

# Analysis of Rising Energy Consumption and Emission from the Transport Sector in Malaysia and Highlighting the Root Causes

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**Abstract:** Malaysia has witnessed outstanding economic growth since the 1980's which has led to rapid urbanization within the nation. As a result, energy consumption and emission in Malaysia has been growing at a significant rate which is a serious concern for the country's socio-economic development, domestic air pollution and global climate change. This paper examines the scenario of the transportation sector particularly the road transport sector in Malaysia which has now become the highest energy consuming sector in the country in addition to a leading contributor of CO<sub>2</sub> and GHG emissions. The growth pattern of energy consumption and emission from the Malaysian transport sector is reviewed here. This paper highlights the substantial increase in the number of on road vehicles and furthermore a movement away from private mode of transportation to a public mode of transportation as the main reason of increasing energy consumption and emission in the country. Another key reason of rising emission is that the transport sector relies primarily on the usage of non-renewable petroleum products and lacks the utilization of alternative cleaner fuel.

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## I. INTRODUCTION

Transportation sector makes a vital contribution towards the economic growth of a nation. Unfortunately, it is also one of the most energy consuming sectors in the world. Transportation activity mostly consumes non renewable energy sources which leads to huge negative impacts on the climate around the world. Transportation sector is a primary contributor of GHG emissions including carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O) and also various local air pollutants such as carbon monoxide (CO), sulphur dioxide (SO<sub>2</sub>), oxides of nitrogen (NO<sub>x</sub>), non-methane volatile organic compounds (NMVOC) and particulate matters (PM). These emissions immensely affect global climate change. The transportation sector roughly accounts for 15% of overall global greenhouse gas emissions<sup>6</sup>. The global final energy consumption was around 4672 million tons of oil equivalent (Mtoe) in 1973. As shown in Table 1 this number grew to 9425 Mtoe in 2014. The share of transportation sector in the global final energy consumption was 1081 Mtoe (23.14%) in 1973 which later escalated to 2627 Mtoe (27.87%) in 2014. Growing number of vehicles around the world is the key reason as to why transport sector has the fastest growth of energy consumption of any economic sector. Road vehicles dominate global oil consumption representing 81% of transportation energy demand<sup>11,12</sup>. A total of 246 million motor vehicles were registered around the world in 1970. This number grew to 709 million in 1997 and by 2016, global vehicle population stood at 1.32 billion units<sup>17</sup>. In 1973 the global CO<sub>2</sub> emissions were 15.6 billion tons which then increased to 32 billion tons in 2015<sup>4</sup>. Transportation sector contributed 7.5 billion tons of CO<sub>2</sub> in 2015 which is 23% of total CO<sub>2</sub> emissions from fuel combustion in 2015<sup>15</sup>. It is the second largest emitting sector in the world after Electricity and Heat Production<sup>4</sup>. Emissions from the road sector dominate transport emission with road vehicles being the single largest source of major atmospheric pollutants. Global CO<sub>2</sub> emission from the road transport equalled 5.7 billion tons in 2015, portraying a growth of 72% since 1990. This increasing road transport emission is a major cause of deteriorating urban air quality and global warming.

