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Review on CO_2 Emission from Transportation Sector in Malaysia

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Abstract: *Transportation-related emissions are the dominant contributing source of air pollutants today. Considering the negative impacts of transportation-related emissions on our social and economic environment, extensive efforts have been made by researchers and practitioners attempting to find solutions to reduce the emissions. The present study reviews the current state of GHG emission from transportation section, the measures that have been initiated in Malaysia for GHG emission reduction in transportation sector. Various region's car ownership, use and emissions are higher than would be predicted on the basis of population or gross domestic product (GDP), and car traffic clogs the streets and pollutes the air of many countries, Furthermore, global carbon emissions from transport, mostly from cars, are predicted to grow threefold by 2030 as both automobile ownership and vehicle use expand. The total emissions level in the developing countries will still be small compared to those of developed countries, but they will not be trivial. Malaysia has committed to reduce its greenhouse gas (GHG) emissions by up to 40% by the year 2020. The fact that transport sector of Malaysia shares a big portion of national GHG emissions; its role is paramount. The review shows deceleration of GHG emission from transportation sector globally and Malaysia in recent years. However, the study reveals that the present measures may not be enough to reduce GHG emission up to the set target. Malaysia needs more prudent strategies for climate-friendly development of transportation to achieve sustainability goals.*
Keywords: *Emission; Gasoline consumption ; Green House Gas; Transportation; vehicle fleet*

I. Introduction

There is broad consensus that GHGs are warming the planet (IPCC 2007). Many human activities produce GHG emissions, but roughly two-thirds of the total anthropogenic emissions comes from fossil fuel combustion for transportation, buildings, and industry. Anthropogenic GHGs, including methane, CO_2 and small quantities of other potent gases, also come from agriculture, mining, natural gas production, landfills, and industrial processes. Land use changes that remove plants that absorb CO_2 contribute to the problem. The increasing in GHGs concentration has become a major challenge, therefore, the reduction of greenhouse gas emissions has become a primary focus of environmental programs in countries around the world. Though the developed countries are traditionally the main emitters of greenhouse gases, some developing country's emissions are now believed to have surpassed developed country emissions due to huge development activities in recent decades [1]. Emerging economies such as China and India are now considered as the major greenhouse gases emitter in the world [2; 3]. Owing to the above fact, Bali declaration emphasized the joint efforts by both developed and developing countries to take measures against climate change [4].

The origin of CO_2 emissions from all fossil fuel combustion by region of the world. About half of the total emissions comes from Organization of Economic Cooperation and Development (OECD) countries, excluding Mexico, and about 20% are emitted in China, but only 7% are from Latin America. On a per capita basis, the world average was 4.3 metric tonnes of CO_2 per capita, while that from Latin America was only 2.5 tonnes per capita [5] (Fig 2).

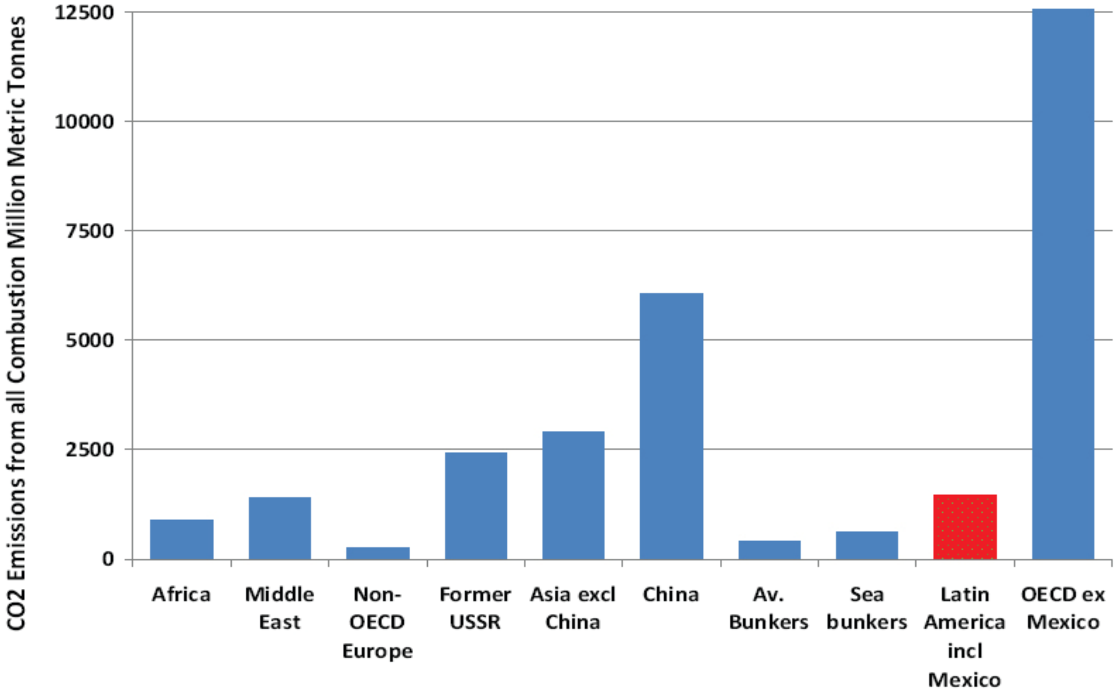

Figure 1. CO_2 Emission from Transportation Sectors in various Countries

The various emission rates are most significant to different countries, taken a view of the United State of America, the transportation-related emissions are the dominant source of air pollutants, which contribute to the environmental problems today. In 2002, the nationwide transportation sources were responsible for 82% of the carbon monoxide (CO), 56% of the nitrogen dioxide (NO2), 45% of the volatile organic compounds (VOCs), 12% of the lead (Pb) emissions, and 5% of sulfur dioxide (SO2) . In addition to the criteria pollutants, the transportation sector was also the second largest source of carbon dioxide (CO_2) emissions globally. It directly emitted approximately 27% of total U.S. greenhouse gas (GHG) emissions in 2003 [6]. Of the major environmental problems, transportation- related emissions are causes of acid rain, the greenhouse effect, ozone pollutants, etc. These environmental problems are huge threats to all living species, especially human beings. In addition to the contribution to environmental problems, the transportation-related emissions also have significant impacts on the economy and society. A National Academy of Sciences study estimated that a nationwide 90% reduction in vehicle emissions from 1973 levels would save $1.6–8.8 billion/yr in 1980 dollars [7].

