

# Energy Efficiency in Massive Public Transport Systems

Transmilenio: a study case

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Seoul, 18 December 2007

UN Forum on Energy Efficiency and Energy Security

# ABSTRACT

- Transmilenio is a massive public transport system that attempts to solve the problems of inefficiency of traditional public transport by the organization of operation, and to contribute to the improvement of the quality of life of people in Bogota, including environmental issues.
- However, it has several problems yet to overcome.

# BOGOTÁ D.C. - COLOMBIA



- Average temperature is 17°C.
- Altitude: 2.600 meters above sea level.
- Extension: 37.414 ha approx.
- Current Population: 7'000.000 inhabitants, 15% of the country.
- Growth rate per year: 2.5%

**BOGOTÁ**



## URBAN DESIGN – 1998 TRANSPORT FACTS

- Long routes for traditional public transport service, old buses and low load factor
- Average time per commute, 1.5 hours per direction
- 95% of the road network is for private transport. It represents 19% of the trips (1'000.000 cars)
- 70% of the air pollution in the city is generated by vehicles



# BOGOTÁ's TRANSPORT FACTS

## Traditional Transport System

- 20.065 buses
- 4.112.214 trips per day
- Rush Hour Speed 18 Km/hr
- 509 routes

## Private Cars

- 1.000.000 vehicles
- 1.394.301 trips per day
- Uses up 80% of the network

## Individual Public Transport

- 45.724 Yellow Cabs
- 350.130 trips per day



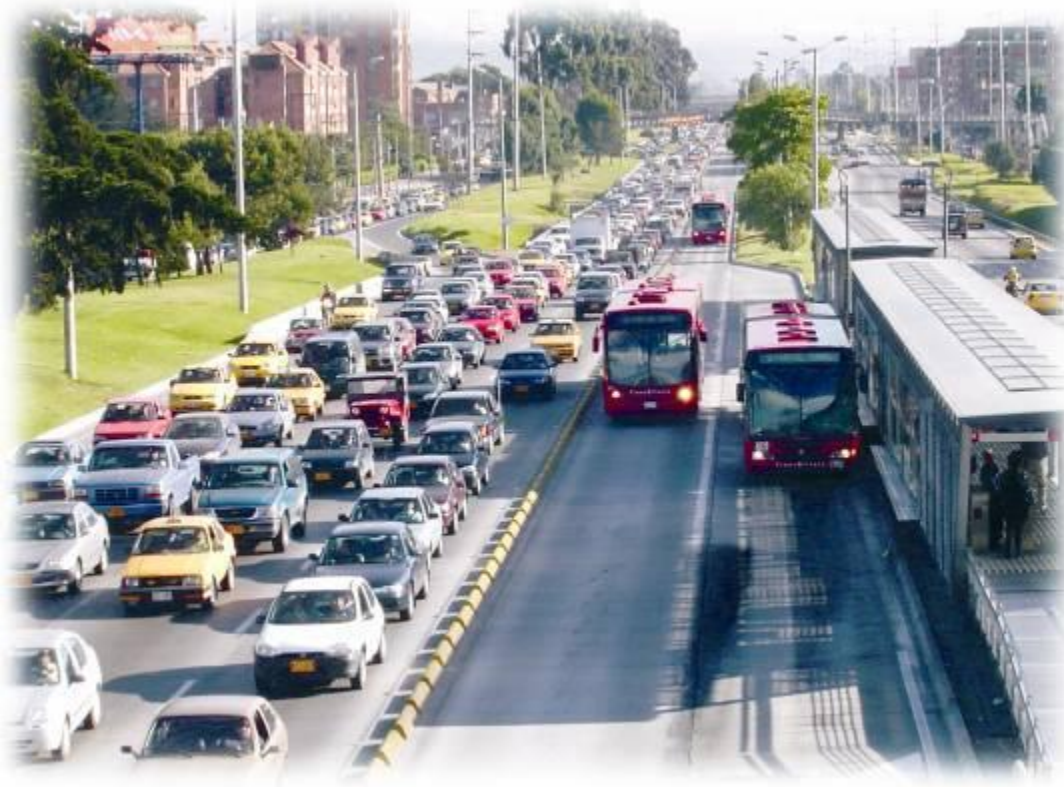
# PUBLIC TRANSPORT INEFFICIENCIES

- **OBSOLETE TECHNOLOGIES:** Vehicles in the public transport system of Colombia are 18 years old in average. This figure in the case of the city of Bogotá is 13 years.
- **NEGATIVE ENVIRONMENTAL IMPACT:** Vehicles generate 86% of air pollution.
- **ABSENCE OF OPTIMAL PROGRAMMING AND OPERATION STANDARDS IN THE CASE OF TRADITIONAL PUBLIC TRANSPORT:** Lack of control and coordination over transportation companies in relation with route programming, schedules and demand distribution.
- **HIGH FUEL CONSUMPTION AND OVERSUPPLY OF VEHICLES.**
- **HIGH OCCURRENCE OF TRAFFIC ACCIDENTS.**

