



Gestores en Soluciones Sustentables  
Para el Ambiente, S.C.

# «High emitters dominate PN emissions of petrol LDV in Mexico City - and probably also in other large cities»

**VERT PTI Focus Event**

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# Background

## Mexico City's Metropolitan Area



➤ **CDMX** ≈ 1,500 km<sup>2</sup>  
876 km<sup>2</sup> conservation areas  
**8.8 million people**

➤ **State of Mexico**  
59 municipalities  
across 6,000 km<sup>2</sup>  
**12.2 million people**

➤ **Altitude: 2,250 m.a.s.l.**



**5.3 million vehicles**



**1,935 regulated industries**



**2,410 regulated commerce & services**



**5.8 million homes**

# Mexico City's Vehicle Inspection Program

<< LDV and HDV >>

**Mexico City's Vehicle Inspection Program** one of the most important strategies by the government to prevent and control air pollution.

- *Control stations are accredited by the standard ISO-17,020.*

- Predominantly gasoline vehicles.
- Inspection every semester.
- 60 control stations.
- Inspection process in accordance with Mexican standards.



# Description of test methodologies

Meteorological stations measuring P, T, and Humidity conditions in a Verification Center



- Calibration of dynamometer MAHA.
- In order to comply with national standards, mass dynamometer calibration is performed daily and dynamic calibration is performed monthly.

## National and International Standards

### NOM-047-SEMARNAT-2014

Characteristics of the equipment and the measurement procedure for the verification of emission limits of pollutants from vehicles using different fuels in circulation

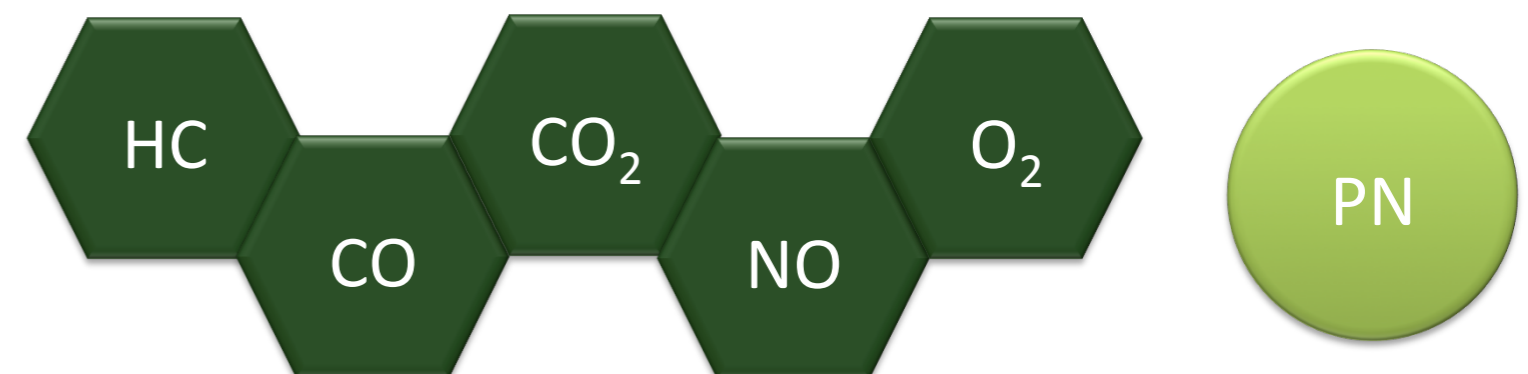
### NOM-167-SEMARNAT-2017

Establishes the maximum permissible limits for the emission of pollutants by vehicles in circulation in the federal entities of Mexico City, Hidalgo, State of Mexico, Morelos, Puebla and Tlaxcala.