II. Global Ghg Emission From Transport

Considering the negative impacts of transportation related emissions, a variety of studies in this area have been conducted by a cadre of researchers from various disciplines such as environmental engineering, transportation engineering, mechanical engineering, etc.

The transportation sector is greatly contributing to the socio-economic development worldwide with inherent environmental impacts [8; 9]. The conflicts are ever increasing between the goals of fulfilling mobility needs and improving quality of environment. The transport sector is responsible for the emission of more than a quarter of carbon dioxide (CO_2) world-wide, as well as considerable shares of methane (CH4), and nitrous oxide (N_2O) emissions, and is thereby one of the largest single contributors to global greenhouse gas (GHG) emissions. Unbounded emissions of greenhouse gases to atmosphere warmed the planet to levels that have never been experienced in the history of human civilization [10]. Climate change due to global warming could have far-reaching and unpredictable environmental, social, and economic consequences [11].

Today, Latin America is a small contributor to the world's emissions of greenhouse gases (GHG). However, the region's car ownership, use and emissions are higher than would be predicted on the basis of population or gross domestic product (GDP), and car traffic clogs the streets and pollutes the air of many Latin American cities. Furthermore, Latin American carbon emissions from transport, mostly from cars, are predicted to grow threefold by 2030 as both automobile ownership and vehicle use expand. The total emissions will still be small compared to those of developed countries, but they will not be trivial. As a heavily motorized and urbanized part of the developing world, Latin American cities suffer from notorious congestion and air pollution. Yet, Latin America has also become one of the birthplaces of Bus Rapid Transit (BRT), first in

Curitiba Brazil, but now in an increasing number of large cities. Reducing carbon dioxide (CO_2) emissions from urban transport in Latin America as population and incomes in urban areas grow is a challenging goal, but it is one that many cities are already pursuing. Substantial additional gains seem achievable [5].

Taken a look at Spain mode of transportation, the interurban road transport is by far the main mode of transport both for passengers and freight, as has gain an importance in the Spanish transport system during last two decades at expenses of rail transport. The increase is due not only in the vehicle fleet, but also is due to the road network that has been developed during this period mainly with the sources from the European Community. The Spanish interurban road network has increased from 156 thousand km in 1990 to 165 thousand km including all types of road [12]. Interurban road transport has experienced higher growth in the last year's, especially since 1995, due to the new registered motor vehicles. The number of registered vehicles has increased from 15.7 million in 1990 to over 30 million in 2008 [13], at an annual rate of 3.5% (Fig. 1). The number of vehicles per 1000 inhabitants has also increased from 394 vehicles in 1990 to 670 vehicles in 2008. In 2007, interurban road transport represented 89.5% of passengers-km and 83.9% of tons-km registering an annual growth of 4.0% in passenger performances and 3.4% in freight performances during the period 1990–2007 [14]. The flexibility of operations, prize advantages and time reliability makes road transport the most usable choice among transport modes [5]. The growth of the Spanish economy, especially during the period 1995–2007, and associated growth of personal incomes, has generated increasing need for transportation (both passengers and freight). This economical growth has induced the increase in the ownership of private cars and the performance of transport services operating and relaying predominantly on diesel vehicles [15]. The diesel cars have become the most popular mode of private transport in Spain in detriment of the gasoline cars, due to lower operation costs (lower fuel prices and fuel consumption of diesel). Similarly, diesel heavy vehicles have been used for the passenger and freight transport and account for a significant share of diesel consumption in Spain (36% in 2004). In 1990, transport consumed 39.5% of total primary energy in Spain and 40.7% in 2004 [12]. In 2004, final energy consumption of the transport sector was slightly more than 38 million tons oil equivalent (toe). Besides being the economic sector with major final energy consumption, transport is the sector with major consumption of fossil fuels (55.2%, 2004). In absolute terms, green house gas (GHG) emissions from transport during the period 1990–2009 have grown 70% [16]. At an annual growth rate of 2.8%, emissions are expected to double over 25 years [17]. Emission growth is due mainly to road passengers and road freight transport. The road passenger traffic demands have increased from 2.07 · 1011 ton-km passenger-km in 1990 to 4.09 · 1011 ton-km passenger-km in 2009. Similarly, the road freight traffic performances have increased from 1.99 · 1011 ton-km in 1990 to 2.94 · 1011 ton-km in 2009. Only road transport is responsible of 75% of total sector emissions [12]. The interurban road transport has experienced an average annual growth rate of 2.5% in freight and 5.1% passenger traffic performances during the last 20 years (which is expected in the future to stagnate or even to decrease due to the declining economic growth in Spain) which consequent increase in emissions of green house gases. In the Kyoto protocol, the European Union undertook to reduce GHG emissions in its area by 8% over 1990 levels between 2008 and 2012. Current trends in transport demand and associated GHG emissions in Spain, expressed as relative indicators, show higher growth rates than the Gross Domestic Product (GDP) and the Spanish population (Fig. 2). The significant increase in GHG emissions for the transport sector in Spain cannot be explained simply by demographic growth, nor even by economic growth [18], both of which have grown at a lower rates. Therefore, mobility of persons and goods is increasing at a faster rate than in our European neighbours [19]. Growth of passenger transport is also observed to be greater than freight transport, whereas the trend in Europe is the opposite. The energy consumption pattern in Spain is characterized by mainly two things. Firstly, diesel consumption has gradually increased its share over the total energy consumption in the road transport at around 79%. It is higher, compare to gasoline consumption, due to the increased in performances of freight and passenger transport using diesel vehicles. Secondly, gasoline (mainly cars) has primarily used for private passenger transportation. The energy intensity per capita of road transport has gone from 0.46 toes per inhabitant in 1990 to 0.71 in 2007 (an increase of 54%) [17]. Similarly, the energy intensity per unit of gross domestic product (GDP) of road transport (at constant 1995 prices) has gone from 0.045 ton per million Euros in 1990 to 0.052 in 2007 (15% growth). However, the maximum elasticity of GHG in relation to GDP was reached, and this implies that future increases in GDP will entail more minor changes in emissions [14]. Productive processes in Spain are increasing their consumption of transport, contrary to Community targets which aim to generate economic growth with lower increases in transport flows of passengers and freight [20; 21; 22]. Therefore, a decided action to supply alternatives to motorized mobility is needed, especially regarding private car use, to reach destinations and goods that guarantee the well-being of the society [19]. Emissions from the interurban road transport are directly proportional to the amount of gasoline and diesel consumption and the increase in CO_2 emissions in the past twenty years has been due both to an increase in the distance travelled by the road vehicles and in the vehicle fleet. The combination of these factors has resulted in increasing CO_2 emissions. There are methodologies and studies which estimate energy consumption and emissions from the transport sector [19]. For instance, energy consumption and CO_2 emissions can be estimated based on transport data by using the methodology and the emission factors developed by the Intergovernmental Panel on Climate Change [23]. These emissions are directly proportional to the carbon content of the fuel used in transport (expressed in kilotons of equivalent CO_2 per pega-joule, ktCO_2 eq./ PJ). Most of the carbon is converted into CO_2 during combustion, although a part is released as carbon monoxide (CO), methane (CH4) or hydrocarbons without methane which oxidize into CO_2 over time. Analogously, the emissions of pollutants (oxides of nitrogen NOx, CO, non-methane volatile organic carbon NMVOC and particle matter PM), acidifying substances and ozone precursors, are proportional to the pollutant content (expressed in kilograms of pollutant per pega-joule, kg/PJ) [17].

