EXAMINATION OF GLOBAL WARMING POTENTIAL FROM TRANSIT BUSES TESTED IN MEXICO CITY ADDENDUM TO REPORT: CHASSIS DYNAMOMETER EMISSIONS CHARACTERIZATION OF BUSES IN MEXICO CITY

Introduction

Transport vehicles contribute to the atmospheric inventory of greenhouse gases including carbon dioxide (CO_2) and nitrous oxide (N_2O) as well as methane (CH_4) in the case of natural gas powered vehicles. Increases in the levels of these greenhouse gases arguably have the potential to contribute to an increase in global atmospheric temperatures, primarily through their role in reflecting additional terrestrial long-wave radiation that would normally escape to space back towards the earth's surface where it can be re-absorbed.

An exhaust emissions evaluation of six conventional diesel powered, one diesel electric hybrid powered and two natural gas powered transit buses was performed in Mexico City, Mexico. During this study, the vehicles were exercised over the Mexico City Driving Schedule (MCS) and the European Transit Driving Cycle (ETC) while both regulated (oxides of nitrogen, hydrocarbons, carbon monoxide and particulate matter) and non-regulated (carbon dioxide) emissions were measured. For the natural gas powered buses, integrated bag samples were collected and analyzed to determine the concentration of gaseous hydrocarbon species (methane, ethane, propane, etc.) present in the exhaust.

Nitrous Oxide Contribution

The N_2O data collected by WVU was invalidated due to interference from carbon monoxide (CO) in the exhaust gas. Normally, the instrument used to measure N_2O would be equipped with a CO cell to automatically compensate for this interference but, as the researchers found out after initially examining the N_2O data and finding it extremely high compared to typical values reported in the literature, the supplier of the instrument failed to install the correct cell. An attempt to recover the data by correcting for CO as measured by the laboratories conventional CO analyzer was unsuccessful. Fortunately, a review of literature from the Intergovernmental Panel on Climate Change (1) and the US Environmental Protection Agency (2) found that typical N_2O contribution from diesel and natural gas powered heavy duty vehicles was less than 1% of that from CO_2 so N_2O can safely be omitted from the GWP for comparative purposes.

Data Analysis

To asses the global warming potential of the emissions from the buses in the study, CH_4 and CO_2 emissions levels were converted into grams per passenger mile and multiplied by their respective 20 year GWP factors, 62 for CH_4 and 1 for CO_2 to obtain CO_2 equivalent global warming contribution. Data from the MX1, MX2 and MX3 portions of the MCS and from the ETC are presented in Figure 1. Table 1 and Figure 2 present the global warming potential from CO_2 and CH_4 for all of the buses examined in this study. This data shows that CH_4 present in the emissions contributed to a significant portion of the global warming potential for the Busscar and FAW CNG buses.