**Table no 1:** Global Final Energy Consumption by Sector

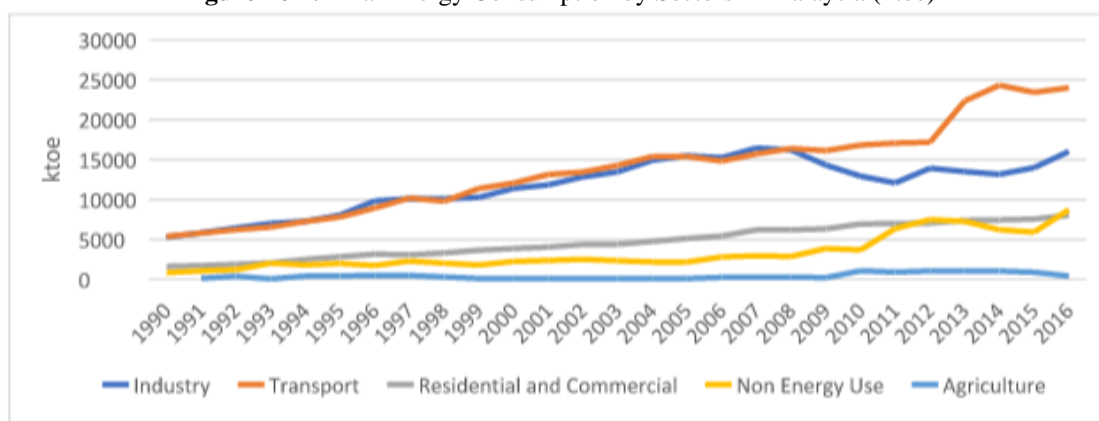
Sector	1973		2014	
	Mtoe	Share (%)	Mtoe	Share (%)
Industry	1534.49	32.92%	2751.17	29.2%
<b>Transport</b>	<b>1081.26</b>	<b>23.2%</b>	<b>2627.02</b>	<b>27.87%</b>
Other	1758.88	37.73%	3218.98	34.15%
Non-energy use	286.56	6.15%	827.52	8.78%
Total	4661.19	100.00%	9424.69	100.00%

Source: Key World Energy Statistics 2016, International Energy Agency

• **Transportation Sector and CO<sub>2</sub> Emission in Malaysia**

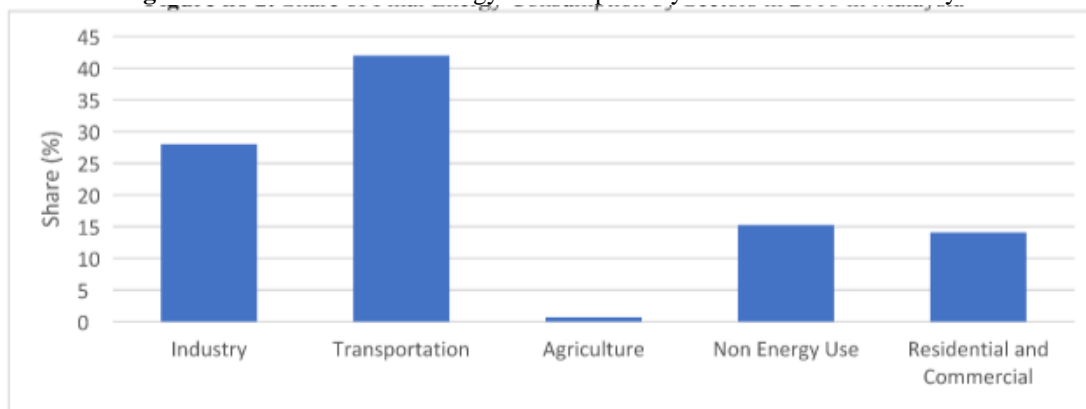
The period 1980-1990 has seen outstanding economic performance from the East Asian economies. Malaysia, for example, has had an average annual GDP growth rate of about 6% since 1980 making it one of the fastest growing economies in the world<sup>21</sup>. Successful and consistent economic growth has led to rapid urbanization and significant rise in income per capita. Malaysia’s annual GDP per capita has increased by about 3 times in the last three decades. Since 1980 Malaysia has experienced a GDP per capita growth rate of about 3.4% on average per year and in 2017 the value stood at USD 9951.5<sup>21</sup>. As a result final energy consumption in Malaysia has grown at an average annual rate of 6.2 % from year 1990 to 2016 and reached 57.2 Mtoe in 2016. Figure 1 demonstrates the growth in final energy consumption by sectors from 1990 to 2016. The average annual growth rate of energy consumption from the transportation sector from 1990 to 2016 has been 5.5%. Transportation sector is the highest energy consuming sector in Malaysia accounting for 42% of the total final energy consumption in 2016 as shown in Figure 2<sup>1</sup>. This can be attributed to the massive rise in vehicle ownership throughout the country. The total number of on road vehicles in the country has increased from about 5 million in 1991 to 23.7 million in 2013 registering an average annual growth rate of 7.5% during this period<sup>13</sup>.