However, regional differences are large in term of emission from road transportation, with some regions showing increases in the ratio, while others have achieved substantial decreases. For Latin America, the ratio of road transport CO_2 emissions to GDP has declined slightly, by less by 0.5 percent per year [5]. In other words, transport emissions in Latin America have increased at almost the same rate as GDP has grown (Fig 2).

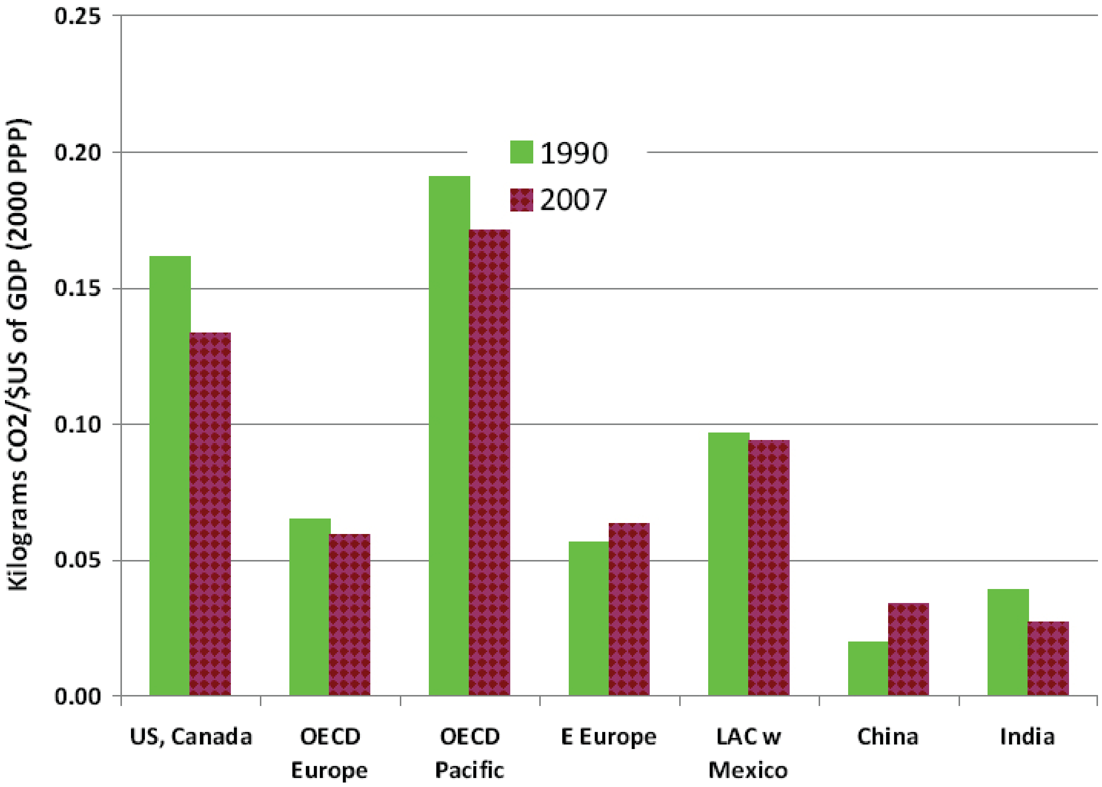

Figure 2. CO_2 Emission in Relation to GDP in Some Countries

In spite the contribution of CO_2 emission from transportation, Germany was more successful than the USA and other countries in reducing CO_2 emissions from passenger transport over the last two decades. Between 1990 and 2010, total ground passenger transport CO_2 emissions in Germany declined by 15% compared to a 12% increase in 90 the USA [24]. CO_2 emissions in the USA increased sharply between 1990 and 2005 (+21%) and then fell between 2005 and 2010. The drop in CO_2 emissions between 2005 and 2010 is likely related reports a sharp drop of 15% in passenger kilometers of car travel between 2006 and 2009 [24] However, even in 2010, passenger transport CO_2 emissions in the USA were 11.7 times greater than in Germany—up from a ratio of 8.9 in 1990. This increase is partially explained by faster population growth in the USA than in Germany.

