the net energy exporter countries [15]. Higher energy intensity normally indicates inefficient use of energy. One of the reasons for the inefficient use of energy has been the subsidised price of energy in the country, especially those of petrol and diesel [22], [26]. The fuel subsidies minimise the incentive for efficient energy consumption and reducing the effectiveness of alternative energy sources [8], [21], [41]. In addition, Malaysian standards for vehicular emissions also not as stringent as in many other developing countries.

VI. Policy and Strategic Options for Energy and Emission Reduction

A. Arresting the Fast Pace of Motorization

Motorization in Malaysia is increasing at a very fast pace and is characterized by increasing fleet of private modes. These private modes are largely used petrol and diesel; the current trend of vehicular growth will raise issues related to availability of these fuels, especially when it is expected that Malaysia may turn into a net importer of these fuels. Therefore, the government needs to adopt policies that can help in arresting such a fast pace of motorization in the country. Government policies will have to play an important role in terms of altering the current pattern of motorization in terms of vehicle ownership and utilization by adopting policies like vehicle quota system and can adopt fiscal measures like charging fee for using congested parts of the cities [15], [37], levy higher parking fees [13], [23], increase vehicle registration charges, cap and share scheme [36], and increase fuel prices to arrest current trends of rapid growth in vehicle ownership and utilization [39].

B. Increasing Share of Public Transportation Modes in Urban Areas

Urban public transportation enhancement need to be undertaken in order to encourage a shift from personal to mass modes of transport [2]. This can be done by improving public transport systems in terms of their capacity, coverage and quality. In fact, the government has initiated moves to improve public transportation through the Government Transformation Programme (GTP) and the Tenth Malaysia Plan covering (2011-2015) period [46],[48].

C. Diversifying the Fuel Mix of Transport Sector

Since road transport is the main consumer of energy in the transportation sector in Malaysia, it is important that the government encourages fuel diversification and promote alternative fuel use in order to reduce dependence on petroleum fuels and the consequent emissions. The government needs to adopt a comprehensive strategy to diversify the fuel basket for the transport sector and promote fuels like natural gas, electricity, hydrogen, bioethanol and biodiesel on a large scale. This strategy needs to evaluate the availability of these alternative fuels in addition to developing adequate infrastructure to encourage the use of these fuels.

D. Encouraging an Optimal Mix of Rail and Road Transport for Intercity Movement

The current trends of energy use show dominance of road sector in the transportation shares. Road based movements are much more energy intensive than rail based movements. It is important that the government develops strategies that specifically target improvement of shares of rail. Investments on rail technology and incentives to encourage faster growth and shift to these modes are necessary.

E. Encouraging Energy Efficient Technologies

In addition to promoting alternative fuels, government could develop mandatory fuel efficiency norms, emission standards and strict inspection and maintenance regime that will encourage energy efficient and less polluting movement. Fuel efficiency norms can be very effective in terms of bringing down the energy consumption and CO_2 emission levels of the sector. Many countries have adopted minimum fuel efficiency standards for their vehicular fleets in order to reduce their oil dependence [45]. Besides, the use of green technologies in vehicles and infrastructure of transportation sector can play a key role in reducing CO_2 emission [31].

VII. Conclusions

Adopting energy efficient measures and advanced technologies for the transportation sector in Malaysia will have a critical role towards reducing the CO_2 emission level. Various issues from the analysis of past trends of energy consumption patterns and transport sector growth has been

discussed. A shift to public and rail-based movement is one of the ultimate options towards reducing the energy use and emission level. However, it is dependent on a number of factors such as the provision of infrastructure, introduction of urban public transportation systems, incentives for shifting to public transport modes, etc. In meeting the CO_2 emission target, the government has undertaken a number of initiatives, including creating policies and tools to accelerate efficient technologies in transportation. However, the path towards meeting the emission reduction target in Malaysia transportation sector demands great support and commitment from the policy makers, political leadership, support from individuals, advancement in technology and major transformation of the transport system and energy market.

REFERENCES

[1] A. Mofleh, S.Taib and W.A. Salah, "Malaysia energy demand and emissions from the transportation sector", *Transport*, vol 25(4), pp. 448–453, 2010.

[2] A. Nurdden, R.A.O.K. Rahmat and A. Ismail "Reasons why buses and trains are not being more extensively as travel mode in Malaysia",*Asian Journal Science*, vol1, pp. 65-71, 2008.

[3] A.A. Azlina and N.N.H. Mustapha, "Energy, Economic Growth and Pollutant Emissions Nexus: The case of Malaysia. *Social and Behavioral Sciences,* vol65, pp. 1-7, 2012.

[4] A.B. Aizura, T.M.I. Mahlia and H.H. Masjuki, "Potential fuel savings and emission reduction from fuel economy standards implementation for motor vehicle", *Clean Technologies and Environmental Policy*, vol 12(3), pp. 255-263,2010.

