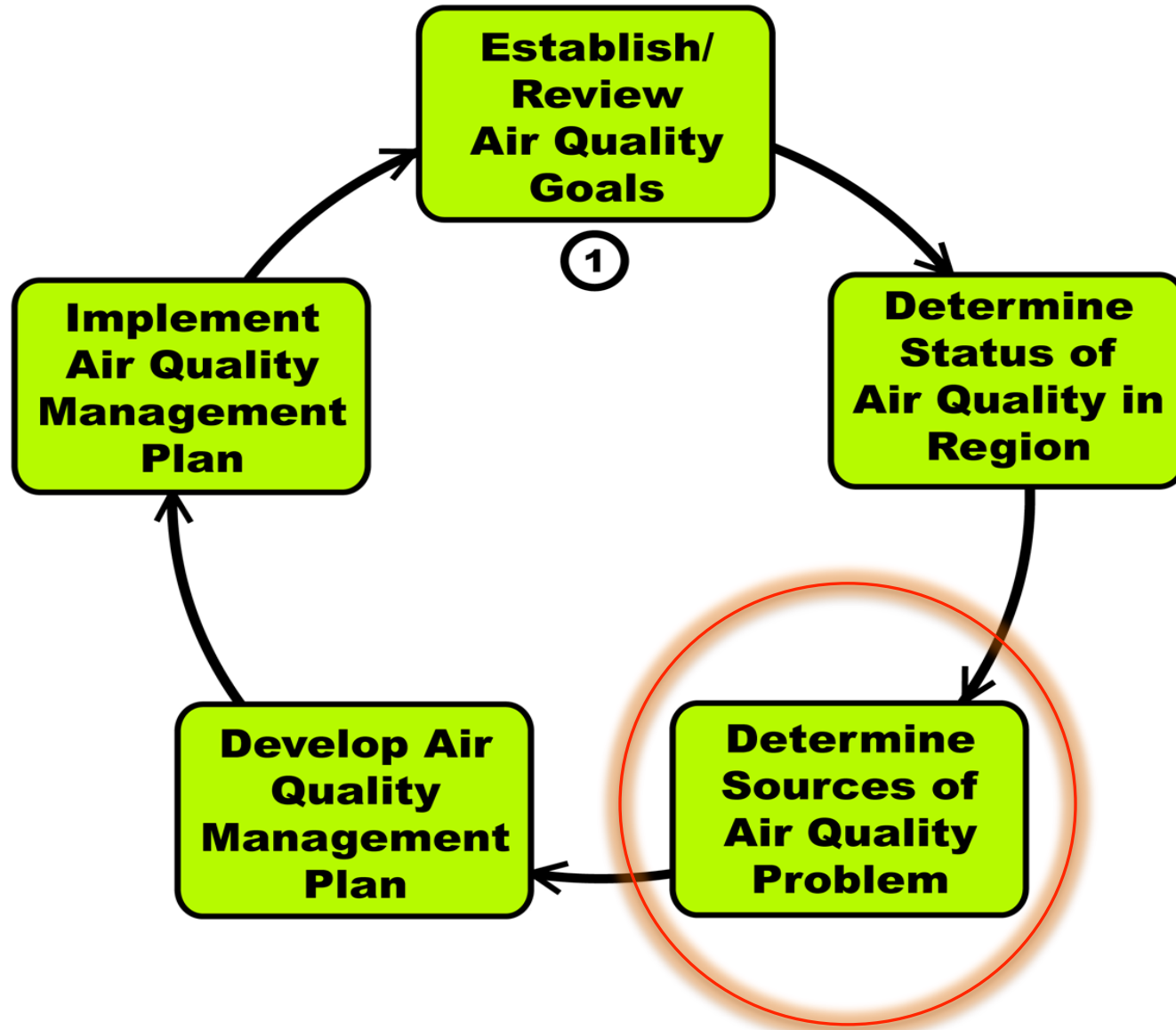# Using PEMs and Local Vehicle Activity Measurements to Improve Inventories and Policy Development in Developing Countries