**Figure no 1:** Final Energy Consumption by Sectors in Malaysia (ktoe)



Source: National Energy Balance 2016, Malaysia

**Figure no 2:** Share of Final Energy Consumption by Sectors in 2016 in Malaysia



Source: National Energy Balance 2016, Malaysia

Transportation sector is also one of the most energy intensive sectors in Malaysia depending primarily on petroleum products which accounts for about 98% of the total energy consumption in this sector. The prime fuels used in the transportation sector include petrol, diesel, ATF and AV gas. Road sector energy consumption has been growing with an average rate of 6.24% per year since 1971 and in 2011 equalled 14432.254 ktoe accounting for almost 19% of the total final energy consumption in this country<sup>21</sup>. The share of petrol and diesel consisted of 95% of the total road sector fuel consumption in 2011<sup>21</sup>. The persistent increase in non-renewable sources of fuel consumption in the transportation sector in Malaysia is demonstrated in Table 2. Malaysia has proven oil reserves of 4 billion barrels as of 2014. Malaysia is the second largest producer of oil and natural gas in Southeast Asia and has the fourth highest oil reserves in Asia-Pacific after China, India and Vietnam<sup>20</sup>. Malaysia’s total oil production in 2013 was 669.53 thousand barrels per day and consumption was 623 thousand barrels per day. Figure 3 displays the total oil production, total oil consumption and net export of petroleum for

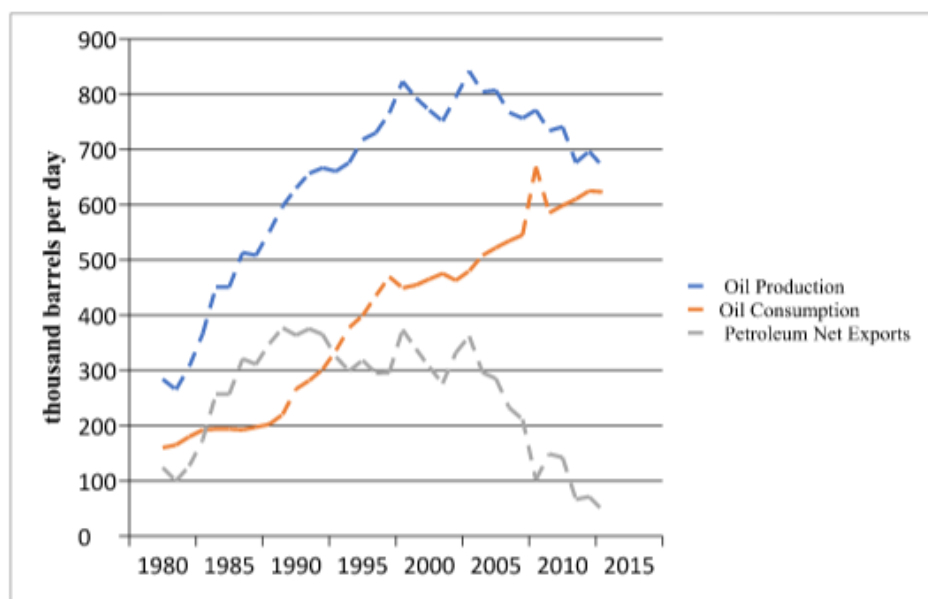
Malaysia since 1980. Production has been declining since its peak in 2003 due to natural depletion of existing fields while domestic consumption has been rising incessantly. As a result, net export of petroleum has been declining for Malaysia over the past few years generating a loss in national revenue. With the ever increasing huge demand of fossil fuel, it is calculated that Malaysia's crude oil reserves will be depleted in 20 years<sup>16</sup>. Malaysia has remained a net exporter of crude oil and petroleum products thus far but this role has reversed and Malaysia has become a net importer in 2015<sup>18</sup>.