[5] A.H. Jafar, A.Q. Al-Amin and C. Siwar C, "Environmental impact of alternative fuel mix in electricity generation in Malaysia". *Renewable Energy*, vol 33(10), pp. 2229– 35, 2008.

[6] A.M. Zanni and A.L. Bristow, "Emissions of CO_2 from road freight transport in London: Trends and policies for long run reductions", *Energy Policy*, vol 38, pp. 1774-1786, 2010.

[7] A.R. Mohamed and K.T. Lee, "Energy for sustainable development in Malaysia: energy policy and alternative energy", *Energy Policy*, vol 34(15), pp. 2388–97, 2006.

[8] A.S. Almselati, R.A. Rahmat and O. Jaafar, "An overview of urban transport in Malaysia", *The Social Sciences*, vol 6(1), pp. 24-33, 2011.

[9] A.Z. Abdullah, B.Salamatinia, H. Mootabadi and S. Bhatia, "Current status and policies on biodiesel industry in Malaysia as the world's leading producer of palm oil", *Energy Policy*, vol37, pp. 5440–5448, 2009.

[10] Asia Pacific Economic Cooperation (APEC), "Peer Review on Energy efficiency in Malaysia", 2011, Tokyo, Japan. Retrieved from: http://www.ewg.apec.org (accessed on November 2013).

[11] Asia Pacific Energy Research Centre (APERC), "APEC Energy Demand and Supply Outlook (5th Edition)", 2013, Tokyo, Japan.

[12] B. Johansson, "Will restrictions on CO_2 emissions require reductions in transport demand?",*Energy Policy*, vol37(8), pp. 3212–3220, 2009.

[13] D.A. Hensher, "Climate change, enhanced greenhouse gas emissions andPassenger transport – What can we do to make a difference?", *Transportation Research Part D*, vol13, pp. 95–111, 2008.

[14] G. Bueno, "Analysis of scenarios for the reduction of energy consumption and GHG emissions in transport in the Basque Country", *Renewable and Sustainable Energy Reviews*, vol 16, pp. 1988–1998, 2012.

[15] G.R. Timilsina and A. Shrestha, "Transport sector CO_2 emissions growth in Asia: Underlying factors and policy options",*Energy Policy*, vol37(11), pp. 4523–4539, 2009.

[16] H.C. Ong, T.M.I. Mahliaand H.H. Masjuki, "A review on energy pattern and policy for transportation sector in Malaysia", *Renewable and Sustainable Energy Reviews*, vol16(1), pp. 532–542, 2012.

[17] Intergovernmental Panel on Climate Change (IPCC), "Climate Change (2007). Synthesis Report", 2007.

[18] International Energy Agency (IEA), "CO_2 Emission from Fuel Combustion", 2012.

[19] International Energy Agency (IEA), "Key World Energy Statistics", 2012.

[20] J. Dargay, D. Gately and M. Sommer, "Vehicle ownership and income growth, Worldwide: 1960-2030", *Energy Journal*, vol28 (4), pp. 143–70, 2007.

[21] J. Ellis, "The Effects of Fossil-Fuel Subsidy Reform: A Review of Modelling and Empirical Studies", Retrieved from: http://dx.doi.org/10.2139/ssrn.1572397 (accessed on February, 21, 2013).

[22] J. Kasipillai and P. Chan, "Travel demand management: Lessons for Malaysia, *Journal of Public Transportation,*,vol11 (3), pp. 41-56, 2008.

[23] L. Chapman, "Transport and climate change: a review", *Journal of Transport Geography*, vol15, pp. 354–367, 2007.

[24] M. Borjesson and E.O. Ahlgren, "Assessment of transport fuel taxation strategies through integration of road transport in an energy system model – the case of Sweden", *International Journal of Energy Research*, vol 36, pp. 648-669, 2011.

[25] M.N. Safaai, Z.Z. Noor, H. Hashim, Z. Ujang and J. Talib, "Projection of CO_2 Emissions in Malaysia", *Environmental Progress & Sustainable Energy*, vol 30(4), pp. 658-665, 2010.

[26] M. S. Indati, A. T. Ghate and Y.P. Leong," Towards greener environment: Energy efficient pathways for the transportation sector in Malaysia", *Earth and Environmental Science*, vol16, 012122,doi:10.1088/1755-1315/16/1/012122, 2013.

[27] Malaysia Airline System Berhad (MAS), "Malaysia Airlines Environmental Report 2012", Retrieved from: http://www.malaysiaairlines.com (accessed on November 2013).

[28] Maritime Institute of Malaysia (MIMA), "Greening the Malaysian maritime sector: Issues, challenges and opportunities",Retrieved from: http://www.mima.gov.my (accessed on December 2013).