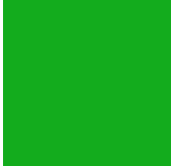
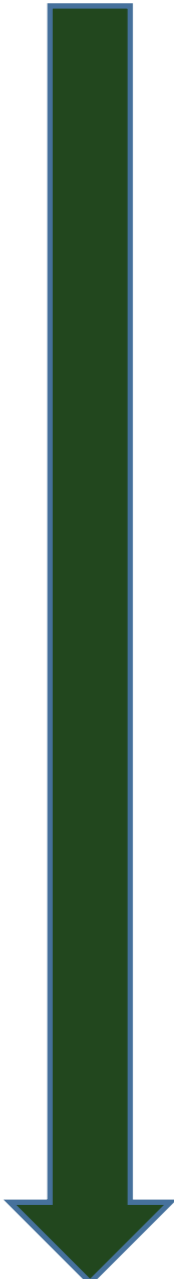




### EPA-AA-RSPD-IM-96-2

Acceleration Simulation Mode Test Procedures, Emission Standards Quality Control Requirements, and Equipment Specifications

## Gases & PN measured



# Hologram Stickers Classified in the Vehicle Inspection Process

	<b>DOUBLE ZERO</b> (00)	New vehicles are subjected to the inspection procedure for the first time.		<b>The cleanest</b>
	<b>ZERO</b> (0)	Vehicles equipped with a three-way catalytic converter and a second-generation OBDII or EOBD (model-year 2006 on).		
	<b>ONE</b> (1)	Vehicles with electronic injection systems (model-year 1994 to about 2005).		
	<b>TWO</b> (2)	Vehicles with mechanical injection systems (model-year 1993 and earlier, approximately).		
	<b>REJECTION**</b>	All of the above that do not pass the test described.		<b>The most polluting</b>

\*\*There different kind of rejections. For instance, the rejection by catalyts-converter must retrofit with a new three-way-catalysts in order to improve the quality of their emissions. (30 days to repair and to re-test)

# NanoMet3 – CDMX version

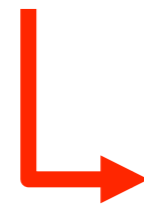
- **The Vehicle Inspection Information System is operated by Mexico City's Ministry for Environment (SEDEMA) using centralized software.**
- **NanoMet3 is designed to be installed into the cabinets of Vehicle Verification Centers (CVV).**
- **General characteristics:**
  - **Manufacturer: TESTO/ Germany**
  - **Sample dilution 1:100**
  - **Temperature: 300 °C**
  - **PN is measured from 50'000 to 10'000'000 P/cc**
  - **Particle size: 10 – 700 nm**



# Gases & PN Data Analysis



**Total**  
**4,726,305**



**PN MEASUREMENT**  
**442,976 (9.4%)**



**Gasoline**  
**354,791 (7.5%)**

**Three semesters**  
**2018-2, 2019-1, 2019-2**

- **Validation and debugging was made by mass balance according to combustion curves in relation to lambda ( $\lambda$ )**