Adjusting for population size, per-capita CO_2 emissions increased in the USA between 1990 and 2005, but declined between 2005 and 2010—resulting in 9% lower CO_2 emissions per capita in 2010 compared to 1990. In Germany, per capita CO_2 emissions declined by 17% between 1990 and 2010. In 1990 emissions per capita were 2.8 times greater in the USA than in Germany. By 2010, this ratio had increased to 3.1—reflecting Germany's stronger decrease in CO_2 emission during that time frame. Between 1990 and 2010, CO_2 emissions per kilometre travelled declined by 20% in Germany but only 3% in the USA—reflecting larger gains in vehicle fuel efficiency as well as increases in public transport use and cycling in Germany during this time. Compared to economic activity, measured in inflation-adjusted $ of constant GDP, between 1990 and 2010 Germany decreased its CO2 emissions from passenger transport at a faster rate than the USA (-110 36% vs. -31%).

In summary, between 1990 and 2010 Germany reduced CO2 emissions from passenger transport at a faster rate than the USA—even controlling for population growth, economic activity, and travel demand. Moreover, for all indicators CO2 emissions from transport were much higher in the USA than in Germany: 11.7 times for total CO_2 emissions, 3.1 times per capita, 2.1 times per passenger kilometer, and 2.4 times per unit of GDP.

III. Federal GHG Reduction Goals For Transport

Since ratifying the Kyoto Protocol Germany has set national targets for reducing GHG emissions. Between 1990 and 2010 Germany reduced its total GHG emissions by 22% and has the goal to achieve a 40% reduction relative to 1990 by 2020 [25]. Between 1990 and 2010, emissions from transport declined at a lower rate than those for industry and energy sectors. Achieving the overall 40% target by 2020, however, requires the transport sector to reduce its annual emissions by 20-25% between 2005 and 2020 [25].

There is no explicit federal policy to reduce GHGs in the USA. However, since 2009 the Environmental Protection Agency (EPA) has regulated GHG emissions as air pollutants that endanger public health and welfare [26]. Moreover, 23 States had GHG reduction targets and 37 States had climate action plans in 2012. GHG reduction targets vary by state. For example, California's target is to achieve 1990 emission levels by 2020 [27]. In both countries federal governments have developed a number of policies that directly or indirectly reduce CO_2 emissions from automobile transport including fuel economy and CO_2 tailpipe emission standards, vehicle registration fees and taxes, incentive programs for the purchase of fuel efficient cars, biofuel standards, and gasoline taxes. Federal governments also support local and state policies that can help change travel demand by promoting public transport, walking, and cycling, as well as land-use policies that keep trip distances short.

IV. Malaysia GHG Emission From Transport

Narrowing CO_2 emission from transport sector in Southeast Asia, Malaysia is second largest per capita greenhouse gas emitter among the group of ASEAN countries [28]. Although, Malaysia shares only 0.3% of global GHG emission [3] the major concern lies in the ever increasing trend of GHG emission. When many developed countries have successfully reduced the GHG emission, Malaysia continues to increase its emission level. A comparative through the time series of GHG emission by Malaysia and a few developed countries of Europe, it is indicated that Malaysia has already surpassed many developed countries in terms of GHG emission [29]. As a result of which the country is facing an increasing domestic and international pressure to decelerate its greenhouse gas emission.

Malaysian is a signatory of many international accords for greenhouse gas emission reduction including Montreal protocol of 1987, Kyoto protocol of 1992, Copenhagen accord of 2009 and Cancun agreements of 2010 [30]. The Cancun agreements provided a framework for all major developed and developing countries to formally anchor their 2020 greenhouse gas targets in a parallel manner [30]. Malaysia has also declared to reduce its greenhouse gas emissions by up to 40% by the year 2020 as comparable with 2005 levels to implement the Cancun agreements and the Bali declaration of joint efforts of emission reduction by both developed and developing countries [31].

The transport sector is an important component of the economy impacting on development and the welfare of Malaysian population. The rapid development of transport sector has contributed a lot to the gross development of socio-economy and people's livelihood of Malaysia [9]. However, the present reality is that the transport sector will be among the first that have to address the fulfillment of the goals of GHG emission reduction. Some concerns are raised by stakeholders that the GHG reduction efforts will affect the growth in transportation sector which in turn will have negative impacts on national economy and people's livelihoods.

The per capita GHG emission in Malaysia is 5.9 million tons which is three times more than the levels recorded for the whole Southeast Asia [29]. In terms of total GHG emission, Malaysia's position is also high among the other developing Southeast Asian countries. Although the total emission for Malaysia is only about 40% of Indonesia and 64% of Thailand, the per capita emission of Malaysia is about 3.5 and 1.6 times of the values of Indonesia and Thailand, respectively. Total emission of GHG in Malaysia was about 180 million metric tons in the year 2012. Energy generation, transport, Industry, residential building and agriculture are the major sectors contributing to GHG in the country. The Energy generation contributes about 54.9% of the total emissions followed by the transport, which accounted for 22.9%. The Industry shares about 17.4% of total GHG emission ranks third which is followed by residential buildings and other sectors.18-20 Time series of CO_2 emission by different sectors. It can be noticed that transport sector superseded industry in term of CO_2 emission in recent years.

