CO_2 Emissions from the Land Transport Sector in the Philippines: Estimates and Policy Implications

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Abstract: Local air pollution problems and as well as the impacts of climate change will continue to plague the Philippines unless a new paradigm for land-use and transportation planning is implemented. The transport sector plays a key role in economic development and cities are often cited as the “engines” of growth of a country. In the past decades the transport planning model adopted by many countries, including the Philippines, prioritized the movement of cars and other motorized vehicles to facilitate the growing demand for mobility of passengers and goods. As such, this has led to the development of more roads, flyovers, and highways. Unfortunately, this has also resulted in the preference for private motorized travel as less investments were made for public transport and non-motorized transport like walking and cycling. The externalities of such actions can be seen in the deterioration of air quality in several cities, increase in road accidents and fatalities, and congestion. Recent estimates of CO_2 and particulate (PM) emissions in the Philippines show that in 2008, emissions of CO_2 totaled 30 million tons and 56 thousand tons of particulate matter. CO_2 emissions from the transport sector accounted for 38 per cent of the total from fuel combustion in 2000. If the business-as-usual scenario prevails, the number of motorized vehicles will double before 2020. This study is an initial attempt of the authors to analyze of the current and future emissions of CO_2 and particulate matter from land transport and as well as estimate the impacts of selected sustainable and low-carbon transport policies.

Key Words: sustainable, low-carbon, emissions

1. TRANSPORT EXTERNALITIES IN THE PHILIPPINES

The transport sector plays a key role in economic development. In the past decades the transport planning model adopted by many countries, including the Philippines, prioritized the movement of cars and other motorized vehicles to facilitate the growing demand for mobility of passengers and goods. As such, this has led to the development of more roads, and highways. Unfortunately, this has resulted in the preference for private motorized travel as less investments were made for public transport and non-motorized transport like walking and cycling, especially in the urban area.

The continued decline of the level of services of public transport and the steady increase of private motorized vehicles brought with a slew of environmental and social problems. The national emissions inventory for 2007 done by the Environmental Management Bureau of the Department of Environment and Natural Resources (EMB-DENR) estimates that the transport sector contributed 31% of total PM emissions, 38% of NO_2 emissions and 85% of CO emissions. The World Bank estimated that the effects of PM_{10} on health costs in Metro Manila, Baguio, Cebu, and Davao reached more than USD 400 million in 2001. In the same year, a total of 515 deaths resulted from 4,705 road accidents, according to the Department of Public Works and Highways.

According to the first National Communication of the Philippines on Climate Change to the UNFCCC the country's GHG contribution in 1994 totaled 100.9 million tons of CO_2 equivalent ($MtCO_2e$) and increased to 169.8 MtCO2e in 2000. The energy sector GHG emissions (mostly CO_2) in 1994 totaled 50,038 ktons, of which the transport sector contributes about 32% and the power generating sector about 31% (Merilo, 2001). In 2007 the total transport GHG Emissions was estimated at 29.3 $MtCO_2e$ with the road sector contributing 23.8 $MtCO_2e$, highlighting the fact that the road sector contributes a substantial amount to total emissions.

2. CO_2 AND PM EMISSIONS FROM THE LAND TRANSPORT SECTOR

2.1. Previous studies that looked at PM and CO_2 emissions

There are only a few studies that estimated the air pollutant and CO_2 emissions and assessed the impacts of policies from the transport sector and most have focused on Metro Manila. The USAID supported "Integrated Environmental Strategies for Integrated Environmental Strategies – Philippines Project Report/Metropolitan Manila: A Focus on the Transport Sector 2004" forecasted the PM and CO_2 emissions and assessed the impact of transport policies such as transportation demand management (TDM), rail-based mass transit systems, bikeways, the motor vehicle inspection system (MVIS), CNG buses, coco-biodiesel, etc. It established BAU scenario for 2005, 2010, and 2015 and came out with percentage reductions considering the selected transport policies. Results pointed to MVIS, replacement of 2-stroke tricycles, and diesel particulate traps for buses and jeepneys as having the highest reduction for particulate emissions; and the MVIS and TDM as having the highest reduction in CO_2 emissions.

In a follow-up study on this subject, Vergel (2005) in a similar analysis concluded that in terms of PM emissions, the highest reductions are achieved through the MVIS and the replacement of 2-stroke tricycles from 11-16 tons/day in 2010 to around 12-16 tons/day in 2015. Expansion of the railway network in Metro Manila resulted to a reduction of 11 tons/day in 2015 and through the installation of diesel particulate traps in public transport vehicles.

2.2. Estimating PM and CO_2 Emissions[1]

The "ASIF" approach was used in estimating emissions where A is the activity of passenger and freight travel; S is the structure, that is, the travel shares by mode and vehicle type; I is the fuel consumption; and F is the fuel use by type of vehicle (Schipper, et. al., 1999).

[1] The studies where vehicle activity and PM emission factors were derived were: the Developing Integrated Emissions Strategy for Existing Land (DIESEL) transport conducted in Bangkok, Thailand (2008); the Emission Factors Study of the Automotive Research Association of India (ARAI) (2008), Metro Manila Urban Transport Integration Study (1995); J.B.M. Biona et al. (2005); IEA-SMP model (2005), EMEP EEA Emission Inventory Guidebook, and Cherry et al.

Activity data of passenger and freight travel, fuel consumption were derived from various studies. In-use vehicle data from Segment Y Ltd for the Philippines was used. This vehicle fleet data is broken down per type of vehicle; fuel used, and engine technology (i.e. with respect to Euro emissions standards compliance). Data from the Land Transport Office and sales data from the Chamber of Automotive Manufacturers of the Philippines, Inc. were used in extrapolating the data and forecasting the number of vehicles to 2035 (see Figure 1). This included taking into account "grey" imports, second-hand imports including conversions, and locally manufactured jeepneys for personal and public transport purpose. Over-all, their forecast for vehicle growth is steady and not explosive except for motorcycles. Their assumption is that the density of motorcycles is still very low compared to other Asian countries and as the average Filipino aspires for mobility, cheaper second-hand cars and motorcycles will drive new acquisition. The increasing cost of fuel and inefficient public transportation system were seen as major drivers.