**Table no 2:** Energy Consumption by Transportation Sector in Malaysia (ktoe)

Year	Petrol <sup>a</sup>	Diesel <sup>a</sup>	ATF and AV gas	Natural Gas	Electricity
1990	2751	1799	628	0	1
1991	2974	1912	690	0	1
1992	3156	2038	764	0	4
1993	3480	1922	875	0	4
1994	3930	2101	978	5	3
1995	4264	2136	1160	5	4
1996	4915	2381	1335	4	5
1997	5309	3060	1439	5	1
1998	5570	2277	1619	4	1
1999	6455	3127	1424	0	4
2000	6074	4042	1574	7	4
2001	6495	4467	1762	14	3
2002	6610	4611	1785	28	4
2003	7002	4945	1852	40	5
2004	7451	5354	2056	54	5
2005	7799	5001	2010	95	5
2006	7137	4971	2152	120	14.117
2007	8136	4787	2155	147	15.295
2008	8364	5205	2112	194	14.862
2009	8255	4988	2120	236	11.358
2010	9025	4625	2380	247	18.439
2011	7614	6078	2553	272	18.428
2012	-	-	2522	292	21.027

a. Includes only road sector energy consumption

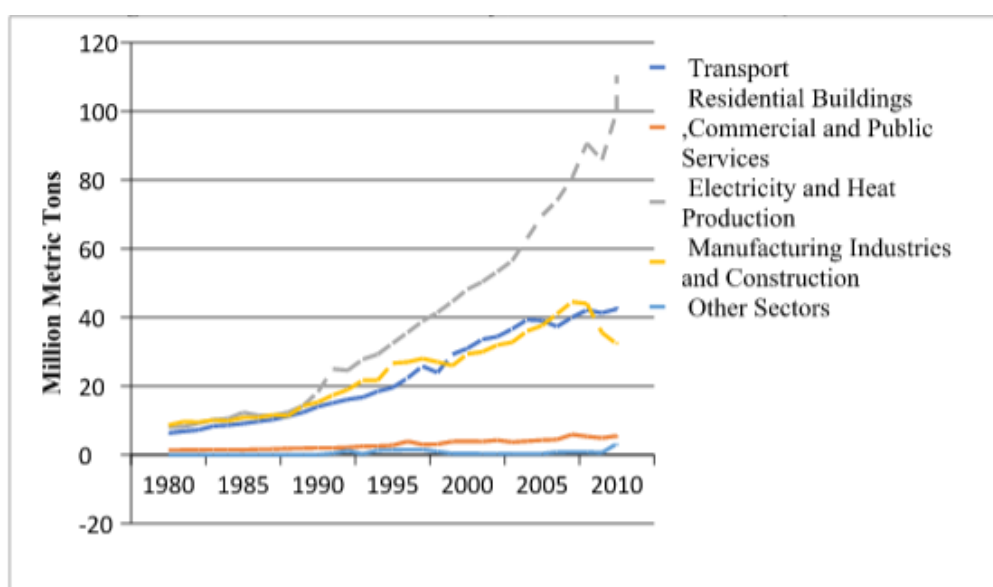
Source: World Bank 2014, National Energy Balance 2012



**Figure no 3:** Total Oil Production, Total Oil Consumption and Net Export of Petroleum for Malaysia (thousand barrels per day)