Malaysia is undergoing rapid development in fulfilling the aspiration of achieving a developed nation status by year 2020. The aspiration towards economic competitiveness and well-being has led to rapid urbanization and increase the need for an effective and efficient public transportation system [9]. The government promoted the transportation sector to support economic development. Tremendous growth in economy, rapid urbanization and rising incomes caused exponential increase in the demand for passenger transport services in the country. Consequently, motorization in Malaysia has increased by five-fold over the past three decades. The number of vehicles registered in Malaysia over the last two and half decades show to increase from about 5 million in 1991 to 19 million in 2009. [32].

The public transportation system in Malaysia is still not developed enough. Hence, the private transport flourished rapidly with growing economic ability [21]. Motor cars and motor cycles together share about 92% of the total vehicles in the country in 2009 [14]. On the other hand, public transportation modes in Malaysia have only 1% share in the total registered vehicles. The share of public transport in cities has continuously declined from 34% in 1985 to 20% in 1997 and is now closer to 10–12%. Poor public transportation system and high demand of mobility caused rapid increase of cars compared to population growth. The time series of car ownership in Malaysia shows to increase rapidly, approximately three people had one vehicle in 1995 which reduced to 1.4 people in 2010 [32].

The consumption of both petrol and diesel has been increasing rapidly with growing motorization and increasing dependence on private modes. At present, transportation sector consumes about 36% of the national energy[33]. Consequently, it has appeared as a major emitter of CO_2. It is also responsible for other gases causing air pollution. Transport sector of Malaysia produced 42.43 million metric tons CO_2 which shares 22.9% of total CO_2 emission in Malaysia. Increased number of registered motor vehicles is expected in years to come which will certainly increase the emission further. Growth of CO_2 emission from transport sector of Malaysia. It can be seen that CO_2 emission has increased from about 15 million metric tons in early nineties to 42.43 million metric tons in 2012. As per calculation, transport sector needs to reduce CO_2 by 9.17 million metric tons in order to reduce 40% emission by the year 2020 [34].

The road transportation has the major share (85.2%) of total GHG emission from transportation. This follows the aviation, shipping and other small sectors. Therefore, the major reduction of CO_2 emission should be achieved in road transportation Cars are the major emitter of CO_2 which stake about 59% of total emission from road transportation. This is followed by motor cycles which contribute about 11% to total emission. This indicates that private transportation is the major sources of CO_2 emission from road transportation. It has already been mentioned that the country experienced unprecedented growth of private cars in last two decades. It has been projected that it will boom further in the coming years. Therefore, the major challenge of GHG reduction in transportation sector of Malaysia is to control emissions from private vehicles.

4.1 Review of Existing Emission Reduction Strategies in Malaysia

The emissions measurement and modeling were supposed to provide an input tool for the policy-making process. The air quality management policy then serves the objective of controlling and reducing emissions. Therefore the emissions- related actions, including the measurement and modelling system, both serve a final purpose to reduce emissions. Since the 1970s, under the force of the CAA, numerous emission reduction strategies have been developed and implemented to control and reduce transportation-related emissions. Among emission reduction strategies, improving vehicle design is the basic and most effective way to control emissions. The improvements of vehicle design include engine/fuel system improvements, catalyst converter refinement, and aerodynamic system improvements. The engine/fuel system controls emissions by optimizing air recycling and fuel-to-air ratio control systems. The catalytic converters control emissions by oxidizing the products of incomplete combustion. Therefore, the process in some cases can convert toxic emissions into nontoxic chemicals by control of the stoichiometric point (e.g., conversion from CO to CO_2). The aerodynamic system improvements increase energy efficiency by optimizing the mechanical operation of vehicles. In addition to the refinement of vehicle systems, new energy technology is another important strategy to reduce transportation emissions. The energy technologies include fuel alternatives, renewable fuel, and clean energy. Recently, biofuels were demonstrated to be able to reduce criteria and GHG emissions.68,69 Hybrid-electric propulsion systems are experiencing increased commercialization as a result of their improved fuel economy and reduced emissions. Reducing or smoothing traffic also plays an important role in reducing transportation-related emissions. Land-use planning and transportation system planning are considered as efficient ways to smooth traffic and concurrently reduce emissions.70–72 I/M programs were created to ensure that motor vehicle emission-control systems operate properly throughout the lifetime of the vehicle. The programs reduce emissions by identifying high emitters and requiring them to be repaired or removed from the fleet. The benefits of I/M programs in emissions reduction are documented in state I/M program reports.73,74 Efficient transportation operations were also shown to be effective emission reduction strategies. The potential operational improvements that may have positive impacts on emissions reduction include traffic system optimization, ramp metering technology, and Intelligent Transportation System technology. The operational strategies are usually evaluated at a microscopic level for certain traffic improvement projects.75 Improving fuel economy was considered as a contribution to reducing transportation-related emissions, especially in terms of reducing GHG emissions. To encourage the fuel economy production, the federal government administered three programs to provide information to consumers about fuel economy. Corporate Average Fuel Economy

(CAFE) is a required average fuel economy for a vehicle manufacturer's entire fleet of passenger cars and light trucks in each model year. EPA annually reports CAFE results of each manufacturer to the National Highway Traffic and Safety Administration (NHTSA), and NHTSA determines if the manufacturers comply with the CAFE standards and assesses penalties as required. Since 2000, EPA annually publishes the *Green Vehicle Guide* to help consumers identify the cleanest and most efficient vehicle that meets their needs. The Gas Guzzler Tax is also imposed on manufacturers of new model year cars that fail to meet the minimum fuel economy level of 22.5 mpg to discourage the production and purchase of fuel in efficient vehicles. On the basis of the review, the emission reduction activities are required by law and are administrated by federal and state governments. The reduction activities need to involve efforts of government, manufacturers, and customers. The actions make credits in terms of reducing criteria pollutants and GHG emissions.