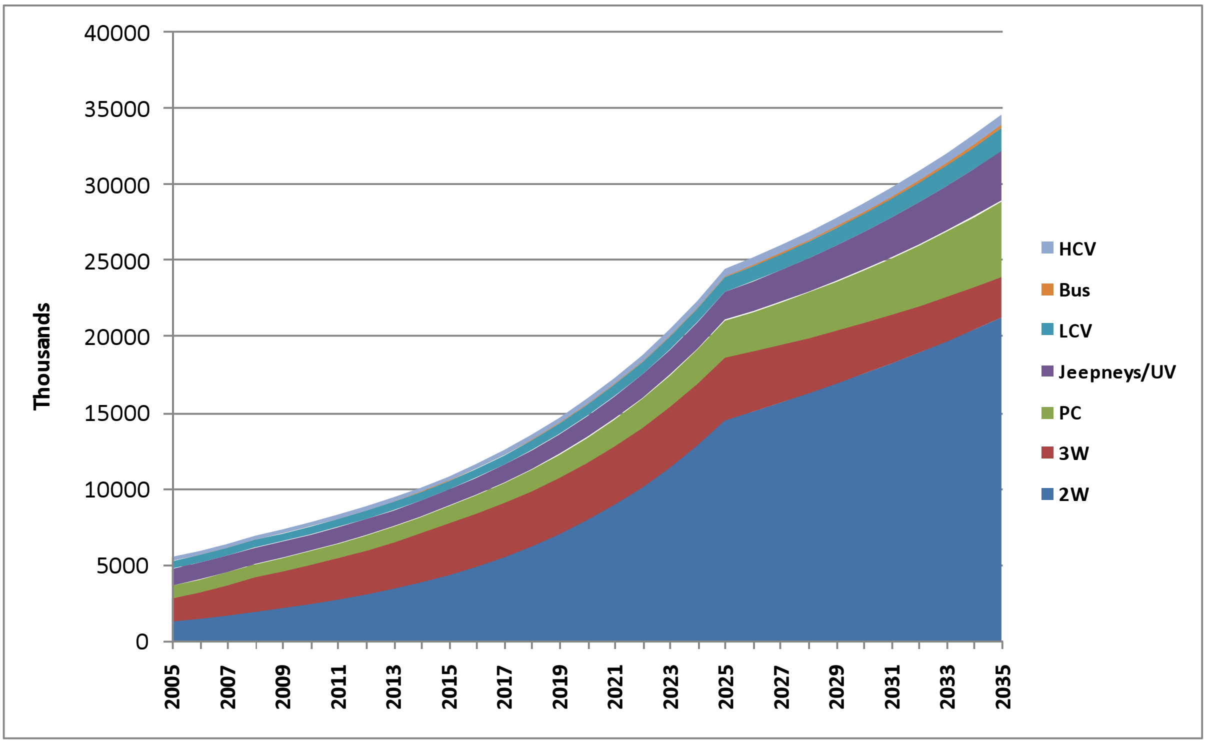

Figure 1. Projected Growth of Motor Vehicles in the Philippines from 2005 to 2035 (in number of units)

Figure 1 shows the data for in-use vehicles and its projected growth using the major categories: 2W = 2-wheelers, 3W = 3-wheelers, PC = personal cars/ SUVs, Jeepneys/ utility vehicles, LCV = light commercial vehicles, buses, and HCV = heavy commercial vehicles. The slight decrease in growth rate has been assumed as roads would be saturated with vehicles and high fuel prices would restrict further increase in ownership. According to data from LTO in 2008, about 29% of all total vehicles in the Philippines are registered in Metro Manila and about 56% when adjacent regions, comprising the expanded Greater Capital Region (including Central Luzon and CALABARZON Regions) are included.

Based on available data, passenger kilometer travel in the Philippines was derived for 2005 and it shows that Jeepneys account for 80% of the total VKT.(see Figure 2).

