grütter consulting

Monitoring Report

CDM Project 0672:
BRT Bogotá, Colombia: TransMilenio Phase II-IV
Monitoring Period 1.1.2008 – 31.12.2008

Monitoring Report prepared by:
Jürg M. Grütter and Susana Ricaurte, grütter consulting
Deysi Rodriguez, TRANSMILENIO S.A.

Report Version 1.1
29/04/2009

CAF

TRANSMILENIO

Lead Author
Dr. Jürg M. Grütter
grütter consulting
jgruetter@gmail.com
www.transport-ghg.com

Project number	0672
Project title	BRT Bogotá Colombia: TransMilenio Phase II to IV
Registration date	December 7th 2006
Start of crediting period	01.01.2006
Sector scope	Transport
Methodology used	AM0031 "Baseline Methodology for Bus Rapid Transit Projects"
Monitoring period	01.01.2008 – 31.12.2008
Project participants	TRANSMILENIO S.A CAF Grütter Consulting
Host country	Colombia
Project developer	grütter consulting
ERs in period	68,813 tCO_{2eq}

Contents

ABBREVIATIONS **4**

1. THE PROJECT **5**

2. PROJECT IMPLEMENTATION **5**

3. MONITORING APPROACH **6**

4. MONITORING PERIOD **6**

5. DATA **6**

5.1. PROJECT ACTIVITY 6
5.1.1. Projects Parameters Monitored *6*
5.1.2. Project Parameters not Monitored *7*
5.1.3. Project Formulas *8*
5.1.4. Project Results *8*
5.2. BASELINE 9
5.2.1. Baseline Parameters Monitored *9*
5.2.2. Baseline Parameters not Monitored *10*
5.2.3. Baseline Formulas *10*
5.2.4. Baseline Results *11*
5.3. LEAKAGE 11
5.3.1. Leakage Parameters Monitored *11*
5.3.2. Leakage Parameters not Monitored *11*
5.3.3. Leakage Formulas *11*
5.3.4. Leakage Results *11*
5.4. EMISSION REDUCTIONS 11

6. COMPARISON MONITORED EMISSION REDUCTIONS WITH PDD **11**

7. ENVIRONMENTAL IMPACT **11**

ANNEX 1: FUEL CONSUMED AND DISTANCE DRIVEN **11**

ANNEX 2: PASSENGERS TRANSPORTED **11**

ANNEX 3: SURVEYS **11**

ANNEX 4: LEAKAGE **11**

ANNEX 5: LITERATURE USED **11**

Abbreviations

AM	Approved Methodology
BRT	Bus Rapid Transit system
CAF	Andean Development Corporation
CDM	Clean Development Mechanism
GHG	Greenhouse Gases
GPS	Global Positioning System
IDU	Instituto de Desarrollo Urbano
IPK	Index Passenger Kilometre
PDD	Project Design Document
SDM	Secretaría Distrital de Movilidad de Bogotá

1. The Project

TransMilenio is a sustainable mass urban transport system based on a Bus Rapid Transit (BRT) system. TransMilenio phase II-IV which is the project is an extension of phase I. Phase I is not part of this CDM project. TransMilenio is a public-private partnership, in which the public sector is responsible for the investment to deploy the required infrastructure (segregated lanes, stations, terminals, etc.), while the private sector is responsible for the investment of the bus fleet, the ticket selling and validating system, and for the operation of the trunk and feeder services. The objective of TRANSMILENIO is to establish an efficient, safe, rapid, convenient, comfortable and effective modern mass transit system ensuring high ridership levels. TransMilenio has as main environmental aspect that the resource efficiency of transporting passengers in Bogotá is improved i.e. emissions per passenger trip are reduced compared to the situation without project. This is realized through new and larger buses, mode switching from taxis and private cars to public transport and improved occupancy rates due to dispatching vehicles based on a centrally managed organisation. The project is located within the metropolitan area of the city of Bogotá, Colombia.

Project participants are TRANSMILENIO S.A., the Andean Development Corporation CAF acting on behalf of the State of the Netherlands for the purchase of Emission Reductions represented by its Ministry of Housing, Spatial Planning and the Environment and Grütter consulting. Host party is Colombia. The project was registered as CDM project # 0672 on December 7th 2006 by the UNFCCC. The methodology used by the project is AM0031 version 1.0.

2. Project Implementation

The technology deployed by TransMilenio has following main components:

- **Infrastructure**: This consists basically of dedicated bus lanes including new bus-stations and integration stations located at the end of dedicated bus lanes to ensure a smooth transfer to feeder lines.
- **Bus Technology**: Bus technology used is Euro II and Euro III. Buses operating on dedicated lanes are new articulated buses with a capacity of 160 persons with platform-level access including room for disabled persons. Feeder buses are new buses with a capacity of 70-90 passengers.
- **Transit Management**: The operational fleet centre manages bus dispatch, informs passengers, produces reports and maintains records. All buses are equipped with a Global Positioning System (GPS) linked to the operation centre.
- **Fare System**: The system is based on pre-board ticketing using magnetic ticketing. This streamlines the boarding process and optimizes operations. The fare system integrates feeder and main lines. Fare collection is centralized and managed by a private company through a concession.