## PN Classification

**Range 0 (R0)**

< 50,000

**Range 1 (R1)**

50,000-250,000

**Range 2 (R2)**

250,000-1,000,000

**Range 3 (R3)**

1,000,000-5,000,000

**Range 4 (R4)**

5,000,000-10,000,000

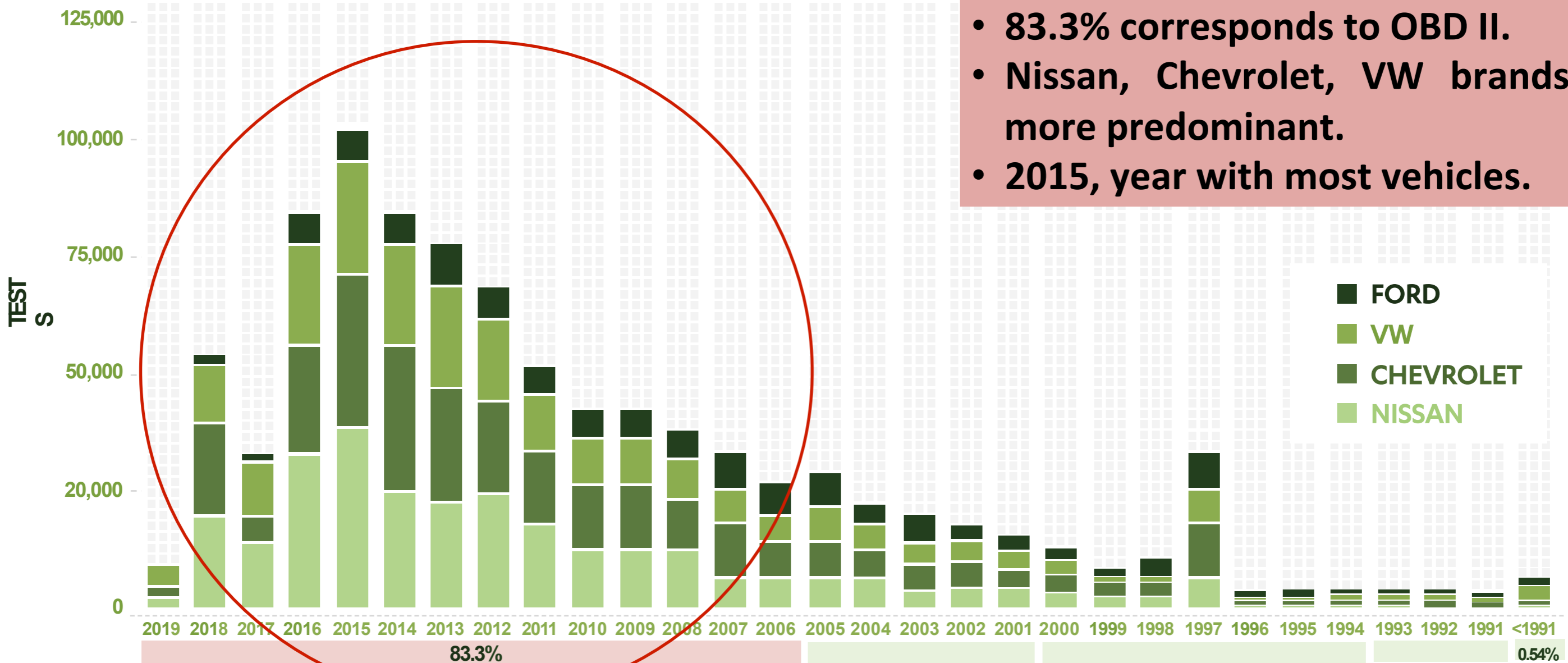
**Range 5 (R5)**

10,000,000-100,000,000

**Range 6 (R6)**

>100,000,000

# Classification by Technology, Age and Brand

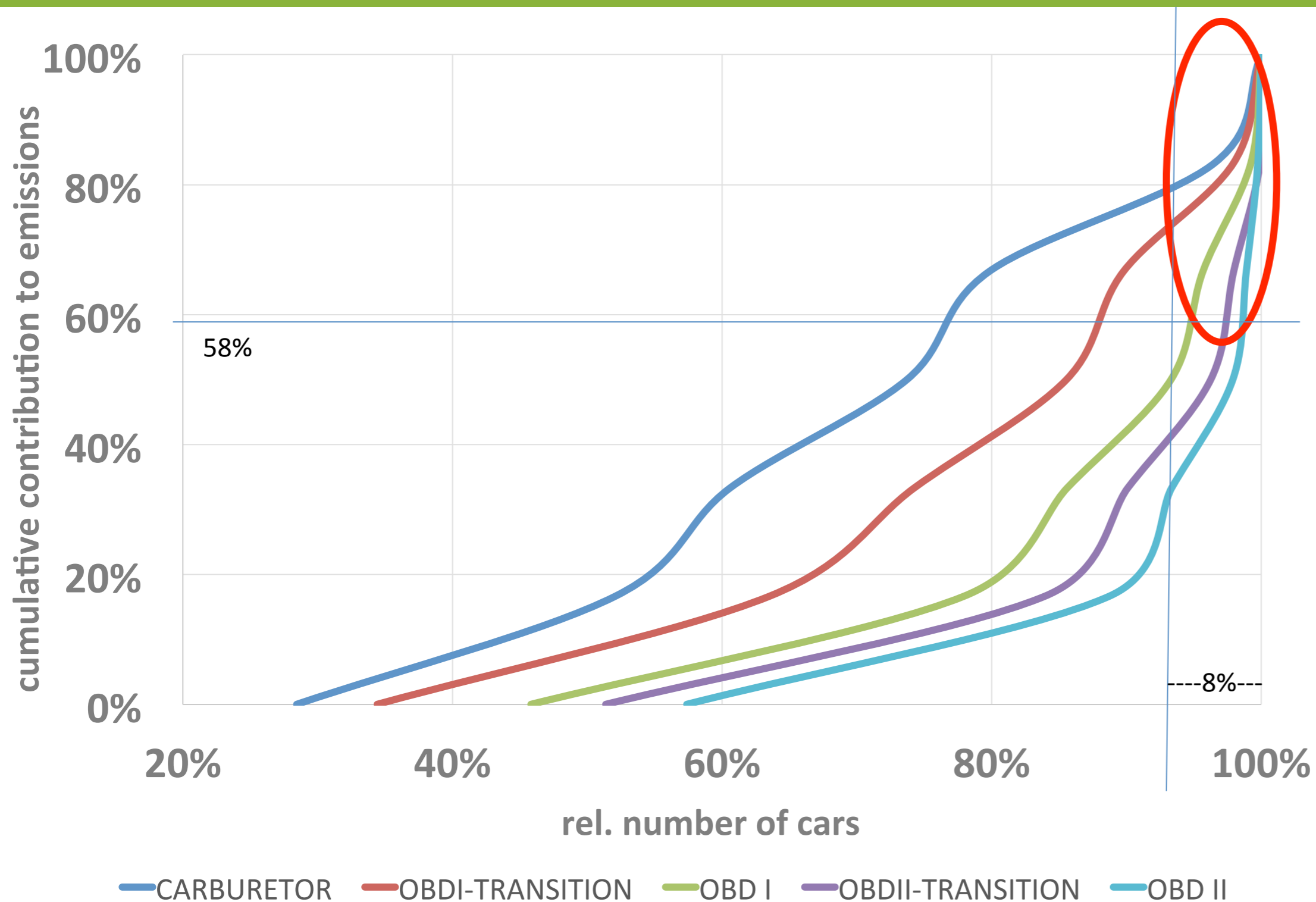