ISSRC

March 24, 2010

The Air Quality Management Process

Typical Overall Contributions to Air Quality Problems

- On-Road Motor Vehicles   48%
- Point Sources   28%
- Fixed Area Sources   15%
- Off-Road Sources   10%

On-Road Mobile Sources

- Most difficult to quantify key emission related data
- Most difficult to estimate emissions
- Most variation over the day

Situation in Most Developing Countries

- No information on total driving
- No information on driving by time of day
- No information on on-road fleet technology distribution
- No information on driving patterns
- No information on on-road emissions per vehicle
- NOW: Determine the emissions in the urban area created my on-road motor vehicles

On-Road Emission Related Data Priorities

- 1. Total Vehicle Number/Total Amount of Driving
- 2. Distribution of Driving Among Vehicle Types
- 3. Driving Patterns
- 4. Vehicle Start Information
- 5. Vehicle Emission Factors
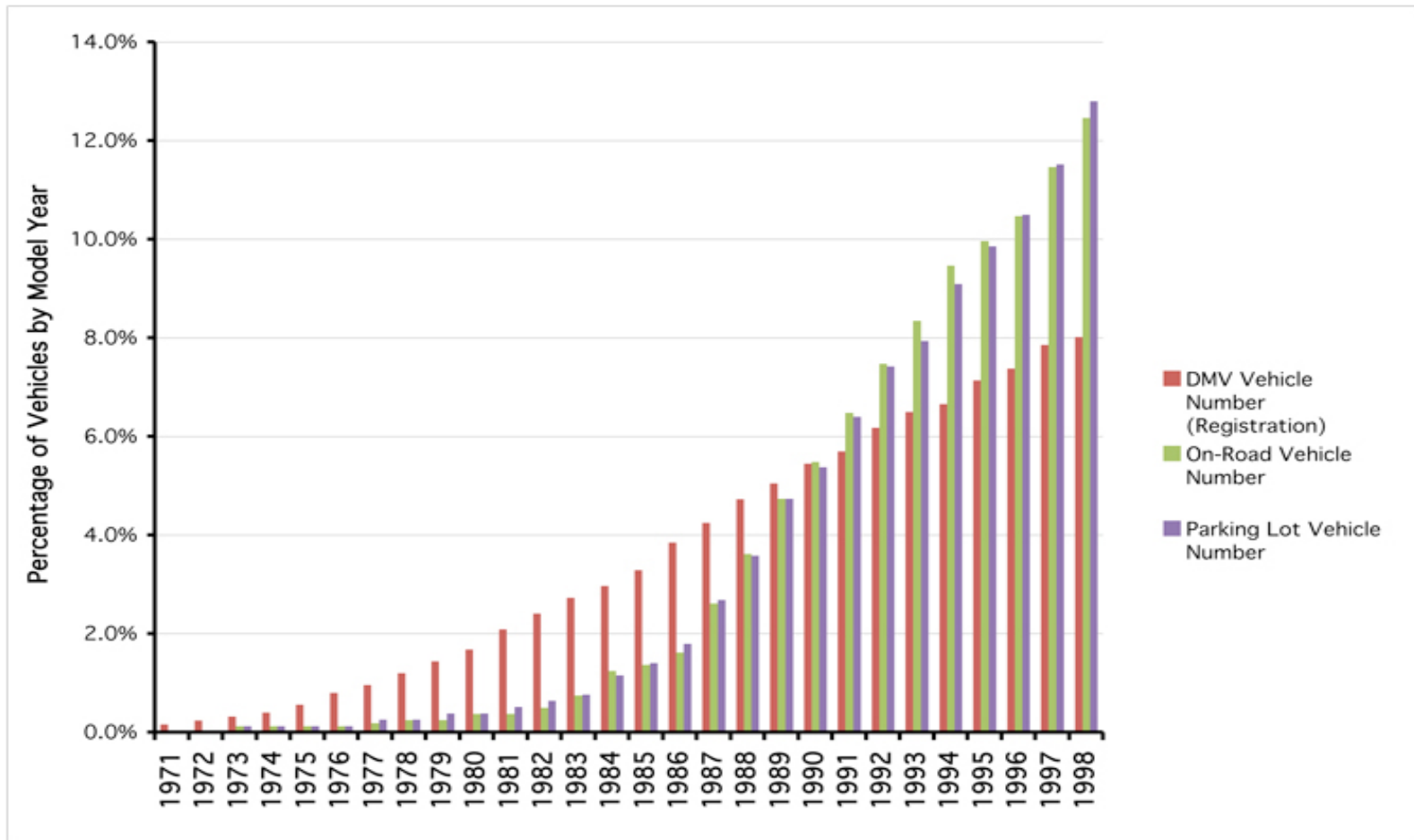
Distribution of Driving in a Region