TRANSMILENIO has implemented the new transit management scheme as well as the fare system prior to starting with operations of phase II. Bus technology used in all buses operating in phase II is Euro II or Euro III. Infrastructure for Phase II has been completed as planned. All trunk routes of Phase II were fully operational in the first semester of 2006. In 2008 no new trunk routes have been built and put into operation[1]. Phase III is not yet in operation. See Table 1 for operational infrastructure as of 31.12.2008.

[1] File 1: Confirmation Letter of IDU concerning built infrastructure in the year 2008

Table 1: Infrastructure Completed by the Project (as of 31.12.2008)

Phase	Trunk route	Distance	Completion date
Phase II	Americas	13.0 km	2003
Phase II	NQS	19.3 km	2006
Phase II	Suba	10.0 km	2006

Source: IDU

3. Monitoring Approach

The monitoring methodology is based on AM0031 Version 1.0 and is detailed in the PDD.

The area in charge of the CDM project monitoring is the "environment area" inside the operations department. This unit is under direct supervision of the CEO[2] of TRANSMILENIO S.A. TRANSMILENIO S.A. is ISO 9001-2000 certified. The staff in charge of monitoring has received during entire 2008 back-up support and quality control services by grütter consulting including various on-site visits. The current monitoring report has been formulated by Jürg M. Grütter, grütter consulting in cooperation with TRANSMILENIO.

A customized monitoring software in Spanish has been designed for the CDM project allowing to enter all required monitoring data, performing quality checks and calculating the outputs in terms of GHG reduced and the environmental impact of the project. Staff in charge has been trained on software usage. The software version used for this report is 2.443. For publication purposes the software supplies a (simplified) and non-protected English spreadsheet.

A (Spanish) CDM monitoring manual has been realized for TRANSMILENIO and staff has been familiarized with this manual in a special training course realized mid 2006. The Manual defines responsibilities and procedures, has a section on all data variables to be monitored, includes monitoring report formats as well as the Spanish formats of the modal split survey, the load factor taxi and the load factor buses surveys. The data section has for each data variable information on how to collect the required information, the frequency of collection, data units (including transformation of common data units), quality control measures to be realized, steps to be taken in case of data problems, how to enter data in the monitoring software (step by step guide) and some additional hints and comments.

Data provided by the operators on fuel consumption and distance driven has been verified on-spot by a team from TRANSMILENIO and Grütter consulting in January 2009.

4. Monitoring Period

The monitoring period is 1.1.2008 to 31.12.2008

5. Data

5.1. Project Activity

5.1.1. Projects Parameters Monitored

Data/Parameter	TC_{TB} and TC_{FB}
Data unit	Liters
Description	Fuel consumption trunk (TC_{TB})and feeder buses (TC_{FB}); total TRANSMILENIO

[2] *Chief Executive Officer*

	and only project
Values	TC_{TB} = 50,580,912 litres (total TM) $TC_{TB,PJ}$ = 15,180,321 litres (only project) TC_{FB} = 11,203,274 litres (total TM) $TC_{FB,PJ}$ = 3,362,322 litres (only project)
Data source	TRANSMILENIO S.A. Each operator of feeder and/or trunk buses reports monthly the fuel consumed to TRANSMILENIO (contractual obligation)
Measurement method	Based on standard measurements of filling stations managed by operators; Data is reported in American gallons; the software translates this into litres based on the standard conversion factor American gallon to litre of 3.7854 l/gal
Quality control	All values reported have been controlled with site-visits at each operator by staff of TRANSMILENIO and Grütter consulting in January 2009. The software automatically calculates specific consumptions and highlights out-of-normal range values. Out-of-normal range values are defined in the monitoring values and have been established based on average recorded values per operator plus an upper and a lower boundary of ±10% respective to the average recorded value per operator for trunk and for feeder units. In case of out-of-normal range values an explanatory note is given which is recorded in the software.
Comment	All buses use diesel fuel See Annex 1 for explanations concerning out-of-range fuel consumptions of specific operators. Calculation of project fuel consumption based on relation project passenger to total passengers of TM.

Data/Parameter	DD_{TB} and DD_{FB}
Data unit	Kilometers
Description	Distance driven trunk (DD_{TB})and feeder buses (DD_{FB}) (all TRANSMILENIO)
Values	DD_{TB} = 85,513,572 kilometres DD_{FB} = 29,217,799 kilometres
Data source	TRANSMILENIO S.A. Based on actual distance driven and not on distance paid to operator (latter is slightly minor)
Measurement method	Based on measurements by operator and GPS
Quality control	Data is used only for quality control of fuel used (see above)

Data/Parameter	$P_{TM,T}$ and $P_{TM,I}$ and $P_{,PJ}$
Data unit	Passengers
Description	Passengers transported by TRANSMILENIO all phases ($P_{TM,T}$), Phase I only ($P_{TM,I}$) and Phase II-IV "the project" ($P_{,PJ}$)
Values	$P_{TM,T}$ = 394,364,082 passengers $P_{TM,I}$ = 276,007,709 passengers $P_{TM,PJ}$ = 118,356,373 passengers
Data source	TRANSMILENIO S.A. Based on passengers entering stations of trunk routes. Passengers using only feeder buses are not counted i.e. the data reported is conservative and sub-estimates the project impact.
Measurement method	Mechanical control at stations (turn-pikes) Phase I passengers are such that enter stations of trunk routes of phase I. Passengers entering stations which cater to trunk routes of more than 1 phase are separated proportionally to the number of trunk routes serving that station. Project passengers are calculated as total passengers minus Phase I passengers.
Quality control	Operations department cross-checks data with fares paid

5.1.2. Project Parameters not Monitored

The following parameters are not monitored but used for calculation purposes. They have all been fixed ex-ante in the PDD and are constant for the entire crediting period.