Transportation-related emissions are important because they have significantly negative impacts on living creatures. Therefore, the research that focuses on transportation emissions dispersion and its impacts on air quality is considered as another important issue. Preferred and recommended models include American Meteorological Society EPA Regulatory Model Improvement Committee Model (AERMOD), California Puff (CALPUFF), Buoyant Line and Point Source (BLP), California Line Source Model (CALINE) series, Complex Terrain Dispersion Model Plus (CTDMPLUS), and Offshore and Coastal Dispersion (OCD) model. The CALINE series are the most widely used emission dispersion models.87 In addition to the preferred and recommended models, there are alternative models such as the Air Force Dispersion Assessment Model (ADAM) and Air Force Toxic Model (AFTOX), screening models such as SLAB (an atmospheric dispersion model for denser-than-air releases developed by the Laurence Livermore National Laboratory) and AERSCREEN (the screen version of AERMOD), and photochemical models such as Models-3/Congestion Mitigationand Air Quality (CMAQ) and Comprehensive Air Quality Model with Extensions (CAMx). The accuracy of the dispersion model relies on the accuracy of the emissions data. For instance, the Sparse Matrix Operator Kernel Emissions (SMOKE) model is used as a preprocessor for the CMAQ dispersion model, then the accuracy of the dispersion will be determined by both SMOKE and CMAQ.88 Another negative impact of transportation-related emissions is their significant contribution to the greenhouse effect. Transportation is the fastest-growing source of U.S.GHGs and the largest end-use source of CO_2. To reduce transportation GHG emissions and save fuel, EPA promotes strategies Clean Automotive Technology research and a range of voluntary programs to encourage efficient freight transport and alternatives to singleoccupancy travel. EPA also developed the *Green Vehicle Guide*, which helps consumers do their part to reduce GHG emissions by providing information to help in selecting the cleanest and most fuel-efficient vehicle that meets their needs. The legislative and regulatory action toward transportation- related emissions defined the research area and directions. The U.S. Department of Transportation Federal Highway Administration (FHWA) did a summary of environmental legislation affecting transportation in 1998. This summary listed three air-quality-related legislative references in addition to the general environmental statutes: CAA-Conformity, CAA-Sanctions, and CMAQ.89 In addition to the legislative references, regulatory emissions standards were assigned to emissions resources at national, state, and regional levels. All emissions research should comply with the laws and regulation requirements. The cost/benefit efficiency analysis is necessary in evaluating emission measurement, modeling, or reduction projects. There are some arguments that sometimes the emission reduction actions may cost more than the emission reduction benefits. For instance, the I/M programs are usually questioned for their high cost but limited emission reduction benefits. However, the costbenefit analysis is ignored in many emission research projects. On the basis of the review, transportation emissions related issues cover a wide range. The research and practice territory of this topic continues to spread. It is a multitask effort to cover all intermodal emission control strategies, impacts on air quality and environment, and regulatory actions and economic impact analyses. Transportation emissions research is becoming an interdisciplinary research area that combines transportation, planning, chemistry, and environmental studies [7].

4.2 Reduction Strategies Related to Transportation-GHG Emission in Malaysia

Malaysia has taken a short term roadmap for the reduction of emissions up to 40% by 2020 compared with 2005 levels. The roadmap identified three key sectors in achieving the target reduction namely, energy efficiency, renewable energy and solid waste management. The plan is to reduce about nine million tons of carbon dioxide annually by improving energy efficiency especially in transportation, another 11 million tons in the energy sector and 25 million tons reduction from the solid waste management sector by the year 2020. Number of initiatives in this line has been taken to improve energy efficiency and reduce GHG emission from transportation sector of Malaysia. The concept of integrating land use and transportation planning has been incorporated in planning of new settlements. Measures are taken to shift passengers from private vehicles to public transportation in urban areas. More public transportation such as MRT, LRT, trains and busses have been implemented and further planned in Kuala Lumpur and many other cities for this purpose. Initiatives also exist to improve vehicle standards, and encouragement of using energy efficient vehicles and diversification of fuels to cut CO_2 emissions. Strict emission testing system has been introduced by Ministry of Transport Malaysia and Department of Environment Malaysia for vehicles. The measures are discussed below in brief.

4.3 Increasing Share of Public and Non-motorized Modes in Urban Areas

The government has taken initiatives to increase the use of public transportation. National Land Public Transportation Master Plan 2012 is designed to improve the standard of public transportation at the main population centers of Malaysia in order to increase the share of public transportation by 25% in 2020 [35]. Other initiatives such as increasing the accessibility and communication of the overall percentage of the population residing within 400 meters of the public transportation route from 63% to 75%, refurbishment of bus stoppages, introduction of new bus service, extension of rail routes, etc. have been taken to attract more people to use public transportation.

V. Planning Efficient Transportation

In planning of transportation system of newly developing urban areas, concept of green transport has been adopted. For example, the urban transportation blueprint of Iskandar Development Region (IDR) proposed smart development of both transit and landuse which is known as Transit Oriented Development (TOD) in order to enable the policy makers to plan for future development in a more sustainable manner. The strategies include reduction of auto dependency by reducing the road-based per capita travel and car ownership, and increase public modes ridership by using push and pull factors such as reliable transit services, development of compact and self-sustained growth centers among many others [36].