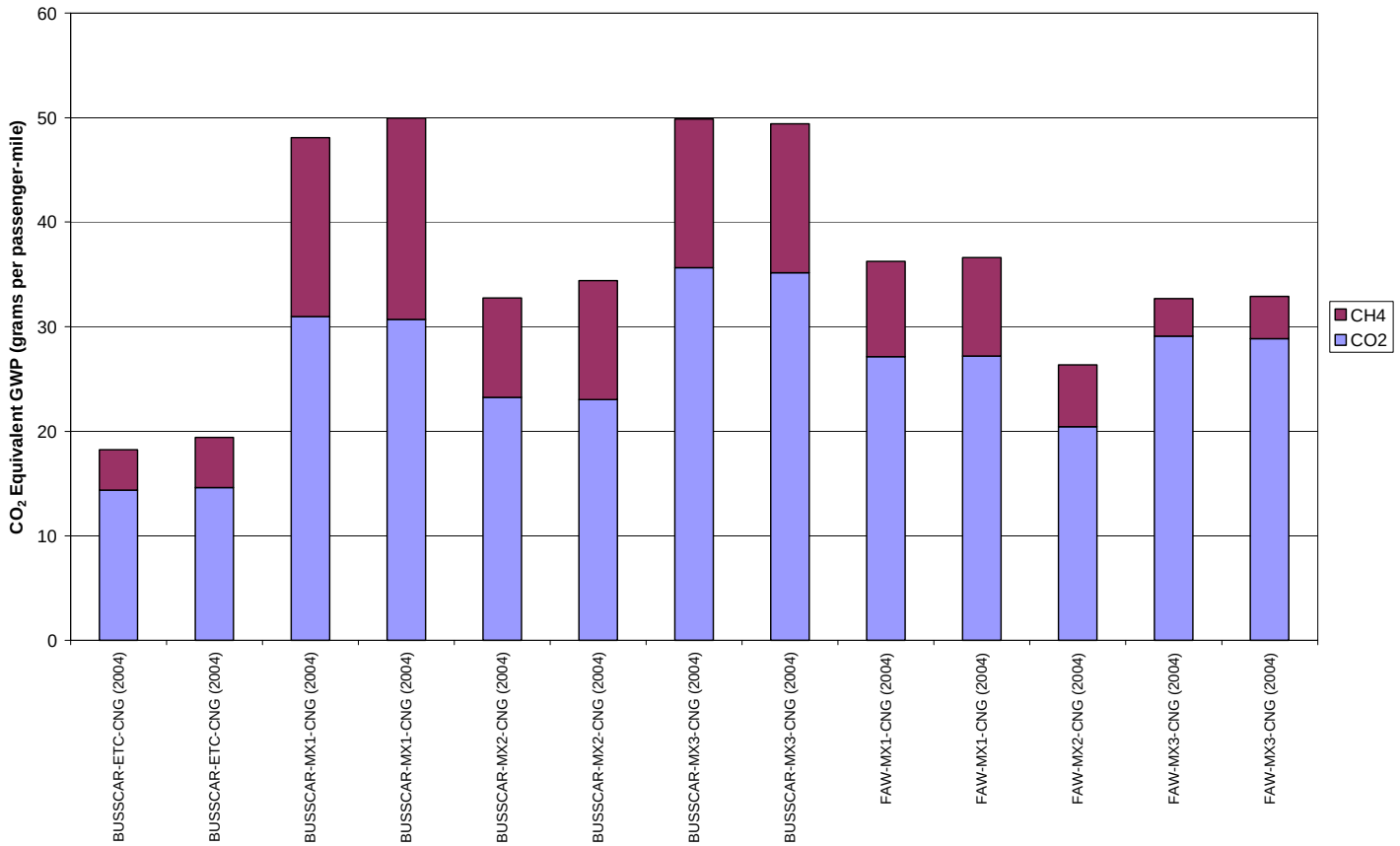

Figure 1: Global warming contribution from the ETC and MX1, MX2 and MX3 portions of the MCS.

Table 1: GWP data for the MCS and ETC cycles for all buses tested in the study.

Vehicle-Fuel	Cycle	CO_2 GWP (g/passenger-mile)	CH_4 GWP (g/passenger-mile)	Total GWP (g/passenger-mile)	% CH_4 Contribution to GWP
ALLISON-D2S15	MCS	25.6	-	25.6	
BUSSCAR-CNG	MCS	29.0	13.6	42.6	31.9%
FAW-CNG	MCS	25.2	6.0	31.2	19.2%
MB10-D2	MCS	26.8	-	26.8	
MB10-D2S15	MCS	26.7	-	26.7	
MB10-D2S50	MCS	26.8	-	26.8	
RTP1-D2S15	MCS	30.9	-	30.9	
RTP1-DS50	MCS	31.1	-	31.1	
RTP3-D2	MCS	31.0	-	31.0	
RTP3-D2S15	MCS	31.4	-	31.4	
RTP3-D2S50	MCS	30.5	-	30.5	
SCANIA15-D2	MCS	28.0	-	28.0	
SCANIA15-D2S15	MCS	28.1	-	28.1	
SCANIA18-D2S15	MCS	25.9	-	25.9	
SCANIA18-D2S50	MCS	25.6	-	25.6	
VOLVO12-D2	MCS	32.8	-	32.8	
VOLVO12-D2S15	MCS	33.1	-	33.1	
ALLISON-D2S15	ETC	14.3	-	14.3	
BUSSCAR-CNG	ETC	14.5	4.3	18.8	22.8%
MB10-D2S15	ETC	18.6	-	18.6	
RTP1-D2S15	ETC	18.3	-	18.3	
RTP3-D2S15	ETC	20.9	-	20.9	