Table 2: Parameters not Monitored During the Project Activity

Parameter	Unit	Description	Value	Source
$EF_{CO2,D}$	gCO_{2e}/litre	CO_2 emission factor diesel large bus	2,661	AM0031, Table A.1.
$EF_{CH4,D}$	gCO_{2e}/litre	CH_4 emission factor diesel large bus	2	AM0031, Table A.1.
$EF_{N2O,D}$	gCO_{2e}/litre	N_2O emission factor diesel large bus	21	AM0031, Table A.1.

5.1.3. Project Formulas

Formula (1)

$$P_{PJ} = P_{TM,T} - P_{TM,I}$$

Where:

P_{PJ}	Passengers transported by the project (TRANSMILENIO phase II-IV)
$P_{TM,T}$	Passengers transported by TRANSMILENIO in total
$P_{TM,I}$	Passengers transported by TRANSMILENIO Phase I

Formula (2)

$$TC = (TC_{TB} + TC_{FB}) \times \frac{P_{PJ}}{P_{TM,T}}$$

Where:

TC	Total consumption of fuel of the project
TC_{TB}	Total consumption of fuel of trunk buses
TC_{FB}	Total consumption of fuel of feeder buses
P_{PJ}	Passengers transported by the project
$P_{TM,T}$	Passengers transported by TRANSMILENIO in total

Formula (3)

$$PE = TC \times (EF_{CO2,D} + EF_{CH4,D} + EF_{N2O,D})$$

Where:

PE	Project emissions
TC	Total consumption of fuel
$EF_{CO2,D}$	CO_2 emission factor diesel
$EF_{CH4,D}$	CH_4 emission factor diesel (based on GWP)
$EF_{N2O,D}$	N_2O emission factor diesel (based on GWP)

5.1.4. Project Results

The total project emissions of the monitoring period (equivalent to the year 2008) are 49,768 tCO_{2eq}

Details of the data reported per month (fuel consumption, passengers transported and distance driven) are found in the Annexes.

5.2. Baseline

5.2.1. Baseline Parameters Monitored

Data/Parameter	TD_T and TD_C
Data unit	Kilometers
Description	Average trip distance of passengers using TRANSMILENIO which in absence of latter would have used taxis (TD_T) or passenger cars (TD_C)
Values	TD_T = 11 kilometre TD_C = 12 kilometre
Data source	Market Team S.A. (Files 4a to 4f)
Measurement method	Based on 6 annual surveys. Survey principles are listed in the PDD. Passengers which would have used taxis or passenger cars are asked entry and departure station. The monitoring software calculates the distance between these stations and calculates the average value for the respective month.
Quality control	Based on values significantly lower or higher than the average value. Values reported for taxis 2006 and 2007 were 10km, respectively 9km and thus comparable to the 11km reported 2008. Values reported for passenger cars 2006 and 2007 were 11km respectively 12km and thus comparable to the 12km reported 2008.
Comment	If the annual average value monitored is higher than pre-fixed baseline value of 7km for taxis and 9km for passenger cars then latter value is taken (conservative approach). The values monitored in 2008 for taxis is 11km and thus higher than the baseline of 7km and for passenger cars the value monitored in 2008 was 12km which is also higher than the baseline value of 9km. Therefore in 2008 no adjustment is made to changing trip distances neither for taxis nor for passenger cars.

Data/Parameter	$N_{x,C}$
Data unit	Cars
Description	Share of passenger cars using fuel type “x” of passengers using TRANSMILENIO which in absence of latter would have used a passenger car
Values	0% of vehicles using alternative fuels 88.1 % of vehicles using gasoline 2.3 % of vehicles using diesel 9.6 % of vehicles using gaseous fuels
Data source	Market Team S.A. (Files 4a to 4f)
Measurement method	Based on 6 annual surveys. Survey principles are listed in the PDD. Passengers who would have used passenger cars are asked the fuel type their car is using.
Quality control	None
Comment	Data is used if the share of vehicles using gaseous fuels is larger than 10% or if the share of vehicles using alternative fuels is larger than 1% (see PDD). The share of diesel vehicles is irrelevant as diesel GHG emissions would be higher than gasoline ones (see PDD Table A.3.10.1). Changes to the fixed baseline emission factor are only made if the result leads to lower than baseline emission factors. 2008 the share of gaseous vehicles is less than 10%. The share of vehicles using alternative fuels is 0%. Thus no adjustments to the baseline emission factor of passenger cars is made.

Data/Parameter	$P_{PJ,i}$
Data unit	%
Description	Share of passengers transported by TRANSMILENIO who would have used transport mode “i”
Values	91.4% would have used conventional buses 2.4% would have used passenger cars 5.5% would have used taxis 0.5% would have used NMT (Non-Motorized Transport)

	0.2% would not have made the trip
Data source	Market Team S.A. (Files 4a to 4f).
Measurement method	Based on 6 surveys realized in 2008. Survey principles are listed in the PDD.
Quality control	Based on values significantly higher than the average value. Table 3 compares the values recorded 2008 with those recorded 2006 and 2007. **Table 3: Mode Shares Passengers Using TRANSMILENIO (%, rounded values)** **Mode** / **2006** / **2007** / **2008** Conventional buses / 89% / 90% / 91% Passenger cars / 4% / 3% / 2% Taxis / 5% / 5% / 5% NMT / 1% / 1% / 0% Induced trips / 0% / 0% / 0% Table 3 shows that values registered in 2008 were comparable to values recorded in previous years.