- 83.3% corresponds to OBD II.
- Nissan, Chevrolet, VW brands more predominant.
- 2015, year with most vehicles.

OBDII - Model 2006 and later  
 OBDII-Transition - Model 2005 to 2001  
 OBDI - Model 2000 to 1994  
 OBDI-Transition - Model 1993 to 1991  
 Carburetor - 1990 and previous



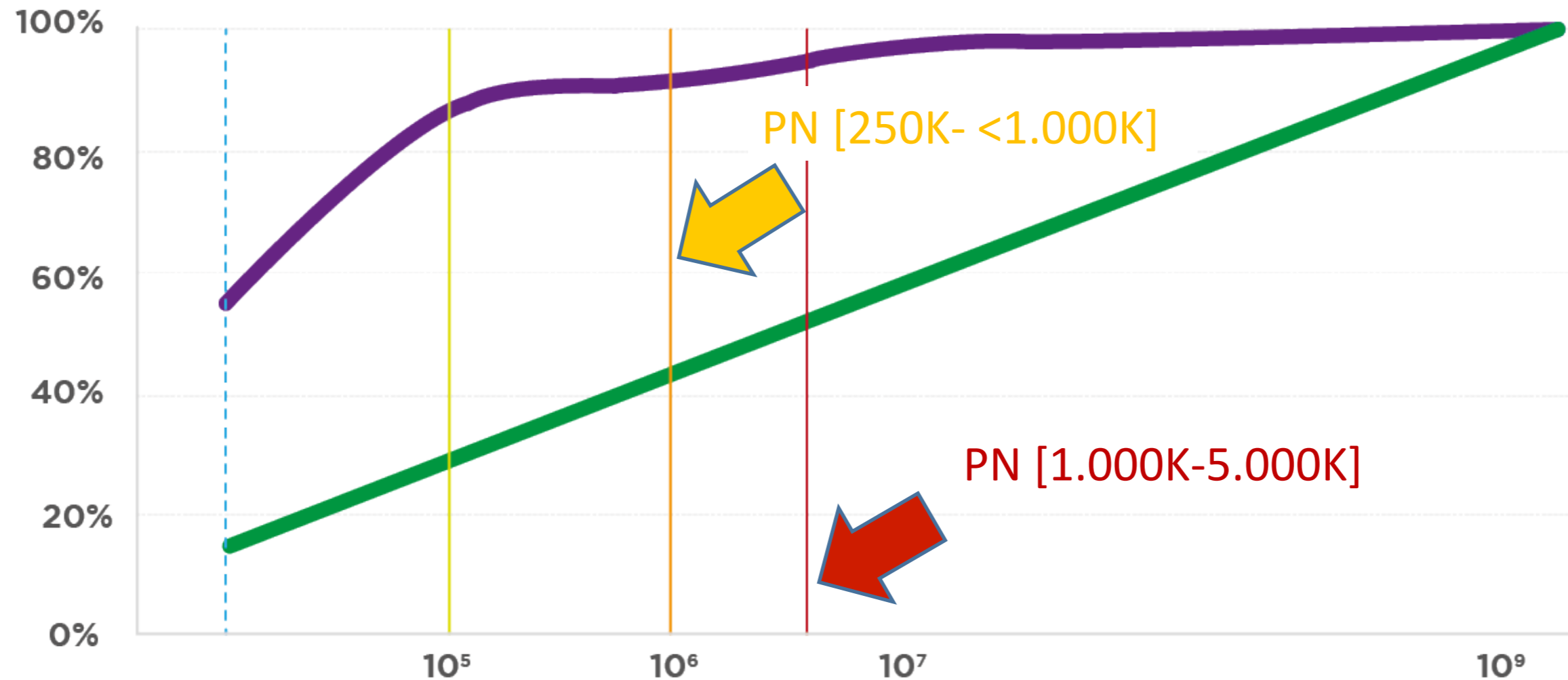
# Characteristics of high polluting vehicle fleet (PN > 1.000.000)