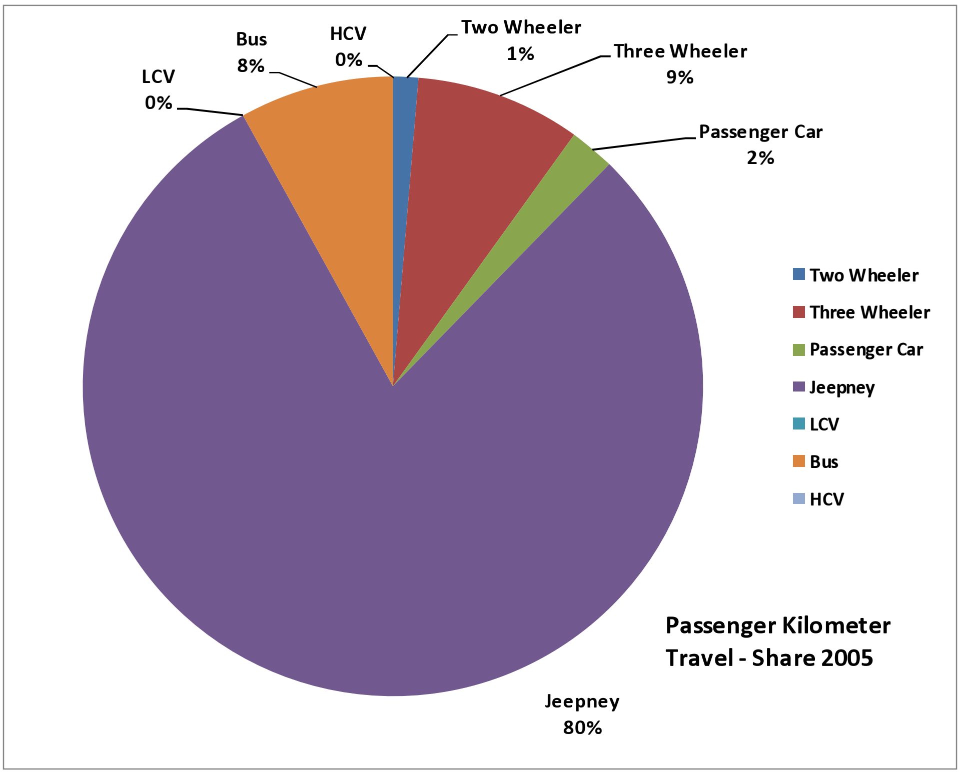

Figure 2. Passenger Kilometer Travel in the Philippines in 2005

For doing bottom-up estimations, choosing reliable emission factors play a major role. Emission factors are generally derived from dynamometer-based drive cycles to simulate typical driving conditions and traffic speeds and expressed in grams per kilometer traveled or one of its derivatives. Fleet based emission factors often used in sector calculations depend on "driving behavior" (how we drive), "fleet characteristics" (what we drive), and "infrastructure" (where we drive). It is to be noted that "no two vehicles will have the same emission factor profile, even if they are nominally identical models, produced on the same day on the same production line, however, in order to simplify the calculations, we often tailor the emission factors to fit "best possible local conditions". These "tailoring" are often done using local studies on various models. Since not many studies have been conducted to determine such average factors for all modes, the authors tried to include many research studies in Asian countries for the best possible numbers (see Figure 3).

Using the vehicle projections, travel characteristics data from the baseline and using the emission factors from various studies in Philippines and Asia, the CO_2 emissions from the land transport sector in the Philippines were estimated. Compared to other ASEAN countries (ADB 2009), the estimated CO_2 emissions from the road transport sector is less than Thailand, Malaysia and Indonesia. Interesting to note that though motorization levels in Viet Nam is higher than Philippines, emissions much lower as bulk of transport in Viet Nam is carried out in efficient two wheelers.

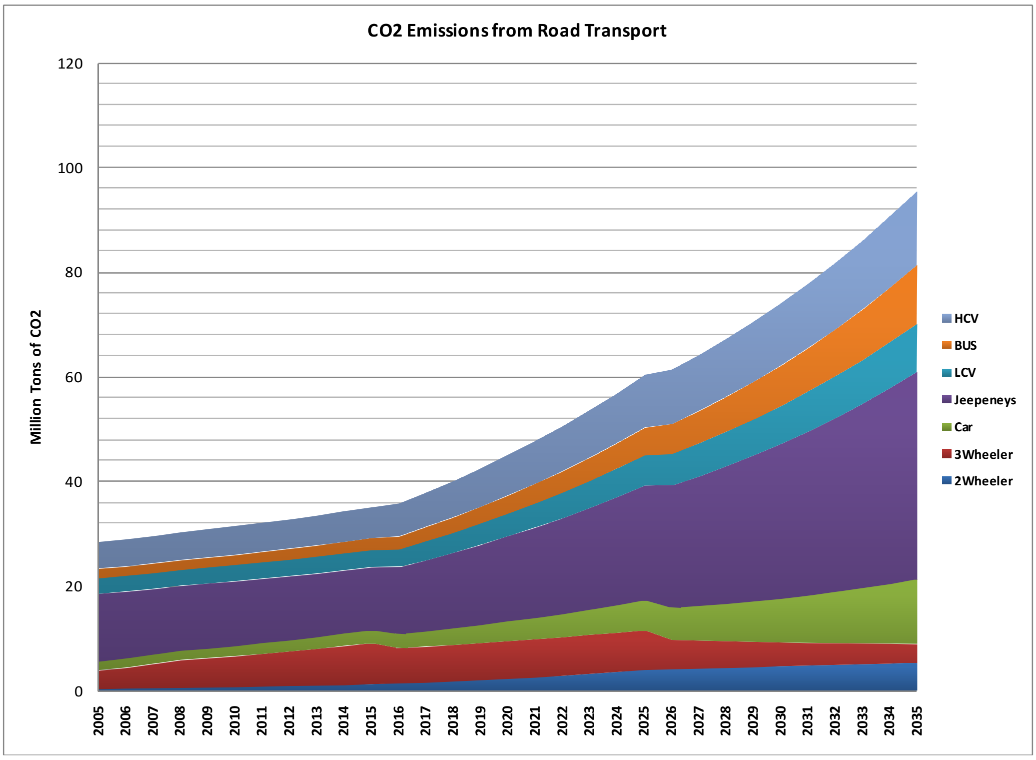

Figure3. Projected CO_2 Emissions in the Philippines from 2005 to 2035 (in Million Tons)

Substituting the CO_2 emission factors with air pollutant emission factors based on Euro emissions standards and other studies in the region as shown in Figure 4. Particulate matter (PM) emissions were estimated using the same set of data. Figure 5 shows a rapid decline of PM emissions from 2008. This is based on the assumption that newer vehicles coming into the market comply with Euro 2 standards as legislated and the possible introduction of Euro 4. This is also takes into consideration the number of vehicles shifting to alternate fuels due to government support. This rapid decline is also due to the assumption that 2-stroke tricycles, which are now a major source of PM, are substantially reduced in number by 2015.

However, it is to be noted that “renewal” of fleet takes a long time and thus impact of strengthening standards are seen only after duration of few years. As the new vehicles start replacing the scrapped ones, the average fleet improvement takes place. Such a slow process shows the importance of “leapfrogging” of emission standards.

This rapid decline in PM emissions does not necessarily mean that our cities will meet the national air quality guidelines for particulate matter because of substantial reductions in the transport sector. It is important to note that emissions is not equal to ambient concentrations but provides an indication as to how much emissions can be dispersed in the air.