Source: U.S. Energy Information Administration 2014

Since petroleum products are the primary source of energy in the growing transportation sector in Malaysia, this sector has become a major contributor of GHG emissions and other atmospheric pollutants in the country. CO<sub>2</sub> emissions from the various activity sectors in Malaysia are shown in Figure 4. It can be seen that electricity and heat production is responsible for the highest amount of CO<sub>2</sub> emissions in Malaysia followed by the transport sector. Transport sector has the second highest growth rate of CO<sub>2</sub> emission after electricity and heat production. CO<sub>2</sub> emission from the transport sector in Malaysia have been steadily increasing with an average annual growth rate of 6.5% since 1980 and reaching 43.02 million metric tons in 2011. These emission rates are considered to be comparatively high among emerging nations. Overall 22% of the CO<sub>2</sub> emissions from fuel combustion in Malaysia in 2011 originated from the transport sector<sup>21</sup>. Furthermore, road transport CO<sub>2</sub> emission in 2011 equalled 42.5 million metric tons which accounted for almost 99% of the total transport sector CO<sub>2</sub> emission in Malaysia for that year<sup>3</sup>. CO<sub>2</sub> emission from road transport in Malaysia increased by a 176% during the period 1990 to 2007<sup>6</sup>. Road transport is also a significant contributor of atmospheric emission of various GHG in Malaysia. According to the world ranking of GHG producers published by Yale University, Malaysia was positioned 26<sup>th</sup> among 149 countries<sup>2</sup>. Greenhouse gases such as CO<sub>2</sub> trap heat in the atmosphere which causes global warming. Other subsidiary GHG such as CO and NO<sub>x</sub> and furthermore pollutants such as NMVOC, besides indirectly causing global warming, contributes towards the formation of ground level ozone which carries damaging impacts on human health for example respiratory and cardiovascular problems.



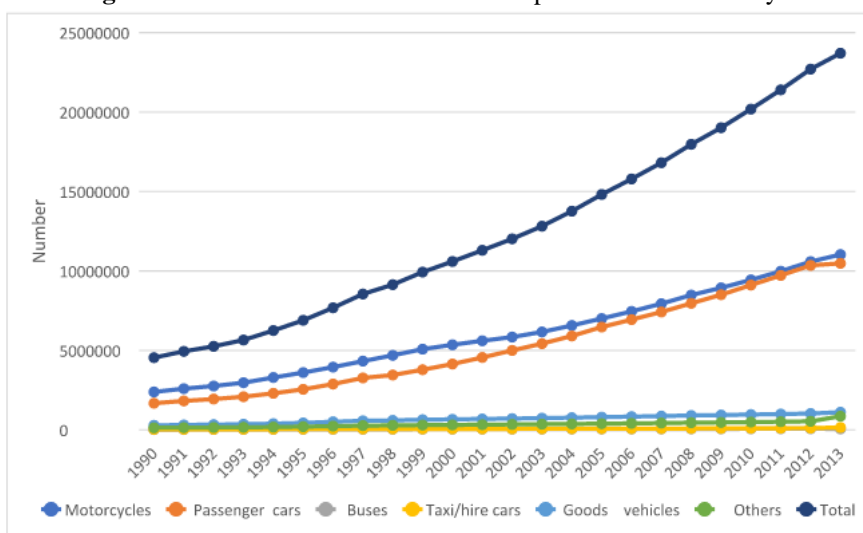
**Figure no 4:** CO<sub>2</sub> Emissions in Malaysia from Different Sectors (Million Metric Tons)