## **RESERVES, PRODUCTION, QUALITY AND PRICES OF FUELS**

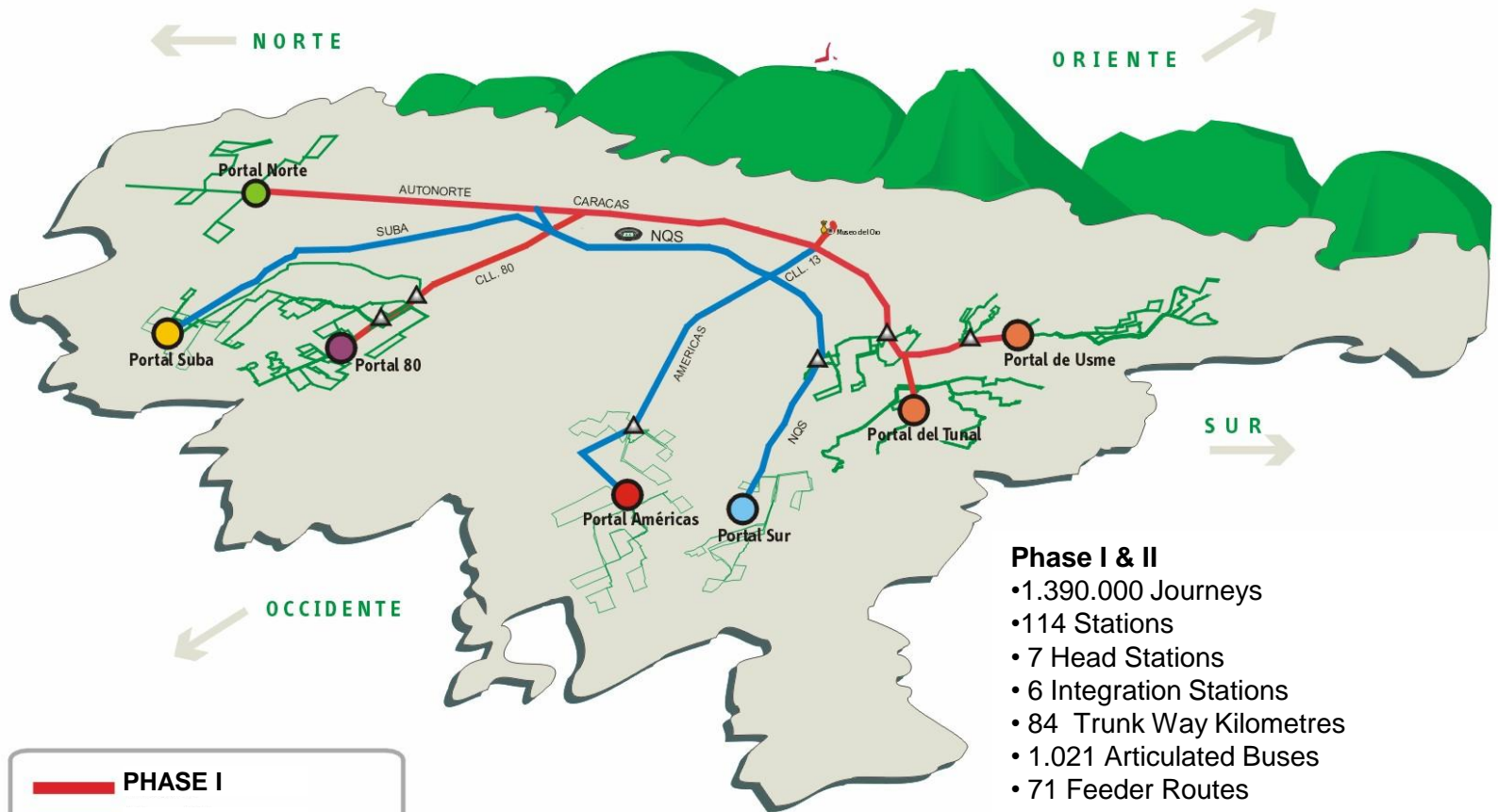
- Colombia's fossil fuel reserves are declining.
- International fuel prices are increasing.
- Low fuel quality: diesel sulfur levels are around 4.500 ppm at a national level. In Bogotá this figure is 1.200 ppm.
- The subsidy level for diesel is higher compared to other fuels, which in turn is increasing the demand for this less environmentally-friendly product.
- The Colombian government current policy is aimed at eliminating subsidies for fossil fuels.
- There are technical and economic barriers for the production of fossil fuels of better quality in the country.
- There are economic, logistic and demand-related issues that impose limitations for the importation of better quality fuels.