Getting Fleet Distribution Information in India
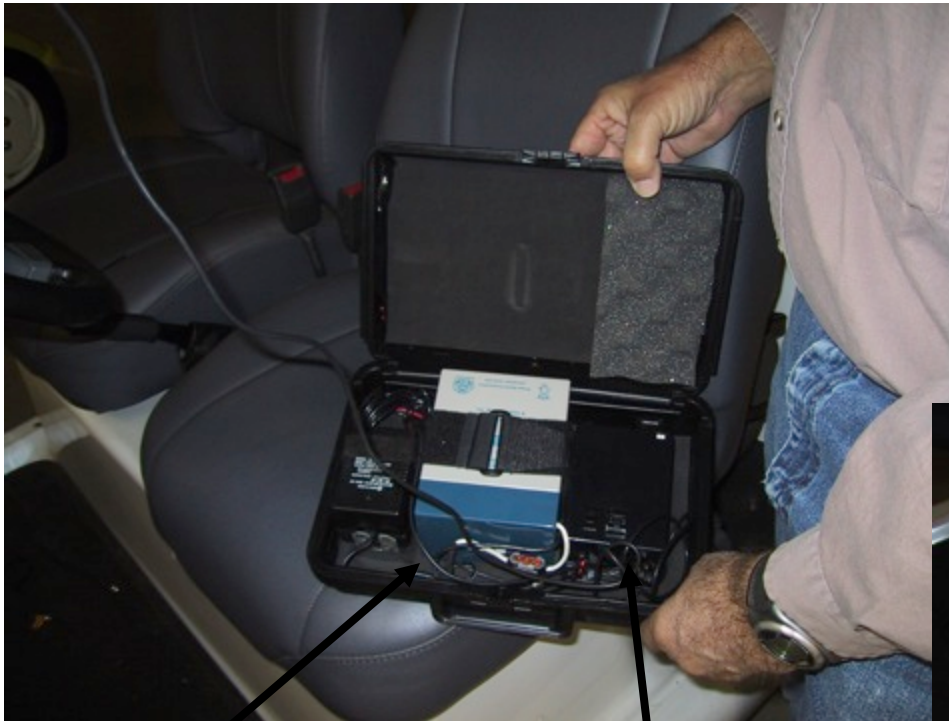
Parking Lot Surveys for Information

Los Angeles Registration, Videotape, Parking Lot

Driving Patterns: GPS / Microprocessor Unit

Unit easily carried and used to collect bus driving patterns with lid closed.

Battery good for 40 hours of testing.

GPS/Microprocessor Module

Note: This is the original style GPS used.