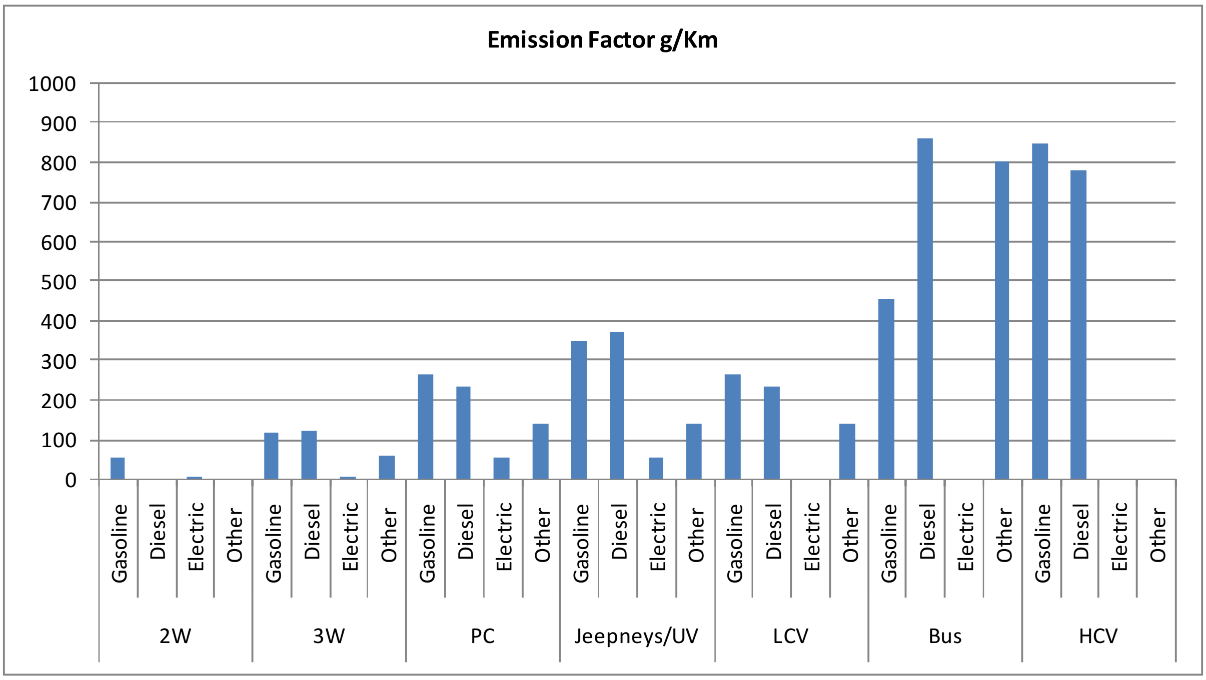

Figure 4. PM Emission Factors in Grams per Kilometer (g/km)

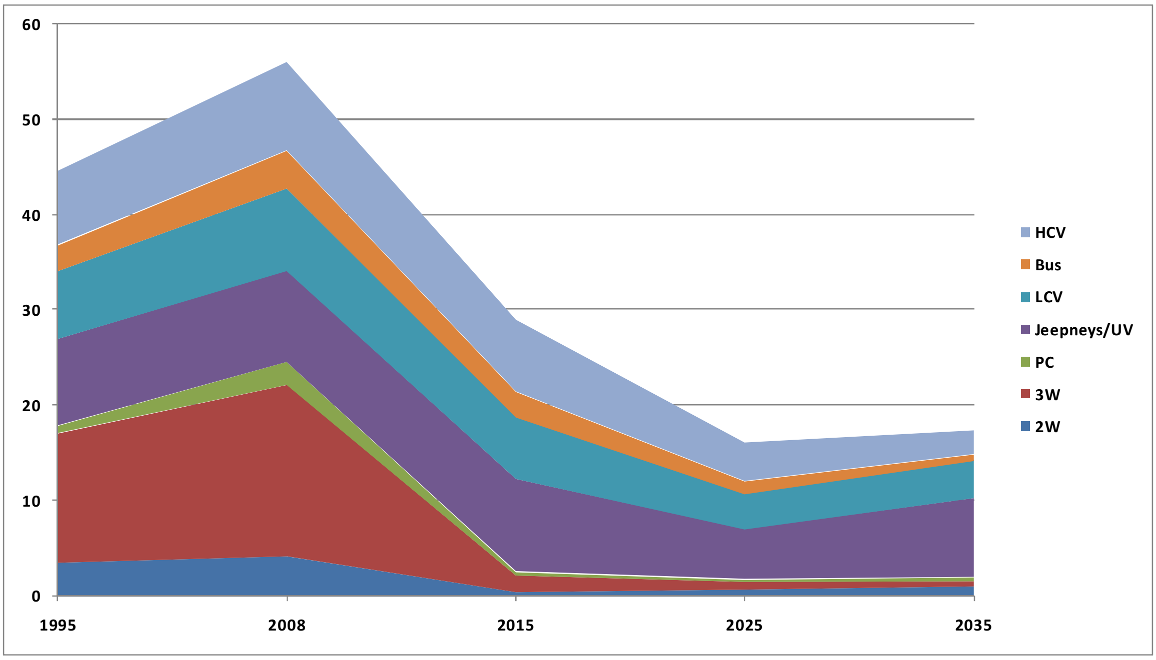

Figure 5. Projected PM Emissions in the Philippines from 1995 to 2035 (in Thousand Tons)

3. POTENTIAL IMPACT OF SELECTED POLICIES TO REDUCE CO_2 EMISSIONS FROM ROAD TRANSPORT

Two important policy directives related to climate change and sustainable transportation were issued from the Office of the President in December 2008 and January 2009. First, the Executive Order 774, which reorganized the Presidential Task Force on Climate Change (PTFCC) naming the President as the Chair and organizing 14 Task Groups that include a

Task Group on Fossil Fuels with the aim to reduce fossil fuel consumption, reform the transport sector to include walking, cycling and other human-powered vehicles. The 2007 Philippine Climate Change Strategic Framework and Response Action Plan of the PTFCC in October 2007, though still undergoing stakeholder consultations, also included strategic directions to be taken to address climate change-related development issues, specifically, the introduction of technologies establishing low-carbon infrastructure for transport, energy, agriculture, industry and settlements.