# MASS TRANSPORT SYSTEM



- 18.000 direct jobs during the construction.
- More than 6.000 direct jobs in operation.
- Just 280 jobs are from the government.

# TRANSMILENIO SYSTEM - STATISTICS



**PHASE I**  
**PHASE II**  
**FEEDER ROUTES**

## Phase I & II

- 1.390.000 Journeys
- 114 Stations
- 7 Head Stations
- 6 Integration Stations
- 84 Trunk Way Kilometres
- 1.021 Articulated Buses
- 71 Feeder Routes
- 515 Feeder Operational Kilometres
- 410 Feeder Buses
- 1.498 Bicycle Parking Lots

# TransMilenio (TM): AN EFFICIENT SYSTEM

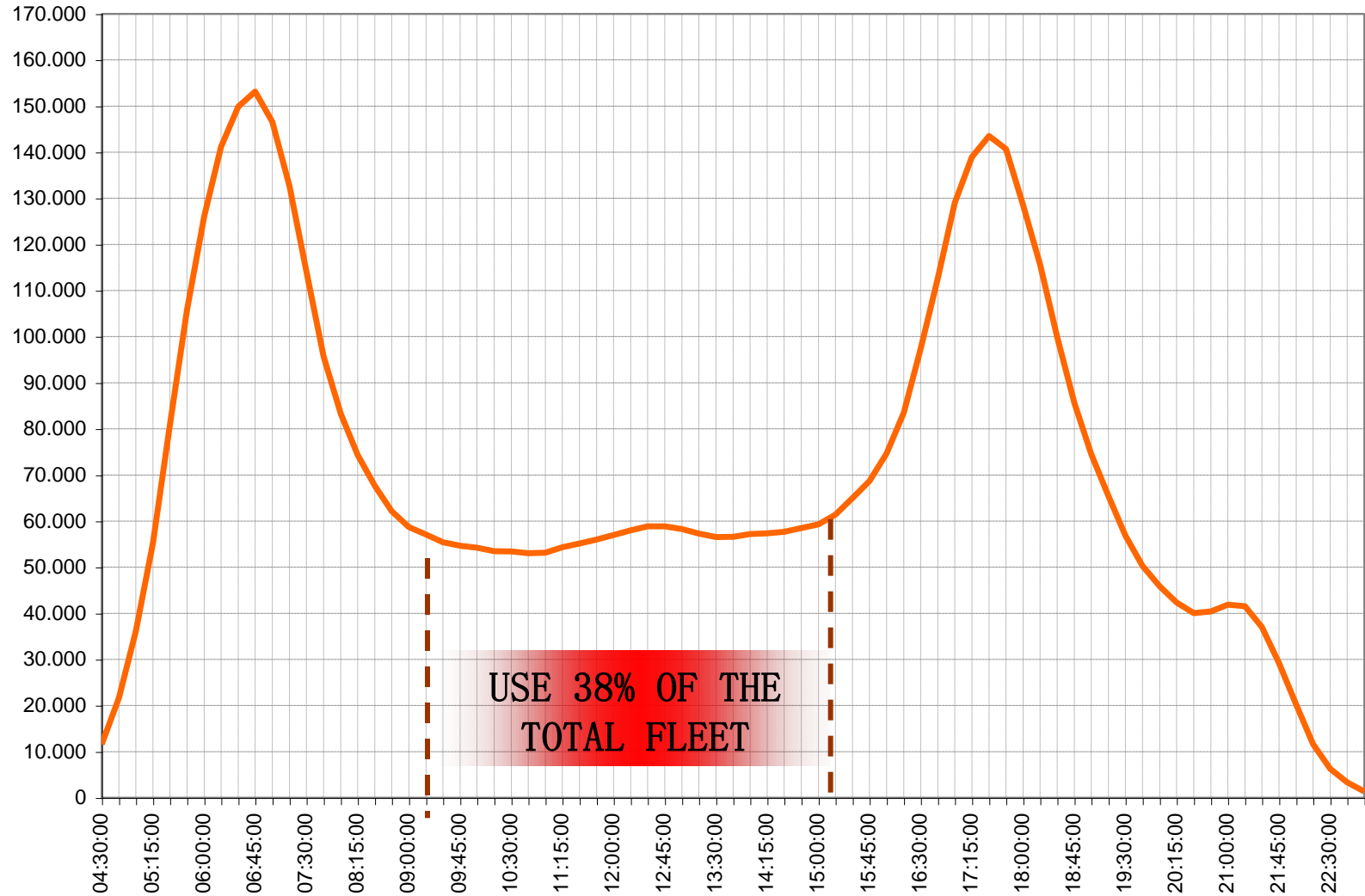
- **CLEAN DEVELOPMENT PROJECT IN THE TRANSPORT SECTOR:** TM is an organized massive transport system which generates the following benefits (among others): fuel substitution, is time saving compared to with traditional transport, increases productivity and the quality of life for all citizens.