Source: World Bank 2014

- **The Rising Number of on Road Vehicles in Malaysia**

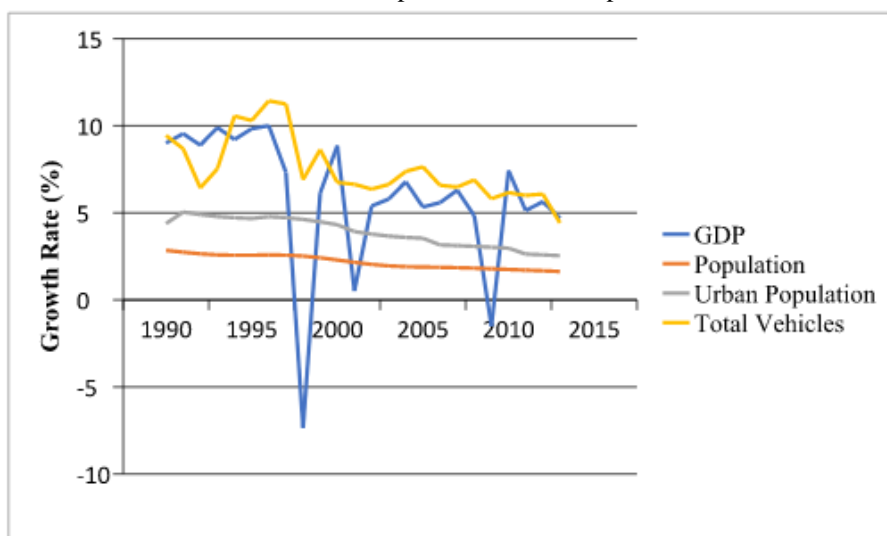
There are a number of reasons for the increasing energy consumption and emissions from the transport sector in Malaysia. A main reason of rising energy consumption and emissions in the road transport sector is a substantial increase in the number of on road vehicles in the country. Figure 5 shows that the total number of on road vehicles in the country has increased from about 5 million in 1991 to 23.7 million in 2013 registering an average annual growth rate of 7.5% during this period<sup>13</sup>. From 1990 to 2013 the population in Malaysia has grown by about one and a half times whereas the total number of road vehicles increased by about five times. Growth in GDP and rapid urbanization are two of the reasons why the number of road transport vehicles has been increasing sharply. The share of urban population in the country in 1980 was 42% and in 2013 this share stood at 74%. Urban population has been growing at an average annual rate of 4% since 1980 in Malaysia<sup>21</sup>. Figure 6 demonstrates the annual growth rates of GDP, population, urban population and the total number of road vehicles in Malaysia since 1990. It is seen that the growth rate in the number of on road vehicles has remained higher than the steady population growth rate and the fluctuating GDP growth rate over the years. The vehicle ownership rate in Malaysia calculated according to the values obtained, increased from about 250 vehicles per thousand populations in 1990 to about 798 vehicles per thousand populations in 2013. This growing pattern of vehicle ownership rate in Malaysia for the period is demonstrated in Figure 7.

**Figure no 5:** Total Number of Road Transport Vehicles in Malaysia



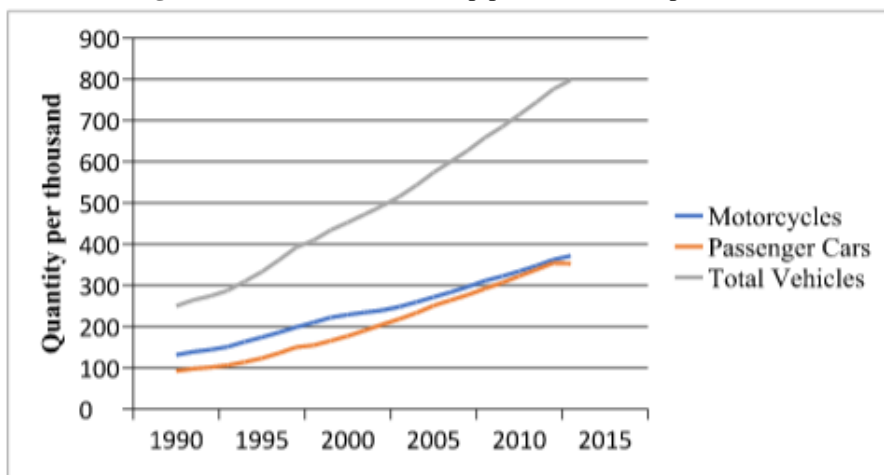
Source: Ministry of Transport, Malaysia 2014