Second, the Administrative Order 254 that mandates the Department of Transportation and Communications (DOTC) to lead in formulating a National Environmentally Sustainable Transport (EST) Strategy for the Philippines, setting a new paradigm on the movement of passenger and goods by following this principle “Those who have less in wheels must have more in road.”

The authors assessed the potential impact of selected policies that can reduce both CO_2 and PM emissions, taking into consideration the pronouncements of the government and their impact. In terms of potential reductions against the business-as-usual scenario, only the impacts of CO_2 emissions were assessed for this paper. The policies are improvements in the current fuel efficiency and reductions in VKT through assuming improvements in the public transportation system, including Jeepneys, the promotion of NMT, and the promotion of better operations of HCVs or freight logistics.

Table 1 shows the policies and measures selected in analyzing the effects of these policies on CO_2 and PM emissions. These policy options were chosen to analyze the potential of cause of their relative reduction potential for specific transport modes.

Table 1. Selected Policies and Measures and Potential Reduction of CO_2

P/M #	Policy/ Measure	Description
1	Fuel efficiency for personal cars and light-commercial vehicles	Assuming 30% improvement of fuel efficiency (FE) from 2012 to 2035 through gradual fleet renewal of new vehicles
2	Better Jeepney engine technology and operations	Increase in number of alternate powered jeepneys (fuel type reorganization) - alternate fuels start increasing from 2015, 30% increase by 2030, increasing to 50% by 2040 and the fleet share remains same after that. + 10% reduction in VKT from 2010-2020 by integration and route rationalization
3	Demand management and improvement of public transportation and NMT	30% reduction in VKT in Metro Manila resulting from a combination of demand management measures and improving public transportation and NMT from 2010 to 2015
4	Better logistics for HCV	20% reduction in VKT of HCVs resulting from better freight and logistics management from 2010 to 2020
5	Better fuel efficiency of HCV	Assuming 13% improvement in fuel efficiency (FE) from through gradual fleet renewal of new vehicles and by technological solutions such as single wide tyres, inflated tyres, aerodynamics improvement etc.

The impact of fuel efficiency on LDVs were estimated by considering a scenario where changes on vehicle fuel efficiency starts increasing from 2012 considering a hypothetical scenario where fuel efficiency standards are implemented for new vehicles in 2012. The fuel efficiency of the entire fleet gradually increases until 2027 when entire LDV fleet has been renewed of "in-efficient" vehicles (see Figure 6). It is important to note that fuel efficiency standards (like vehicle emissions standards) take a relatively longer time to manifest its impact because it is only a requirement for new vehicles. However, the government cannot rely only on such measures for "new-vehicles" as vehicles deteriorate over age and efficiency obtained on "road" is reduced from "factory conditions". By influencing I&M policies and by mandating compulsory eco-driving training, existing fleet can be "efficiently" used.

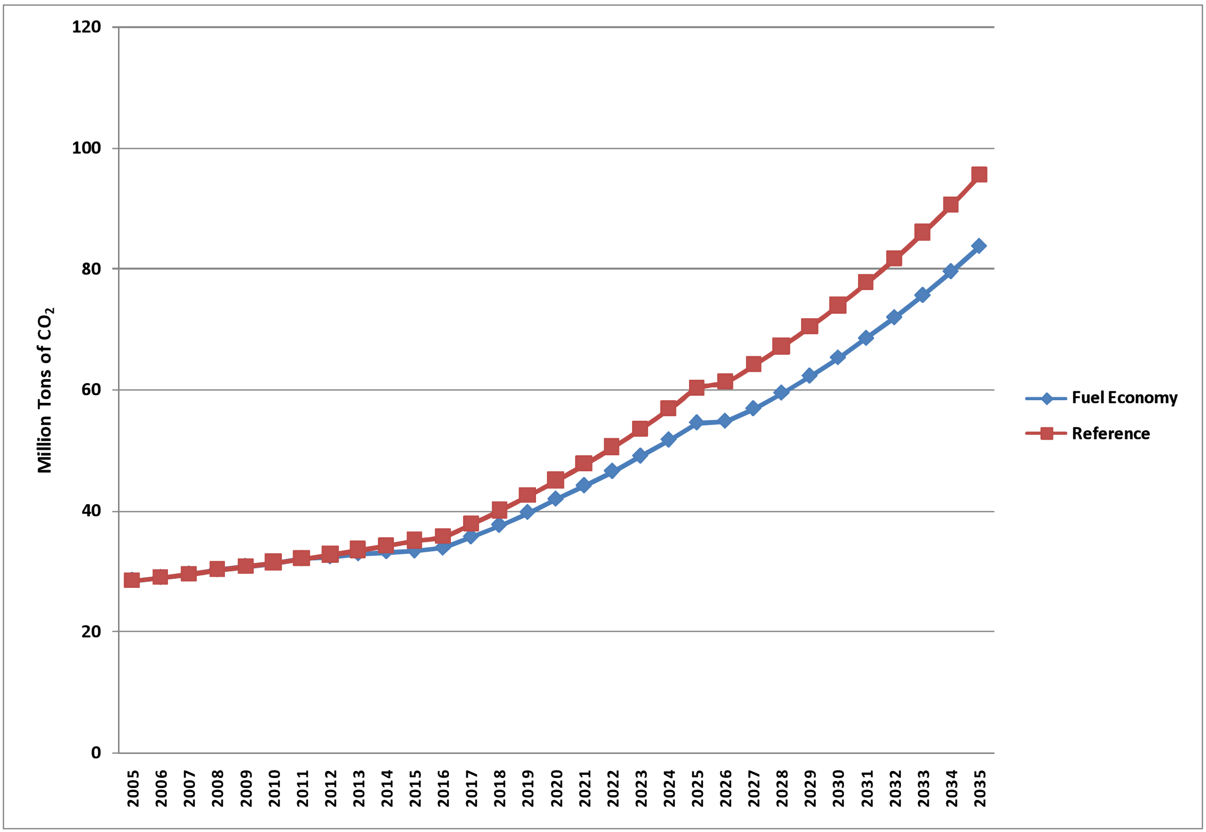

Figure 6. Fuel efficiency improvement of personal cars and light-commercial vehicles (collectively LDVs) from 2012 to 2035