## ADVANTAGES OF THE SYSTEM

- **EFFICIENCY AND USE OF CLEANER TECHNOLOGIES:** TM is an efficient massive transport system because it applies state-of-the-art technology: Euro II and Euro III. It also applies state-of-the-art technologies in maintenance processes.
- **OPERATION PROGRAMMING:** TM applies an optimal design of schedules for services, bus itineraries of and driving services.
- **PARAMETERS OF DESIGN AND OPERATION:** Profile and space location of demand.
  - Volume of passengers, optimal frequency, cycle times and restrictions.
- **SECURITY:** There is an opportunity to implement improvements in the processes of security management - road security audits.
- **RESEARCH:** TM has promoted a processes of evaluation of technological improvements to the system, to the vehicles and the development of pilot tests to use alternative fuels.
  - **Natural Gas – Bus IKARUS – Express of the Future.**
  - **Biodiesel test storage facility – SI99**

# EFFICIENT USE OF THE FLEET

PASSENGERS PER HOUR



# INDICATORS

- **RATIONAL AND EFFICIENT USE OF PUBLIC INVESTMENT AND INFRASTRUCTURE:** Private vehicles consume 16 times more infrastructure compared to massive public transport.
- **EFFICIENT ENERGY USE:** Massive transport (articulated buses) are 10 times more energy-efficient compared to private vehicles. In massive transport you have a capacity of 160 passengers and an equivalent of 0.19 gallons/km. 2 gallons of fuel will be needed in private transport in order to move 160 passengers one kilometer. More energy efficiency = less pollution



## CONTRIBUTION TO BOGOTÁ'S SUSTAINABLE ENVIRONMENT SYSTEM – REDUCTION OF GREENHOUSE GASES

Average emissions of CO2 per passenger in Bogotá	
<i>Transport system</i>	<i>Grams / passenger</i>
Transmilenio	360
Traditional buses	970
Taxis	3.400
Private vehicles	1.900

Source: Guidelines for National Greenhouse Gas Inventories 1996

Calculations: CAF.TM.2005

## CDM BACKGROUND

- CLEAN DEVELOPMENT MECHANISM in TM
- Agreement subscribed with CAF in November 2001: Initiation of an evaluation of the environmental potential of the TransMilenio system and the conditions of participation of each party are defined.
- In 2004 the methodology was presented and rejected by United Nations due to:
  - **Additions:** It did not present parameters for the system enlargement.
  - **Base line methodology:** It did not present a generic form for Bus Rapid Transportation (BRT) other than a specific one for TM.
  - **Monitoring plan:** The parameters to be monitored were listed but the process of emission reduction calculations was not defined.
- In July 2006, a new methodology, “Baseline for Methodology for Bus Rapid Transit Projects”, was presented and approved by United Nations, under code AM0031



## METHODOLOGY

- **Age:** Units with less emissions per kilometer .
- **Capacity:** Units with less emissions per person transported.
- **Occupation:** More efficient transport (better degree of occupation).