Data/Parameter	Policies
Data unit	None
Description	Policies that affect baseline
Values	None
Data source	Alcaldía Mayor de Bogotá, Ministerio de Minas y Energía, Ministerio de Ambiente Vivienda y Desarrollo Territorial, Ministerio de Transporte
Measurement method	Review of legislation
Quality control	None
Comment	Relevant national or local legislations in 2008: • Ley 1205 de 2008 National Level which regulates the diesel quality. No influence on project or baseline parameters relevant for GHG (file 2) • Pacto calidad del aire Bogotá of 7.2.2008 which regulates the diesel quality in Bogota; no influence on project or baseline parameters relevant for GHG (file 3) No policy which affects baseline parameters was implemented in 2008 and thus no adjustment is made.

5.2.2. Baseline Parameters not Monitored

The following parameters are not monitored but used for calculation purposes. Values are fixed ex-ante based on the registered PDD.

Table 4: Baseline Parameters not Monitored (all for 2008)

Parameter	Unit	Description	Value	Source
$EF_{P,C}$	gCO_{2eq}/passenger	Emission factor per passenger transported of passenger car	1,748	PDD Table A.3.10.2.
$EF_{P,T}$	gCO_{2eq}/passenger	Emission factor per passenger transported of taxis	2,299	PDD Table A.3.10.2.
$EF_{P,Z}$	gCO_{2eq}/passenger	Emission factor per passenger transported of baseline buses	911	PDD Table A.3.11.2.

5.2.3. Baseline Formulas

Formula (4)

$$BE = \sum_i \left(EF_{P,i} \times P_{PJ,i} \right)$$

Where:

BE Baseline CO_{2eq} emissions

$EF_{P,i}$ Baseline emission factor per passenger transported in vehicle category "i"

$P_{PJ,i}$ Passengers transported by the project that without the project activity would have used category "i", where "i" includes Z (buses, public transport), T (taxis), or C (passenger cars)[3]. The passengers transported per category "i" are calculated based on the share of passengers per category "i" determined through the sample survey.

5.2.4. Baseline Results

The total baseline emissions of the monitoring period (equivalent to the year 2008) are 118,582 tCO_{2eq}

Details of the data reported are found in the Annex.

5.3. Leakage

5.3.1. Leakage Parameters Monitored

Data/Parameter	CEM, ASP
Data unit	Tons
Description	Amount of cement / asphalt used per km trunk road
Values	No trunk roads constructed and delivered in 2008
Data source	IDU
Measurement method	
Quality control	
Comment	See confirmation File 1

Data/Parameter	DT_{CEM} and DT_{ASP}
Data unit	Kilometres
Description	Length of trunk roads built with cement / asphalt
Values	No trunk roads constructed and delivered in 2008
Data source	IDU
Measurement method	
Quality control	
Comment	

Data/Parameter	$BSCR_w$
Data unit	Buses
Description	Buses scrapped by project
Values	20 buses
Data source	TRANSMILENIO S.A. (File 5)
Measurement method	Based on scrapping reports; see
Quality control	
Comment	Small and medium sized buses are translated into large buses (relation 4:1 and 2:1 according to PDD); cut-off date of buses registered until 31.12.2008

Data/Parameter	BA_{PJ}

[3] NMT and IT is not included as emissions are 0 for this category in the baseline

Data unit	Years
Description	Average age of scrapped buses
Values	26 years
Data source	TRANSMILENIO S.A. (File 5)
Measurement method	Based on scrapping reports
Quality control	
Comment	Small and medium sized buses are translated into large buses (relation 4:1 and 2: 1 according to PDD); cut-off date of buses registered until 31.12.2008

Data/Parameter	ROC_Z
Data unit	%
Description	Average occupancy rate relative to capacity of conventional buses
Values	61.2%
Data source	Data of Secretaria Distrital de Movilidad de Bogotá, 2008; calculations by Grütter Consulting (File 6 Load Factor Bus New).
Measurement method	In accordance with TORs for this study in accordance with PDD (file 7). Equivalent to baseline study. Visual occupation study from 5AM to 11PM various days and various locations (various routes). Based on the average load factor of each route multiplied by the total number of passengers in the route, divided by the total passengers.
Quality control	The study is revised if the monitored values are beyond 76% or below 56% (10 percentage plus/minus of original value). The result of the study realized is in the margins defined.
Comment	No load factor leakage of buses needs to be calculated as the result is above 56%. The baseline load factor was 66% (table A.3.6.1) and the methodology defines that leakage of the load factor of remaining buses needs only be realized if the monitored value is 10 percentage points lower than the baseline value (i.e. lower than 56%) (Methodology AM0031 chapter leakage, number 2, page 16). The distance driven and the number of remaining baseline buses thus needs not be monitored.