Addressing emissions from Jeepneys is tantamount to reducing the over-all contribution of the transport sector to CO_2 and PM emissions if we look at figures 3 and 5. As such the potential impacts of better vehicle technology and reduction of VKT were explored. The numbers of Jeepneys running on cleaner and better technologies were assumed to start increasing from 2015 and increasing to about 30% of the entire fleet by 2030 and 50% by 2040. A 10% reduction in the overall VKT of Jeepneys was also assessed from 2010 to 2020, through a hypothetical scenario where integration and route rationalization happens. The results are shown in Figure 7.

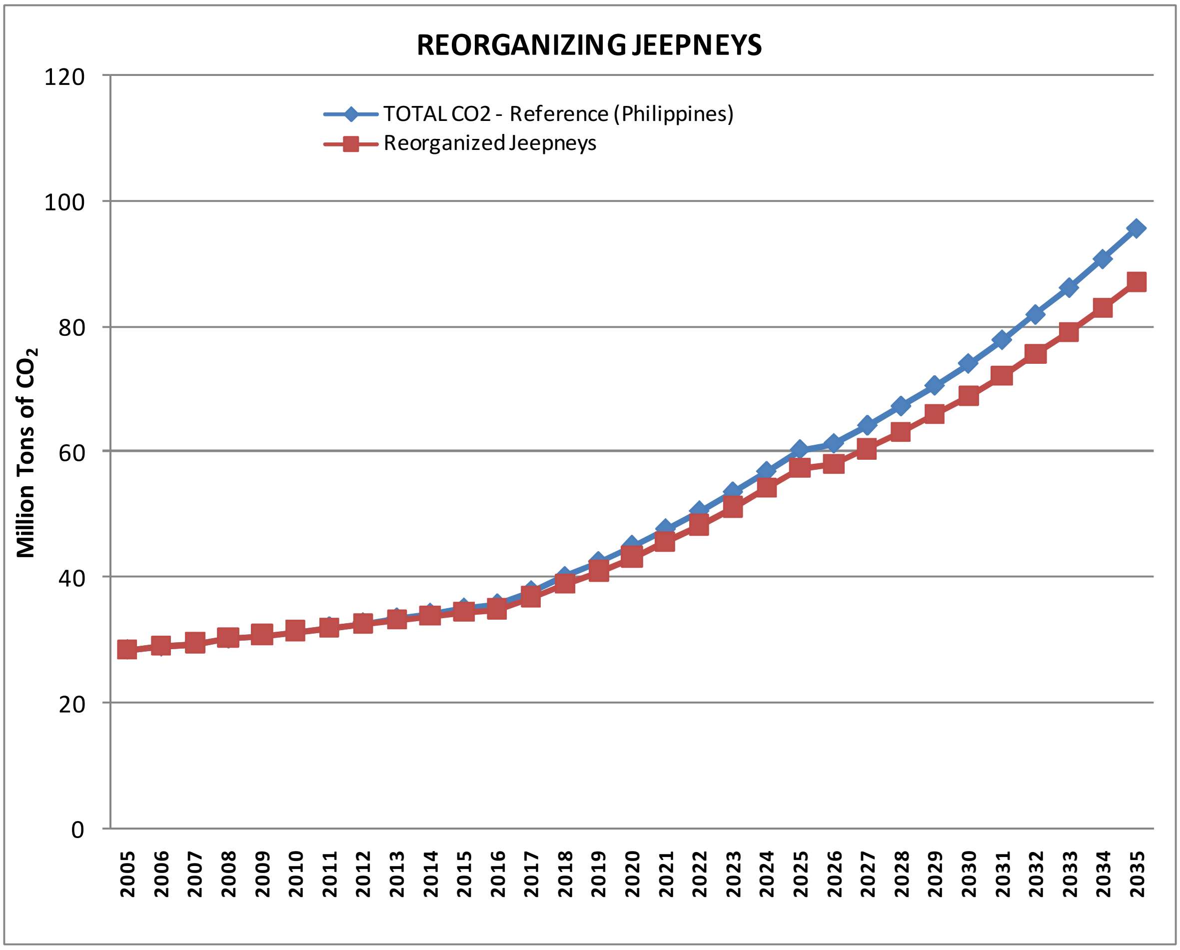

Figure 7. Reorganizing Jeepneys by changing fuel type and using it efficiently

Another policy/measure considered was the overall reduction of VKT through demand management and improvement of public transport and NMT in Metro Manila. Nearly 30% reduction in VKT was assumed in Metro Manila by demand management measures from 2010-2015. The modes whose VKT has been reduced is 2-3 wheelers, Cars and Jeepneys. It is to be noted that in this scenario, it cannot be assumed that the entire shift happens to bus as it may increase the average occupancy of existing buses to 248. Hence part of the solution lies in improving the MRT facilities to accommodate additional travel, improving bus speeds, reorganizing the jeepneys and tricycle fleet to prevent dry runs and to improve the NMT facilities. NMT is often neglected but its impact can be very high. Analysis indicates that as high as 11% reduction in emissions is possible by shifting 10% of motorized trips to non motorized modes. MMUTIS data also indicates high amount of short and medium trips which can be facilitated by such modes.