Bus TPC



Bus TM

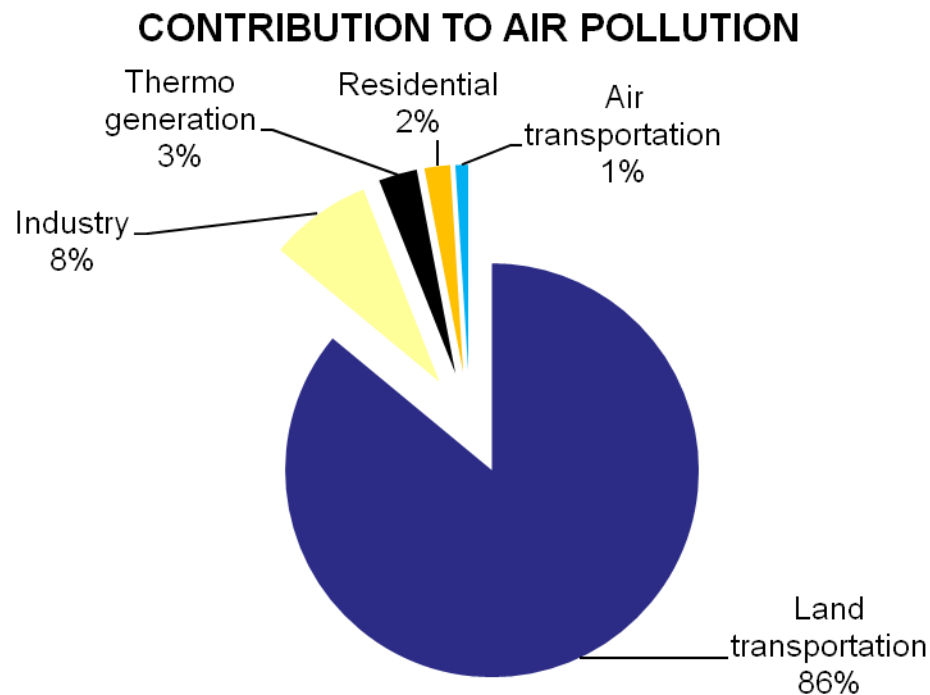
- **Modal change:** 20% of people with private vehicle use TM, 10% switched to TM and the other 10% use TM in hours of private vehicle circulation restrictions (pico y placa).

## ADDITIONAL BENEFITS

- The project has also a local scale environmental impact:
  - For phases I y II between **2001 and 2006** the reductions were:
    - **3.823 ton of PM10 (material particles)** – The first and most polluting agent in Bogotá.
    - **28.929 ton of NOx (Nitrogen monoxide)** – The second polluting agent in Bogotá.
    - **601 ton of SO2 (Sulfur dioxide).**
- The positive economic impact in the health sector has been calculated to **US\$229,662,000** as a consequence of the reduction of **33.353 ton** of local pollutants.

# ENERGY EFFICIENCY IN THE TRANSPORT SECTOR

## SECTOR EMISSIONS CONTRIBUTION



**Source: CONPES No 3344/2005**

<http://www.upme.gov.co:8080/upme/tematico/consultaTematica.jsp>

# LEGAL FRAMEWORK

## NATIONAL GOVERNMENT STRATEGIES AIMED AT INCREASING THE ENERGY EFFICIENCY OF THE TRANSPORTATION SECTOR

- **THE NATIONAL DEVELOPMENT PLAN AND THE NATIONAL ENERGY PLAN.**
  - Production optimization at the Barrancabermeja refinery. Aimed at increasing the quality of 80% of the gasoline and diesel consumed in Colombia: less sulfur and higher hydrogen.
  - Enlargement and optimization of production at the Cartagena refinery. Aimed at increasing the quality of 20% of the gasoline and diesel consumed in Colombia: less sulfur and higher hydrogen.
  - Adoption of a fuel price policy that reflects the international price conditions and the environment costs of each fuel.
  - Incentives for the use of natural gas for vehicles: substitution of 30% of the gasoline and diesel demand in the 8 largest urban and industrial centers. It will achieve a 10% reduction of  $PM_{10}$  and 1.2% of  $SO_x$  emission levels by 2020.

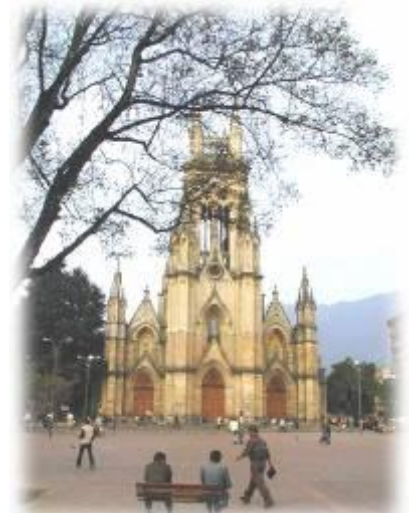
## MOBILITY MASTER PLAN

- Signed & Published by the city Mayor on August 15th / 2006
- Complement of the Urban Development Plan in terms of Mobility.
- It is the fundamental document to organize the city in mobility aspects.
- It projects the sector resources and investment that are going to be used in the short, medium and long term, according to development and growth.

## URBAN DEVELOPMENT PLAN – MOBILITY RESULTS

Once the Plan has been structured, public companies will join efforts in order to develop the city.

Bogotá D.C. today:



# Thank you

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