Data/Parameter	OC_T
Data unit	Passengers
Description	Average occupancy rate of taxi
Values	0.89
Data source	Data of Secretaria Distrital de Movilidad de Bogotá, 2008; calculations by Grütter Consulting, (File 6)
Measurement method	Based on visual occupation rate using TOR (File 8) equivalent to the PDD Equal to the study baseline the percentage of occupied taxis is recorded and this percentage is multiplied with the same factor as in the baseline (1.5 passengers per occupied taxi). The average percentage of occupied taxis was 59%[4] thus resulting in 0.89 passengers on average per taxi.
Quality control	The study is revised if the monitored values are beyond 0.91 or below 0.71 (0.1 point plus/minus of original value). The result of the study realized is in the margins defined.
Comment	No load factor leakage of taxis needs to be calculated as the result is above 0.71. The baseline load factor was 0.81 (table A.3.7.1) and the methodology defines that leakage of the load factor of taxis needs only be realized if the monitored value is 0.10 points lower than the baseline value (i.e. lower than 0.71) (Methodology AM0031 formula 19, Note, page 18). The distance driven and the number of taxis thus needs not be monitored.

5.3.2. Leakage Parameters not Monitored

[4] Baseline study made by Universidad Nacional de Colombia had 54%

The following parameters are not monitored but used for calculation purposes. Values are fixed ex-ante based on the registered PDD.

Table 5: Leakage Parameters not Monitored (all for 2008)

Parameter	Unit	Description	Value	Source
EF_{CEM}	tCO_{2eq}/t cement	Emission factor for cement	0.99	AM0031, Appendix A
EF_{ASP}	tCO_{2eq}/t asphalt	Emission factor for asphalt	0.03	AM0031, Appendix A
EF_{BM}	tCO_{2eq}/ bus	Emission factor for bus manufacturing	42	AM0031, Appendix A
BA_{BL}	Years	Average replacement age baseline scenario	40	PDD Table A.3.3.1.
UEF	%	Default factor for upstream emissions from fuel production	14	AM0031, Appendix A
LE_{CONG}	tCO_{2eq}	Emissions leakage from reduced congestion	-4,937	PDD Table A.3.8.2.

5.3.3. Leakage Formulas

Formula (5)

$$LE = LE_{UP} + LE_{CONG}$$

where:
LE Emissions leakage
LE_{UP} Emissions leakage due to upstream processes
LE_{CONG} Emission Leakage from reduced congestion

Potential emissions due to reduced load factors buses and taxis need not be considered as the load factors did not change significantly and are higher than the margins defined in the PDD/methodology which would require for calculating the leakage of a changed load factor.

If LE < 0 then leakage is not included
If EL > 0 then leakage is included

Formula (6)

$$LE_{UP} = LE_{CON} + LE_{LSP} + LE_{UFP}$$

Where:
LE_{UP} Emissions leakage due to upstream processes
LE_{CON} Emissions leakage due to construction
LE_{LSP} Emissions leakage due to reduced life-span of buses
LE_{UFP} Emission leakage due to upstream emissions from fuel production

Formula (7)

$$LE_{CON} = \frac{CEM \times EF_{CEM} \times DT_{CEM} + ASP \times EF_{ASP} \times DT_{ASP}}{Y}$$

Where:
LE_{CON} Emissions leakage due to construction
CEM Cement used per kilometre of trunk lane
ASP Asphalt used per kilometre of trunk lane
EF_{CEM} Specific emissions factor for cement
EF_{ASP} Specific emissions factor for asphalt
DT_{CEM} Total kilometres of trunk lanes built in project made of cement (km * number of trunk lanes)

DT_{ASP} Total kilometres of trunk lanes built in project made of asphalt (km * number of trunk lanes)
Y crediting years of project (7)

Formula (8)

$$LE_{LSP} = \frac{\sum_{w=1}^{y} BSCR_w \times EF_{BM} \times \frac{BA_{BL} - BA_{PJ}}{BA_{BL}}}{Y}$$

Where:
$LE_{LSP,y}$ Emissions leakage due to reduced life-span of buses
$BSCR_w$ Bus units scrapped by project in the year "w", where w = 1 to "y"
EF_{BM} Emissions factor for bus manufacturing
BA_{BL} Average age BAU when buses are replaced /retired in the baseline scenario
BA_{PJ} Average bus age of scrapped buses under the project activity
Y crediting years of project (7)

Medium sized and small buses are "converted" into large buses based on the passenger capacity, taking large buses as such with a capacity of 80 persons[5].

Formula (9)

$$LE_{UFP} = (PE - BE) \times UEF$$

Where:
LE_{UFP} Emission leakage due to upstream fuel production emissions
PE Project emissions
BE Baseline emissions
UEF Upstream emissions multiplier, based on default factor

5.3.4. Leakage Results

Table 6 explains the data sources and calculation methods for the different leakage sources in accordance with the formulas presented above and in AM0031.

Table 6: Calculation Method and Data Sources Leakage

Leakage Source	Calculation method	Data source	Value used (tCO_{2eq})
Construction	Based on data 2006 as no new construction activities took place in 2007 and in 2008 (formula 7 is based on cumulative values)	CER Monitoring report 2006 TRANSMILENIO, 6.3.2007, Table A.4.	5,481
Scrapping	Based on data 2007 plus data 2008 using formula (8) for each year; Value 2007 was 3,829 tCO_2 Value 2008 excl. cumulative 2007: 42tCO_2	For value 2007 CER Monitoring report 2007, 20.6.2008, Table A.4. Data 2008 based on parameters listed in 5.3.1 and 5.3.2.	3,871
Upstream	Based on formula (9)	Parameter listed in table 5 (UEF) and values PE and BE listed in 5.1.4. and 5.2.4.	-9,634
Congestion	Calculated ex-ante in PDD for entire crediting period	As listed in table 5 (PDD A.3.8.2)	-4,937

[5] 2 medium = 1 large, 4 small = 1 large

The total leakage emissions of the monitoring period (equivalent to the year 2008) are -5,219 tCO_{2eq}. According to the methodology and for a conservative approach negative leakage is not claimed by the project as additional emission reduction and the leakage value is thus set at 0 tCO_{2eq}.