VI. Diversification Of Fuel

The government promoted natural gas vehicles (NGV) with incentives and legislation, and encouraged vehicle owners to use natural gas. The import duty and sales tax on NGV conversion kit are exempted. Besides those measures, gradual reduction of fuel subsidies and the price hikes on petrol and diesel led to a drastic increase in the number of new NGV in Malaysia. The increase of natural gas vehicles in Malaysia over the time period 2000-2009 is shown in Figure 9. The number of NGV increased to 42 thousand vehicles in 2009 as compared to less than 5 thousands in 2000 [37]. Furthermore, the government has planned to use bio-fuel for vehicles involving 5% of palm methyl ester blended with 95% diesel under the B5 program. Use of biodiesel is encouraged in National Bio-fuel Policy of 2006.

Therefore, Malaysia needs to take prudent strategies for climate-friendly development of transportation to fulfill national aspirations for sustainability. Studies are needed to review, analyze and formulation of the policy options in Malaysian context. Few studies have been carried out in recent years in this regard [8; 38; 39; 40; 41]. However, studies are still in their infancy and many relevant issues are ignored. Thus, more analyses in terms of policy initiatives are needed to identify the most effective and applicable measures.

6.1 Increase Vehicle Fuel Efficiency

With the technological advances, vehicle fuel efficiency has increased worldwide. Malaysia is not out of this trend. However, vehicle fuel efficiency at national level depends on various direct and indirect measures including reducing fuel subsidies, increasing fuel price, encouraging alternative fuels, etc. Changes in vehicle fuel efficiency in Malaysia in recent years. It can be seen from the figure that vehicle fuel efficiency has increased drastically in recent years. This may be due to technological advances at global scale as well as various measures taken at national level. It can be anticipated that gradual reduction of fuel subsidies and the price hikes on petrol and diesel has promoted fuel economy in new automobiles and discourage driving by owners of new and used vehicles alike. Increased fuel efficiency has reduced fuel use and consequently, reduced average CO_2 emission per vehicle. The trend in percentage of fuel combustion in transport sector of Malaysia. The figure clearly shows that increasing vehicle fuel efficiency has decreased fuel combustion and reduces CO_2 emission from vehicles.

VII. Conclusion

Malaysia has high potential to develop a proper public transportation systems in terms of their capacity, coverage and quality in Selangor and Putrajaya, the administrative headquarters of Malaysia. Improved public transportation can reduce the use of personalized motor vehicles and hence help to cut CO_2 emission from transportation sector substantially. More intra-urban public transportation projects need to be undertaken in order to encourage a shift from personal to mass modes of transportation. Public awareness should be grown on the benefit of smooth driving. Eco-driving can be made mandatory part of driver's training. Roads development and maintenance are also required to facilitate to reduce the number.

References

[1]. Den Elzen, M. G. J., Olivier, J. G. J., & Hohne, N. J-M. (2013). Countries' Contributions to Climate Change: Effect of Accounting for All Greenhouse Gases, Recent Trends, Basic Needs and Technological Progress. Climatic Change. 21(2):," vol. 21, no. 2, pp. 397–412.

[2]. Leal-Arcas R. (2012). Top-down & Bottom-up Approaches in Climate Change and International Trade. X Annual Conference of the Euro-Latin Study Network on Integration and Trade (ELSNIT), Trade and Climate Change, Milan, Italy, October 19 – 20.

[3]. Olivier, J.G., Janssens-Maenhout, G., Muntean, M., Peters. .J.A.H.W. (2013). Trends in Global CO_2 Emissions: 2013 Report. PBL Netherlands Environmental Assessment Agency, The Hague.

[4]. Allan et al. (2007). Bali Climate Declaration by Scientists. Sydney, Australia: Climate Change Research Centre, University of New South Wales (UNSW). http://www.ccrc.unsw.edu.au/news/2007/Bali.html.

[5]. Schipper, L, Deakin, E., & Mcandrews, C. (2007). Carbon Dioxide Emissions from Road Transport in Latin America," pp. 1–15.

[6]. Institute (2007).Institute; available at http://www.filebox.vt.edu/users/hrakha/Software. htm (accessed on July 15, 2007).," 2007.

[7]. Lei, S.J., & Yu, Q.S. (2009). Research on Transportation-Related Emissions : Current Status and Future Directions Research on Transportation-Related Emissions : Current Status and Future Directions, Journal of the Air & Waste Management 59:2," pp. 183–195.

[8]. UNEP. (2001) "The Role Of The Transport Sector In Environmental Protection (BACKGROUND PAPER NO. 15). Department of Economic and Social Affairs, United Nations Environment Programme Commission on Sustainable Development Ninth Session 16– 27 April 2001, New York.," no. 15, 2001.

[9]. Aziz, A. B. A & Amin, N.F.M. (2012). Transforming the Land Public Transport System in Malaysia: Transforming the Land Public Transport System in Malaysia. JOURNEYS. (May): 30 – 37.

[10]. IPCC. (2007). Climate change, impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change. In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE (eds) Intergove.

[11]. IPCC. (2007). Climate Change 2007. Climate Change Impacts, Adaptation and Vulnerability. In Working Group II 2007 Geneva, Switzerland.

[12]. MF. (2009). Los Transportes y Los Servicios Postales. Informe anual 2008. Centro de Publicaciones, Secretaria General Tecnica, Ministerio de Fomento (MF). Madrid, Espana (in Spanish).

[13]. DGT. (2009). Anuario Estadístico General 2008. Centro de Publicaciones, Direccion General de Trafico (DGT), Ministerio del Interior. Madrid, Espana. Available from Internet: http://www.dgt.es/was6/portal/contenidos/es/seguridad-vial/estadistica/publicacion.

[14]. Perez-Martinez, P. J.; Monzon, A. (2007). Transporte y medio ambiente en Espanaun analisis que exige un mayor control de la demanda, Estudios de Construcción y Transportes 107: 65 – 72.