**<<<Dirty tail>>>**

- **8% of the fleet contributes 58% to the PN contamination of Mexico City.**

# Characteristics of high polluting vehicle fleet (PN > 1.000.000)



Gasoline vehicles can emit equal or more PN emissions than diesel vehicles

A few high polluters >1'000'000 P/cc dominate the overall PN pollution

--- Lower Detection Limit < 50K

— Limit for Medium Polluters < 1,000K

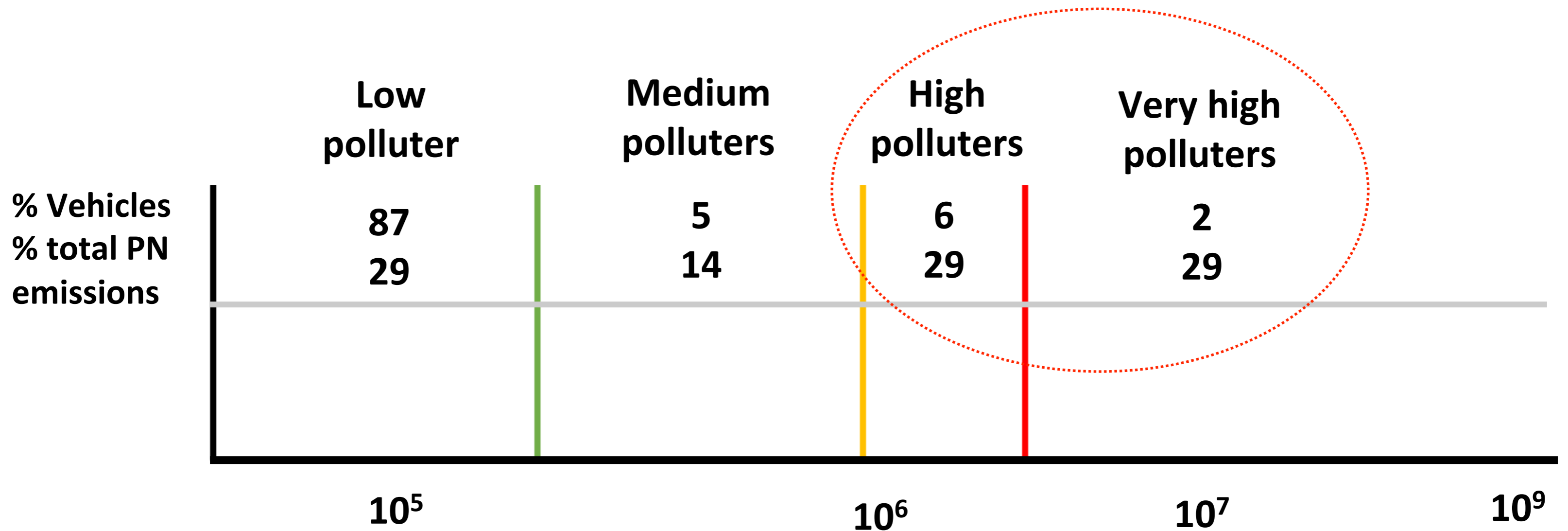
— Cumulative relative number of measurements (%)