For additional information on leakage see the Annex.

5.4. Emission Reductions

Table 7: Emission Reductions

Emission	tCO_{2eq}
1. Baseline Emissions	118,582
2. Leakage Emissions	0
3. Project Emissions	49,768
4. Emission Reductions (1-2-3)	68,813

Total emission reductions monitored in the crediting period (year 2008) are 68,813 tCO_{2eq}

6. Comparison Monitored Emission Reductions with PDD

Table 8 compares expected with actual results of core data influencing emission reductions.

Table 8: Comparison Actual and Expected Core Data

Parameter	Actual value	Expected value	Comment
Emission reductions	68,813 tCO_2	230,201 tCO_2	70% lower than expected Reasons see passenger numbers
Baseline emissions	118,582 tCO_2	365,885 tCO_2	68% lower than expected same relation as emission reductions
Project emissions	49,768 tCO_2	135,685 tCO_2	65% lower than expected same relation as emission reductions
Leakage emissions	0 tCO_2	0 tCO_2	As expected
Passengers transported by project	118 million	356 million	67% lower than expected According to planning 63km of Phase II should already be in operation. However construction of the first part of Phase II has just begun, thus resulting in much lower passenger numbers. Also Phase II faced projection deficiencies such as misunderstanding of the interdependence of the quantity of passengers phase II with the implementation of Phase III and a deficient rerouting of conventional buses.
Fuel consumed by project	19 million litres	51 million litres	63% lower than expected Related to passengers transported.
IPK trunk buses (Index Passenger-Kilometre)	4.6	5.4	15% lower than expected the lower average load factor is due to the operational difficulties described above
Fuel efficiency trunk buses	59l/100km	61l/100km	Value as expected
Fuel efficiency feeder buses	38l/100km	38l/100km	Values as expected
Share of passengers which would have used passenger cars	2.4%	5.5%	Lower than expected but comparable to previous year; projections of mode change where based on a very slim data bases, thus deviations could be expected
Share of passengers	5.5%	5.6%	Value as expected

which would have used taxis			
Share of passengers which would have used buses	91.4%	88%	Slightly higher than expected; see explanation in passenger cars
Share of passengers which would have used NMT or not made the trip	0.7%	0.8%	Value as expected

The most important difference is the number of passengers transported primarily due to a strong delay in the implementation of Phase III of TRANSMILENIO. Work is underway to reorganize remaining public transit routes integrating them as feeder lines to TRANSMILENIO. This could boost emission reductions of the project. However also for 2009 an underperformance of emission reductions can be expected.

7. Environmental Impact

The project also monitors local environmental impacts including:

- SO_2 emissions based on the fuel used and its sulphur contents
- NO_x emissions based on distance driven and emission factors
- Particle emissions based on distance driven and emission factors

The sulphur contents of fuel in Bogotá was mid 2008 500ppm (from 1200ppm in 2007) according to official regulations and in accordance with measurements made[6].

Table 9: Impact of Project on Local Emissions

Pollutant	Emission Reductions (tons)
SO_2	22
NO_x	2,332
Particle Matter	306

[6] See File 9

Annex 1: Fuel Consumed and Distance Driven

Table A1: Fuel Consumption, Distance Driven and Fuel Efficiency of Trunk Buses (total TRANSMILENIO)

Operator	Fuel consumed in gallons	Distance driven in kilometres	Fuel efficiency in kilometres per gallon
SI 99	2,261,354	13,992,652	6.2
Express del Futuro	2,118,512	13,237,854	6.2
Transmasivo	2,309,900	15,469,827	6.7
Metrobus	1,636,354	9,405,439	5.7
Ciudad Movil	1,496,879	9,058,828	6.1
SI 02	1,797,685	12,193,587	6.8
Connexion Movil	1,741,421	12,155,384	7.0
Total	**13,362,105**	**85,513,572**	**6.4**

1 gallon = 3.7854 litres

Table A2: Fuel Consumption, Distance Driven and Fuel Efficiency of Feeder Buses (total TRANSMILENIO)

Operator	Fuel consumed in gallons	Distance driven in kilometres	Fuel efficiency in kilometres per gallon
ETMA	524,305	5,021,449	9.6
ALNORTE	333,572	3,337,489	10.0
Transporte Alimentador de Occidente	572,764	5,323,735	9.3
SI 03	718,347	7,221,933	10.1
ALCAPITAL	275,454	2,830,238	10.3
CITIMOVIL	535,159	5,482,954	10.2
Total	**2,959,601.0**	**29,217,799.2**	**9.9**

1 gallon = 3.7854 litres

Specific Fuel Consumption Operator Connexion Movil

The specific fuel consumption of Connexion Movil is looked at in greater detail as specific fuel consumption levels in many months of 2007 were slightly above the ±10% range of average consumption of this operator as registered in 2006 and 2007. All data of the operator were controlled by an audit realized at the premises of the operator by staff of TRANSMILENIO and grütter consulting.