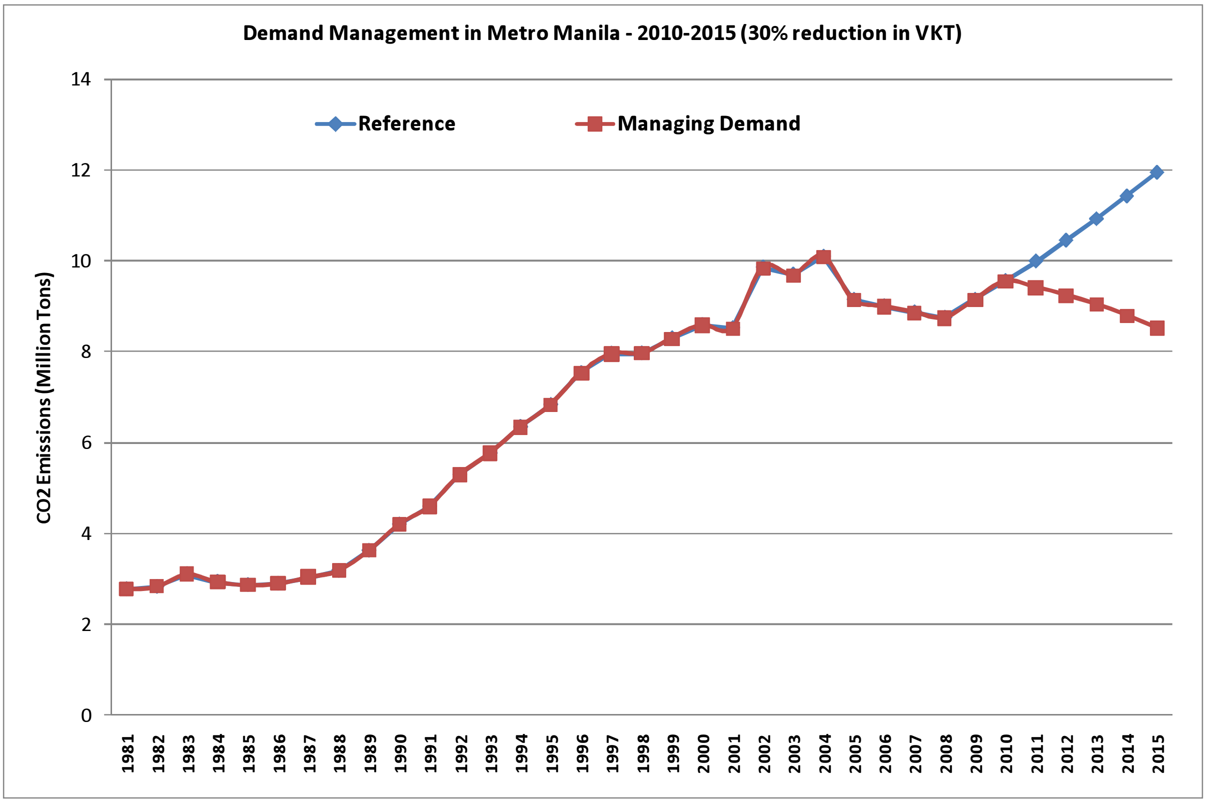

Figure 8. Demand management and improvement of public transportation and NMT in Metro Manila

Efficient freight policy was also estimated with 20% VKT reduction from 2010-2020. Current freight transport in Philippines can be considered as energy inefficient as significant share of vehicle fleet accommodates dry run (empty loads as indicated by many DOTC studies) and heavy overloading in many other cases. By restructuring the logistics and increasing the share of multi axle trucks, ton-km/vehicle can be increased thus reducing emissions. In this scenario 20% reduction in VKT has been considered. Following figure gives the reduction expected from such a scenario.