— Possible Limit for Low Polluters < 250K

— Limit for High Polluters > 1,000K

— Cumulative relative particle number emission (%)

# Characteristics of high polluting vehicle fleet (PN > 1.000.000)



**Eliminating the 8% high polluters would immediately improve the air quality in Mexico City by factor 2.**

# Comparison of emissions (particle number & gaseous pollutants)

## PN emissions: > 1.000.000

Technology	PN contribution to total fleet by technology	Contribution to total fleet
CARBURETOR	39%	1%
OBDI-TRANSITION	26%	1%
OBD I	14%	6%
OBDII-TRANSITION	10%	12%
OBD II	7%	80%
<b>Total fleet</b>		<b>100%</b>

- 1% of the total fleet corresponds to Carburetor technology.
- 39% of the carburetor total fleet presents PN > 1.000.000

- 80% of the total fleet corresponds to OBD II technology.
- 7% of the OBD II total fleet presents PN > 1.000.000.

# Comparison of emissions (particle number & gaseous pollutants)

## PN emissions: > 1.000.000 (High Polluters)

Technology	CO emissions (%)
CARBURETOR	1.11
OBD I – TRANSITION	0.54
OBD II	0.23

OBD II technology with the same range of particle emission, there is less CO emission than the Carburetor and OBDI-Transition technology.

## Technology: Carburator

PN emissions	CO emissions (%)
< 250.000	0.90
> 1.000.000	1.11

In Carburetor technology with > 1.000K PN emissions has a less efficient combustion (CO) than vehicles with < 250K

# Conclusions

- 4.7 million vehicles were analyzed.
- More than 400,000 vehicle datasets of PN measurements.
- Light gasoline vehicle: vehicle fleet majority
- 83.3% vehicles with OBDII technology ( $\geq 2006$ )
- 8% of the vehicles fleet contribute to the 58% of the total PN emissions.
- Almost the 50% of rejections are of those vehicles with OBD II technology.

# Conclusions

- PN-measurement is a very sensitive parameter to detect high polluters.
- High emitter phenomenon of petrol engines might not be limited to Mexico.
- Gasoline vehicles can emit equal or more PN emissions than diesel vehicles.
- Particles of gasoline engines are smaller than diesel engines, also are more harmful, because they have more PAH.
- Gasoline particle filters GPF coated by TWC should be implemented in Mexico

## Further work.....

**A study is needed to resolve the following issues:**

- Which are the major reasons for high PN emission of gasoline cars?
- Which are frequent failures contributing to this high emission?
- Can these failures be eliminated by repair or replacement of standard parts?





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## About us

*Gestores en Soluciones Sustentables para el Ambiente* (GESSPA) is a leading company in environmental impact assessments and related services. GESSPA was founded by Candi Dominguez and Iris Cureno in 2010 and it is meeting a growing demand from organizations for accurate measurements of environmental and social impact.

## FOUNDERS



**M.Sc. Candi Dominguez**  
**CEO**

**Environmental Consultant at GESSPA.** Candi has years of experience working for Mexico City's Ministry of Environment as Director of Sustainable Transport and Mobile Resource Programs. She has been responsible for implementing a range of projects and programs, including one for mandatory vehicle inspection and others related to pollution control and clean transport. Most recently, she has worked for Mexico City's Ministry of Mobility for Public Transport and Mobility.



**M.Sc. Iris Cureño**  
**Executive Director**

**Environmental Consultant at GESSPA.** Iris has extensive experience in the energy sector. Her specific expertise lies in the development of renewable energy projects and for more than 7 years she has worked for the Electricity Company of Mexico.