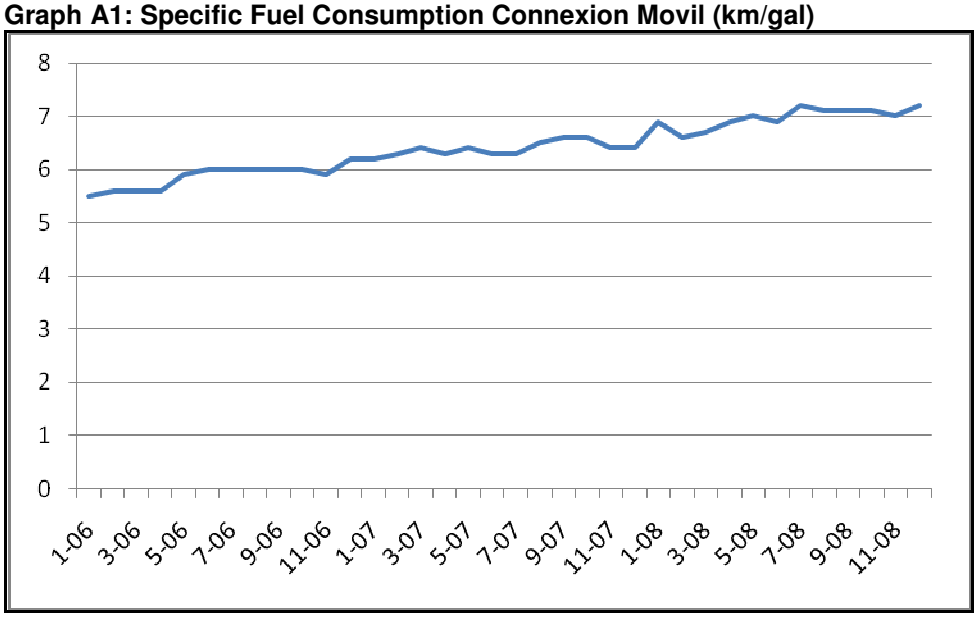
Graph A1 shows the average specific fuel consumption of the operator since 2006 on a monthly base. The graph shows that the operator has a continuous improvement of the specific fuel consumption.

Graph A2 compares the performance of Connexion Movil in comparison with other operators. This shows that the average performance of the operator is at the upper range but comparable to other operators.

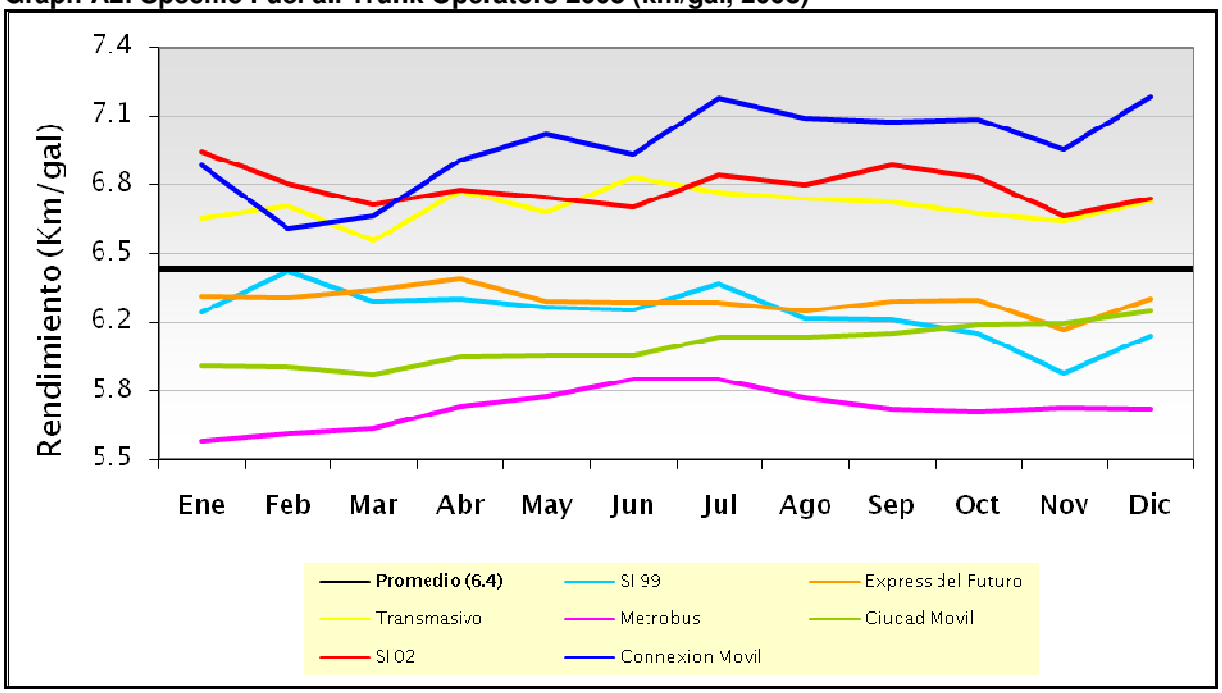
The specific fuel consumption of Connexion Movil is 9% better than the average of all operators which is inside the margin of ±10% as mentioned in the PDD chapter D3, point 2.