[15]. Perez-Martinez, P.J (2009). "The vehicle approach for freight road transport energy and environmental analysis in Spain, European Transport Research Review 1(2): 75–85. http://dx.doi.org/10.1007/s12544-009-0010-9," vol. 1, no. 2, p. 12544.

[16]. MMA. (2009). Sumario de Resultados. Subdireccion General de Calidad Ambiental, Ministerio de Medio Ambiente (MMA). Madrid, Espana. Available from Internet: http://www.sosclima.org/wp-content/ uploads/file/Sumario-de-Inventario-Nacional_Emisiones- GEI-serie-1990-2008.

[17]. Pérez-martínez, P.J. (2012). "Energy consumption and emissions from the road transport in Spain : a conceptual approach transport in Spain : a conceptual approach," no. March 2015, pp. 37–41, 2012.

[18]. Tolon-Becerra, A.; Otero-Pastor, I.; Perez, P.; Ezquerra-Canalejo, A.; Lastra-Bravo, X. (2009). Bases for building a sustainability indicator system for transport, in Highway and Urban Environment: Proceedings of the 9th Highway and Urban Environment Symposium, Vol. 17: 49–57. http://dx.doi.org/10.1007/978-90-481-3043-6-6.

[19]. Schipper, L., Deakin, E., & Mcandrews, C. (2008). Carbon Dioxide Emissions from Urban Road Transport in Latin America : CO_2 Reduction as a Co-benefit of Transport Strategies.

[20]. Tapio, P. (2002). Climate and traffic: prospects for Finland, Global Environmental Change 12(1): 53–68.

[21]. OECD. (2003). Analysis of the Links Between Transport and Economic Growth: Project on Decoupling Transport Impacts and Economic Growth. Paris: OECD. 94.

[22]. EEA, (2009). Transport and environment: facing a dilemma. TERM 2008. Environmental issues series. Copenhagen: European Energy Agency.

[23]. IPCC, (1995). Greenhouse Gas Inventory Reference Manual: IPCC Guidelines for National Greenhouse Gas Inventories. UK: Bracknell..

[24]. Buehler, B.R. (2013). Daily Travel and CO2 Emissions from Passenger Transport : A Comparison of Germany and the United States," pp. 1–26.

[25]. UBA. (2010). CO2 -Emissionsminderung im Verkehr in Deutschland, Dessau, Germany: 528 Umweltbundesamt.

[26]. PewCenter/C2ES, "PewCenter/C2ES (2011). Climate Climate Change 101: State Action. Arlington, VA: Pew Center/Center for 532 Climate and Energy Solutions.," 2011.

[27]. TRB. (2012). Climate Change and Transportation. Circular E-C164. Washington, DC: Transportation 530 Research Board of the National Academies.

[28]. Saxena, A.K. (2009). Greenhouse Gas Emissions: Estimation and Reduction. Asian Productivity Organization, India.

[29]. Salahudin, S.N., Abdullah, M.M. (2013). Emissions: Sources, Policies and Development in Malaysia. International Journal of Education and Research. 1(7): 1–12.

[30]. Ibarahim, R. (2011). Malaysia's Second National Communication to the UNFCCC. IMPAK, 4/2011. http://enviro.doe.gov.my/lib/digital/1380092364- Impak-2011-Bil-4.pdf.

[31]. Shahid, S. (2012). Vulnerability of the Power Sector of Bangladesh to Climate Change and Extreme Weather Events. Regional Environmental Change. DOI 10.1007/s10113- 011-0276-z.," p. 10113.

[32]. Shahid, S., Minhans, A., & Che, O. (2014). Jurnal Teknologi Full paper Assessment of Greenhouse Gas Emission Reduction Measures in Transportation Sector of Malaysia," vol. 4, pp. 1–8.

[33]. Kari, F. (2008). Automobile Emissions and the Environment: The Malaysian Experience. Making Choices about Hydrogen. Transport Issues for Developing Countries. http://www.idrc.ca/en/ev-132167-201-1-DO_TOPIC.html.

[34]. Kadir, W., Philip, E., Shamsuddin, I., Takada, M., Yamada, T., Liang, N., Okuda, T. (2010). Soil respiration in tropical rainforest: Its spatial variation and impact of logging. Joint Research Project on Tropical Forest Ecology and Biodiversity . Nishiki Publishing: Higashi-Hiroshima , Japan," pp. 21–28.

[35]. SPAD. (2012). National Land Public Transport Masterplan 2012. Final Draft, 27 September 2012, Suruhanjaya Pengangkutan Awam Darat, Kuala Lumpur, Malaysia.

[36]. IRDA (2011). Transportation Blueprint 2010-2030 for Iskandar Malaysia. Iskandar Regional Development Authority (IRDA) 2011.
[37]. IANGV (2010). International NGV statistics; 2010. Available from: http://www.iangv.org/tools- resources/statistics.html.
[38]. Indati, M. S., Ghate, A. T., Leong, Y.P. (2013). Towards Greener Environment: Energy Efficient Pathways for the Transportation Sector in Malaysia. 4th International Conference on Energy and Environment 2013. IOP Conf.Series:Earth and Environmental Science 16," vol. 16, p. 12-22.
[39]. Almselati, A. S. I, Rahmat, R. A. O. K. & Jaafar, O.(2011). An Overview of Urban Transport in Malaysia. Social Sciences. 6(1):," vol. 6, no. 1, pp. 24–33, 2011.
[40]. Ong, H. C., Mahlia, T. M. I., Masjukia, H.H. (2012). A Review on Energy Pattern and Policy for Transportation Sector in Malaysia. Renewable and Sustainable Energy Reviews . 16: 532 – 542.," 2012.
[41]. Hosseini, S. E., Wahid, M. A., Aghili,N. (2013). The Scenario of Greenhouse Gases Reduction in Malaysia. Renewable and Sustainable Energy Reviews. 28: 400 – 409.