[29] National Energy Balance 2012.Malaysia: Ministry of Energy, Green Technology and Water (MEWC); 2013.

[30] National Energy Balance 2009.Malaysia: Ministry of Energy, Green Technology and Water (MEWC); 2010.

[31] National Green Technology Policy. Malaysia:Ministry of Energy, Green Technology and Water (MEWC), 2009. Retrieved from: http://www.kettha.org.my(accessed on September 2013).

[32] Ministry of Plantation Industries and Commodities, "Formation of the biodiesel to spearhead the implementation of the B10 programme", Retrieved from: http://www.kppk.gov.my (accessed on November 2013).

[33] National Biofuel Policy. Malaysia: Ministry of Plantation Industries and Commodities, 2006. Retrieved from: http://www.mpoc.org.my(accessed on November 2013).

[34] Transport Statistics 2012. Malaysia:Ministry of Transport (MoT), 2013.

[35] Ministry of Transport (MoT), Malaysia. Retrieved from http://www.mot.gov.my (accessed on November 2013).

[36] M. N. David and C.Brian, "Measuring the potential implications of introducing a cap and share scheme in Ireland to reduce greenhouse gas emissions", *Transport Policy*, vol 18, pp. 579–586, 2011.

[37] N.V.S.N.M. Konda, N. Shah N. and N.P. Brandon, "Optimal transition towards a large-scale hydrogen infrastructure for the transport sector: The case for the Netherlands", *International Journal of hydrogen Energy*, vol 36, pp. 4619-4635, 2011.

[38] P.Y. Gan and Z.D. Li, "An econometric study on long-term energy outlook and the implications of renewable energy utilization in Malaysia",*Energy Policy*, vol 36, pp. 890–899, 2008.

[39] R. Hickman and D. Banister, "Looking over the horizon: Transport and reduced CO_2 emissions in the UK by 2030", *Transport Policy*, vol14(5), pp. 377–387, 2007.

[40] R. Kannan and N. Strachan, "Modelling the UK residential energy sector under long-term decarbonisation scenarios: Comparison between energy systems and sectoral modeling approaches", *Applied Energy*, vol86, pp. 416-428, 2009.

[41] S. Ahmad, Z.A.Kadir and S. Shafie, "Current perspective of the renewable energy development in Malaysia",*Renewable and Sustainable Energy Reviews,* vol15(2), pp. 897-904, 2011.

[42] S. Lim and K.T. Lee, "Implementation of biofuels in Malaysian transportation sector towards sustainable development: A case study of international cooperation between Malaysia and Japan",*Renewable and Sustainable Energy Reviews*, vol16(4), pp. 1790–1800, 2012.

[43] S. Proost and K.V. Dender, "Energy and environment challenges in the transport sector, *Economics of Transportation*, vol 1, pp. 77–87, 2013.

[44] S.K. Kamarudin,W.R.W. Daud, Z. Yaakub, Z. Misron, W. Anuar and N.N. Yusuf, "Synthesis and optimization of future hydrogen energy

infrastructure planning in Peninsular Malaysia",*International Journal of Hydrogen Energy*, vol34(5), pp. 2077–2088, 2009.
[45] T.M.I. Mahlia, S. Tohno and T. Tezuka,"History and current status of the motor vehicle energy labeling and its implementation possibilities in Malaysia". *Renewable and Sustainable Energy Reviews*, vol 16, pp. 1828–1844, 2012.
[46] Tenth Malaysia Plan, 2011-2015. Putrajaya, Malaysia: The Economic Planning Unit, Prime Minister's Department, 2010.
[47] The Economic Planning Unit, Prime Minister's Department, "Energy use in the transportation sector in Malaysia", 2004.
[48] The Performance Management and Delivery Unit (PEMANDU), Prime Minister Department, "GTP Delivering Outcome Booklet", 2013, Malaysia, Retrieved from (http://www.pemandu.gov.my).
[49] W. Leighty, J.M. Ogden and C. Yang, "Modeling transitions in the California light-duty vehicles sector to achieve deep reductions in transportation greenhouse gas emissions" *Energy Policy*, vol44, pp. 52–67, 2012.
[50] Y.Y. Tye,K.Lee, W.N. Abdullah and C.P. Leh, "Second-generation bioethanol as a sustainable energy source in Malaysia transportation: Status, potential and future prospects",*Renewable and Sustainable Energy Reviews,* vol 15, pp. 4521-4536, 2011.
[51] NERI. Emission factors for mobile sources. Denmark: National Environmental Research Institute; 2008.
[52] GreenTechMalaysia, "*Study on Grid Connected Electricity Baselines in Malaysia, 2010 & 2011",* Retrieved from: http://cdm.greentechmalaysia.my (accessed on September 2013).

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