The conclusion is thus reached that the specific fuel consumption as registered is inside normal ranges of variations. Also data has been checked again with the operator thus ensuring correct reporting. No further action is thus required.

Graph A1: Specific Fuel Consumption Connexion Movil (km/gal)



Graph A2: Specific Fuel all Trunk Operators 2008 (km/gal, 2008)[7]



[7] promedio =average

Annex 2: Passengers Transported

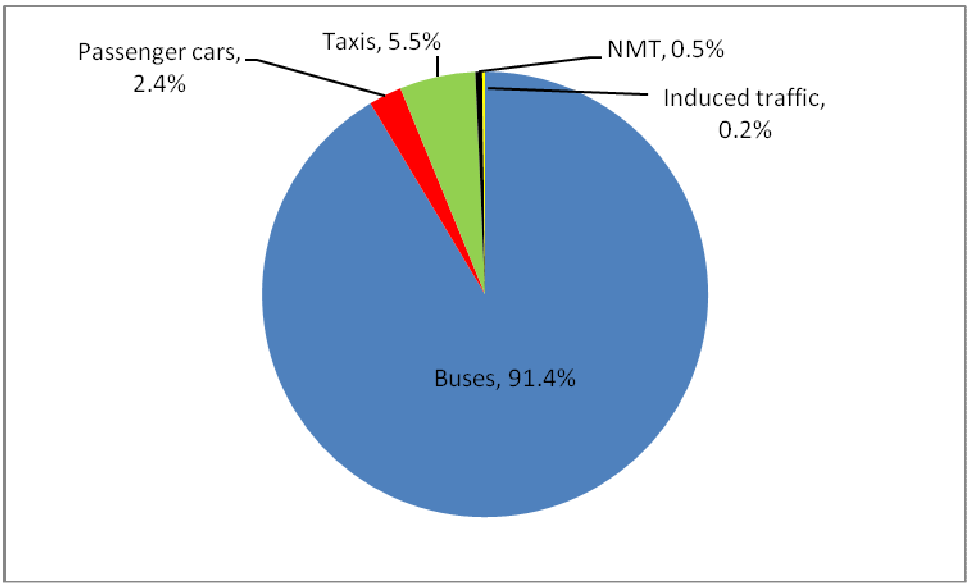
Table A3: Passengers Transported by TRANSMILENIO 2008 per Month

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total passengers	29,054,302	35,521,425	30,146,554	26,053,805	34,719,541	32,221,104	30,299,700	34,852,752	37,216,632	35,555,040	36,098,747	32,624,480	394,364,082
Passengers Phase I	20,281,483	24,963,703	20,881,509	18,353,736	24,257,708	22,438,358	21,052,848	24,761,450	26,601,787	24,880,282	25,347,219	22,187,626	276,007,709
Passengers Project	8,772,819	10,557,722	9,265,045	7,700,069	10,461,833	9,782,746	9,246,852	10,091,302	10,614,845	10,674,758	10,751,528	10,436,854	118,356,373

Annex 3: Surveys

Number of surveys realized 2008: 6 units
Number of persons interviewed: 800 per survey

Graph A3: Modal Distribution of Passengers Using TRANSMILENIO



Annex 4: Leakage

Table A4: Leakage Emissions

Concept	Leakage emissions in tCO_{2eq}[8]
Leakage due to construction	5,481
Leakage due to scrapping	3,871
Leakage due to reduced upstream emissions of fuel saved	- 9,634
Leakage due to reduced congestion	- 4,937
Leakage due to reduced load factor buses and taxis	0
Total leakage	**-5,219**
Leakage as reported for emission reduction	**0**[9]

Construction emissions are identical to 2007 as no new construction has been realized in the year 2008.

Table A5: Buses Scrapped in the Year 2008

	Large buses	Medium buses	Small buses	In large bus units
Scrapped units	9	22	0	20
Average year of scrapped units	1984	1981	--	1982

Source : TRANSMILENIO, File 5
Weighting according to PDD : 2 medium = 1 large ; 4 small = 1 large
Average age: 2008-1982 = 26 years

The annualized scrappage emissions of 2008 are added to the annualized scrappage emissions of 2007.

[8] Positive figure means that the project has caused indirectly additional emissions; negative figure means that the project has caused indirectly additional emission reductions

[9] Negative leakage is taken as 0 i.e. the project does not claim these additional emission reductions.

Annex 5: Literature Used

File 1: IDU, 21.1.2009, Letter of Confirmation of Trunk Roads Built Year 2008

File 2: Congreso de Colombia, 14.7.2008, Ley 1205 de 2008

File 3: Alcaldía de Bogotá, 7.2.2008, Pacto por una mejor calidad del aire para Bogotá, D.C.

File 4ª to 4f: Market Team S.A., 2008 (various months), Survey of passengers of TRANSMILENIO

File 5: TRANSMILENIO, 1.2009, Scrapped buses year 2008

File 6: Data of Secretaría Distrital de Movilidad de Bogotá, 2008, Load factor taxis and baseline buses, Calculations realized by Grütter Consulting

File 7: Grütter Consulting, 2008, TORs load factor study buses

File 8: Grütter Consulting, 2008, TORs load factor study taxis

File 9: ECOPETROL-TIP, 2008, Sulphur in diesel 2008

Plus data from MVP Excel sheet which is partially published.