SCANIA15-D2S15	ETC	16.8	-	16.8	
SCANIA18-D2S15	ETC	15.4	-	15.4	

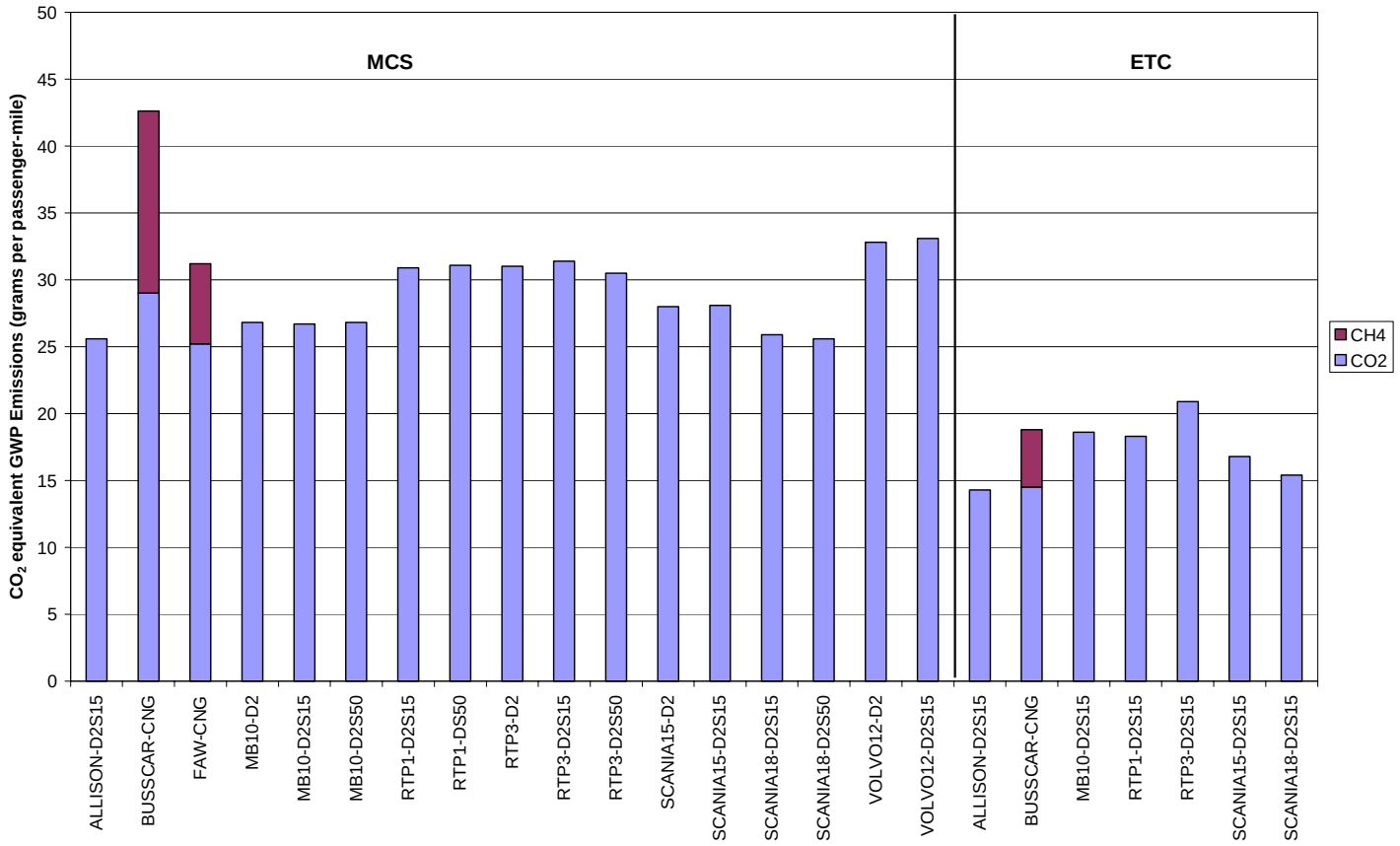

Figure 2 - CO_2 Equivalent GWP data for the MCS and ETC for all buses in the study.

REFERENCES

1. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories - Reference Manual (Volume 3), p 68, 1997.
2. Update of Methane and Nitrous Oxide Emissions Factors for On-Highway Vehicles, United States Environmental Protection Agency – Office of Transportation and Air Quality, EPA420-P-04-016, November, 2004.