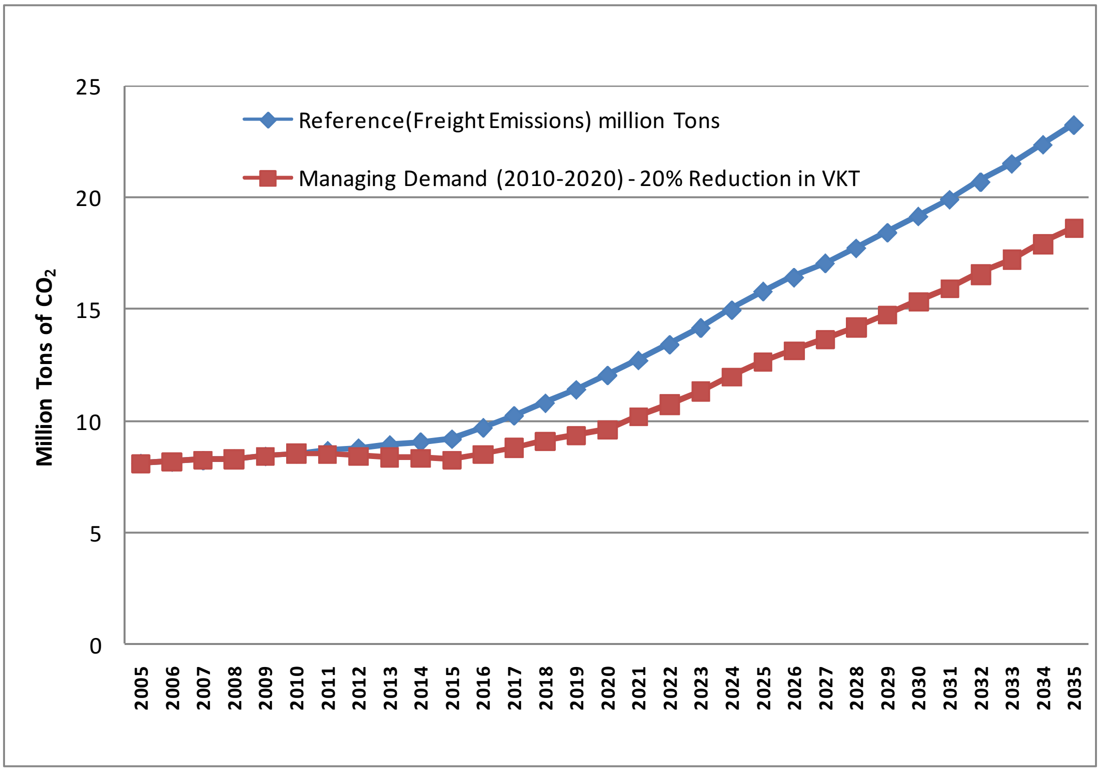

Figure 9. Better logistics management of HCVs

The policy scenario includes improvement in fleet structure and operational efficiency by considering inclusion of new vehicles and assuming 13% improvement in fuel efficiency (FE) from through gradual fleet renewal of new vehicles and by technological solutions such as single wide tires, inflated tires, aerodynamics improvement etc.

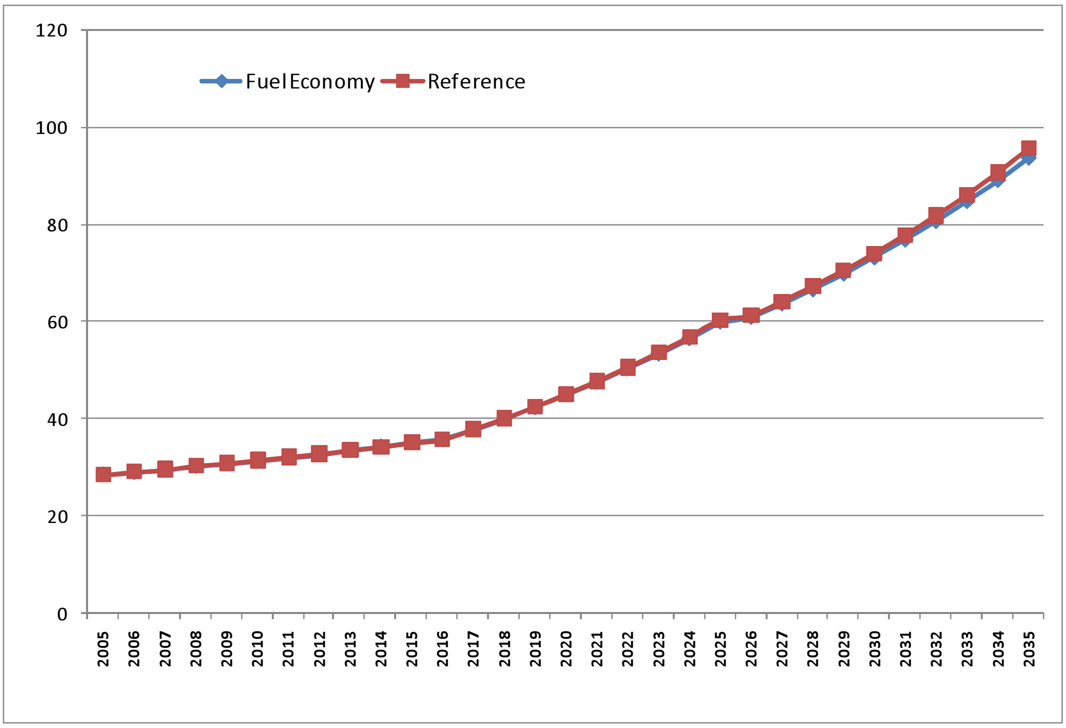

Figure 10. Fuel Efficiency Improvement of HCVs

4. SUMMARY

The Philippines is not a major contributor to global climate change, however, looking at the transport sector and if the "reference case" scenario pervades in the future, the contribution of CO_2 emissions in the transport sector will be substantial. Government policies and infrastructure investments will "lock-in" emissions in the future and if the policies do not promote "low-carbon" policies, it may be difficult to reduce CO_2 emissions from fuel combustion in the road transport sector.

As seen in the CO_2 emissions projections, various transport modes, like the Jeepneys/ UVs, HCVs, and LDVs contribute substantially to the emissions. Likewise, VKT has a direct and substantial influence on the over-all CO_2 emissions. From the policy scenarios, it is clear that reductions from demand management and improvements in fuel efficiency and emission standards can have substantial reductions and should be recognized.

Fuel efficiency standards are "low-hanging fruit" policies that could be implemented by the government in the form of fuel efficiency standards for new vehicles. It is expected that motorization will continue in the future and the implementation of such standards can help ensure reduction in fossil fuel consumption in the future. Furthermore, fuel efficiency measures can help promote fuel conservation and if combined with appropriate fuel taxes and incentives, it can be used to raise funds for implementing sustainable urban transport policies and infrastructure.

From all the policy scenarios, it can be seen that demand management measures, particularly those of VKT for Metro Manila and VKT for HCV operations, had relatively substantial reductions compared to fuel efficiency and technological measures considering CO_2 emissions. Demand management measures can range from various measures, including road pricing or congestion pricing, higher parking fees or restricted parking in central business districts, or even the overall reduction of trips due to better urban planning.

In this context, the summary of David Banister of the University of Oxford in the July 2009 MIT Planning Journal is highly appropriate - "All people like talking about sustainable transport, but there is little enthusiasm about changing the ways in which travel is actually undertaken. When city transport is considered, the common reaction is to look at technological innovation as the way forward, so that existing patterns of travel can continue, but with the use of less carbon."

When further aggravated by fuel security and rising price of oil, the Philippines transportation system will face huge challenges and if not sufficiently addressed, may become the major obstacle towards achieving both economic and environmental sustainability in the future.

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