**Figure no 6:** Annual Growth Rates of GDP, Population, Urban Population and Total Number of Vehicles



Source: Ministry of Transport, Malaysia 2014; World Bank 2014

**Figure no 7:** Vehicle Ownership per Thousand Populations

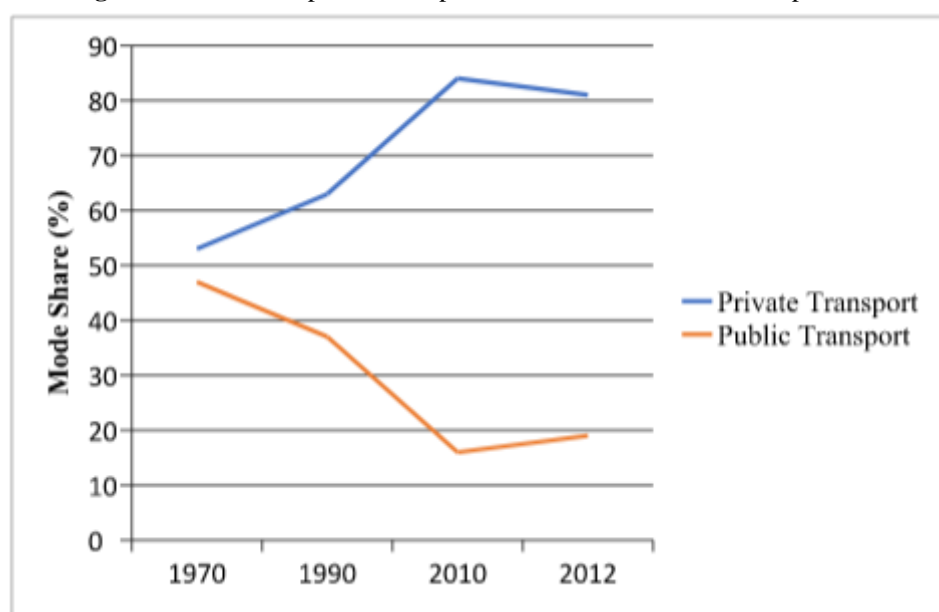


Source: Ministry of Transport, Malaysia 2014; World Bank 2014

The massive increase in road transport vehicles is also due to a movement away from rail transport towards road transport. This also causes the rise in energy consumption and emission from the transport sector. While the road passenger traffic has been increasing, the number of passengers in railways has seen an average annual decline of about 4.4% from 1992 to 2013. The total number of passengers for rail services in Malaysia was 7,614 thousand in 1992 which later decreased to 2,703 thousand in 2013<sup>13</sup>. Moreover in the case of transport infrastructure, while road network has increased by about 10 times from 14,446 km in 1980 to 155,427 km in 2011, rail line has only increased by a mere 1.4 times from 1,639 km in 1980 to 2,250 km in 2012<sup>21</sup>.

Another key reason of rising energy consumption and emissions from the transport sector is the increasing share of private mode of transportation and the continuously declining share of the public mode of transportation. The mode share of public transport in greater Kuala Lumpur area in 1970 was 47% which then decreased to 19% by 2012<sup>9</sup>. The share of private and public mode of transport in the greater Kuala Lumpur area for the period 1970 to 2012 is shown in Figure 8. This proportion of public transport usage in Kuala Lumpur is comparatively low compared to other Asian cities like Seoul (60%), Singapore (56%), Manila (54%), Tokyo (49%) and Bangkok (30%)<sup>14</sup>. Public transport modes in Malaysia include buses, taxis, monorail, light rail and heavy rail. If only road transport is taken into consideration, the number of buses, taxis and hire cars is worryingly low compared to the number of private passenger cars as evidenced in Figure 5. In the case of urban rail transport, the rail-based transit system in Kuala Lumpur began in 1995 with the start of Keretapi Tanah Melayu Berhad's (KTMB) Commuter. Subsequently other rail transit systems were introduced in the 1990's like the Star-LRT, Putra-LRT and KL Monorail which are operated by the private sector. The number of passengers for KTM Commuter, Star-LRT and Putra-LRT has been increasing over the years and the average annual growth rate of passengers since 2000 for these three rail transits is around 5%<sup>19</sup>. The main problems in the usage of all the public transport modes include inefficiency, slow travel times, lack of capacity, lack of integration between modes and lack of coverage to certain areas.

**Figure no 8: Modal Split of Transport Mode in Greater Kuala Lumpur Area**



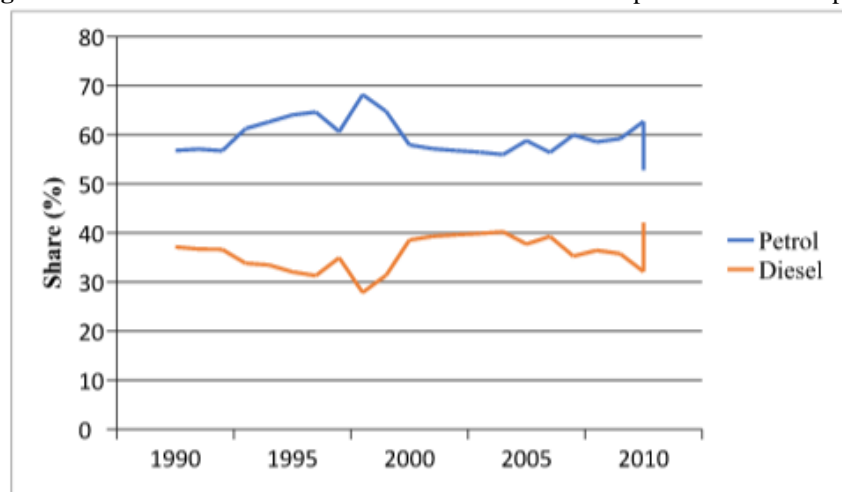
Source: Land Public Transport Commission, Malaysia (SPAD) 2013.

Malaysia's decentralization trend since the 1990's also caused reliance on private mode of transport to increase. Large scale infrastructure investment involving numerous expressways and highways induced residential areas and businesses to move further out of urban zones where public transportation has no access<sup>8</sup>. This has led to the rise in private car ownership. Malaysia's national car projects also encouraged private vehicle ownership. In 1983 Malaysia established a national car manufacturing company called Proton and 1993 another one called Perodua. Imported cars in Malaysia attract tax rates between 140% and 300% and imported car parts are charged 40% duty<sup>14</sup>. The Malaysian government exempted Proton and Perodua from high import duties ensuring these cars' viability, profitability and survival. These protectionist policies make the national cars affordable to the public thereby increasing the number of vehicles on the road. As of 2013, these two national cars hold the top two positions in the auto industry sales in Malaysia with Perodua having a 30% market share and Proton with a 21.5% market share<sup>7</sup>.

- **Lack of Fuel Diversification in the Transport Sector**

The deficiency of fuel diversification in the fuel basket and the almost absence of clean fuel in the road transportation sector is perhaps the fundamental factor for the high emissions from this sector in Malaysia. In 2011, motor petrol had the largest share with 52.76%, followed by diesel with 42.11% of the total road transport energy consumption<sup>21</sup>. The share of petrol and diesel in the total road transport energy consumption in Malaysia is shown in Figure 9. It clearly depicts the dominance of non-renewable petroleum products in the road transport sector in Malaysia over the years. In the case of other sources of energy in the entire transport sector, natural gas, biodiesel and electricity had a share of a mere 0.86%, 1.6% and 0.12% respectively in 2016<sup>1</sup>. There is therefore a clear need to search for alternative fuels beside fossil fuel.

**Figure no 9:** Shares of Petrol and Diesel in Total Road Transport Fuel Consumption



Source: World Bank 2014

## II. CONCLUSION

The rising emissions from the transportation sector in Malaysia may contribute to domestic air pollution and global climate change. This is a major global environmental concern and could also have a detrimental impact on the socio economic development of Malaysia. Malaysia is a party to the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol which fundamentally pledges it to take measures to reduce GHG emission. The Prime Minister of Malaysia has voluntarily set a target to reduce the GHG emission intensity of GDP by up to 40% of 2005 levels by 2020 subject to technology transfer and financial support during COP 15 in Copenhagen (Second National Communication to the UNFCCC). Hence the transportation sector needs to play a crucial role in achieving this target. It has become necessary for Malaysia to implement appropriate energy planning and policies to reduce the demand for fossil fuels in the transportation sector thereby reducing GHG emissions. Energy security in Malaysia is also heavily dependent upon suitable energy and economic policies.

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