Driving Patterns

Start Patterns

Set-up procedure
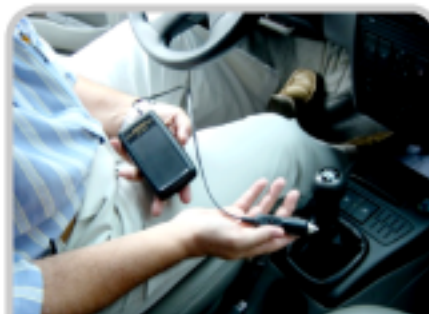
Measurement process

Downloading data

Improved GPS for Recent Studies

- Operate for two weeks collecting second by second data

- Collect vehicle start-up information

- Use with any type of vehicle

- Pressure sensor to estimate road grade

PEMS Gasoline
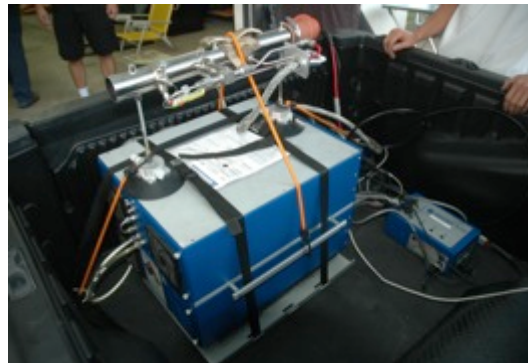
PEMS Diesel

Driving Patterns and Emissions

- On-road driving patterns cannot easily be controlled which changes emissions measured

- For comparisons of vehicles between cities or for development of emission factors there is value in finding a way to standardize emissions to a common cycle.

- ISSRC uses VSP binning to get emission rates by bin and then converts emissions to FTP type cycle for comparisons and creation of emission factors

Results of Interest from Testing Program

How Many Vehicles Should Be Tested?

90%Confidence Intervals

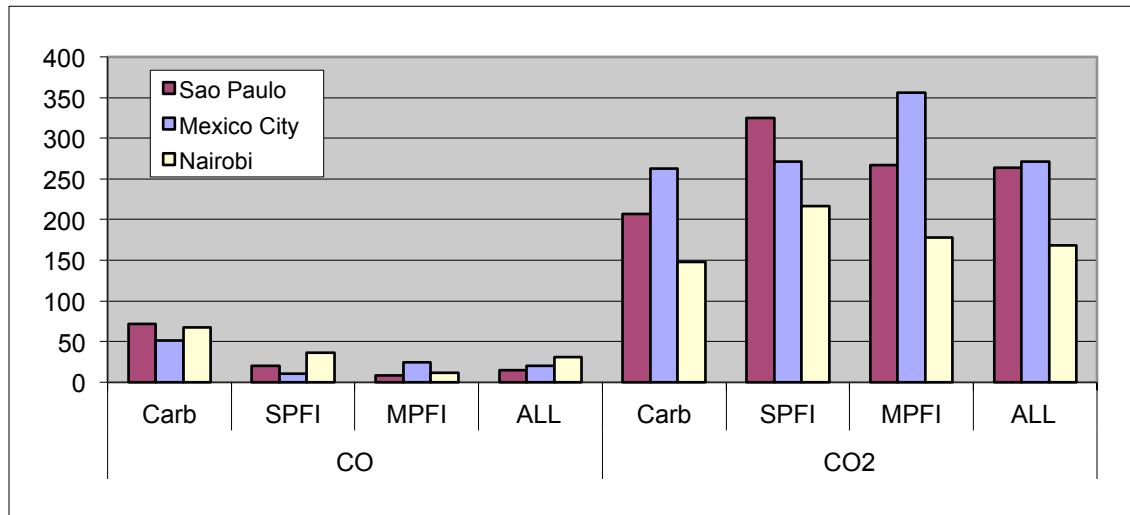| # in Group	CO	CO2	NOx	THC
<5	71%	15%	36%	104%
5-19	44%	11%	40%	50%
20-49	20%	6%	27%	23%
>50	23%	5%	22%	27%

Better

Testing at least 20 vehicles in a technology group is important!

Fleetwide Confidence Intervals

	Ave # per tech group	Total #	CO	CO2	NOx	THC
Sao Paulo	**4.5**	**111**	**31%**	**3%**	**22%**	**34%**
Nairobi	**12.5**	**113**	**17%**	**3%**	**11%**	**15%**
Mexico	**19.5**	**234**	**16%**	**3%**	**12%**	**16%**

Comparison of Emissions from Gasoline Vehicles

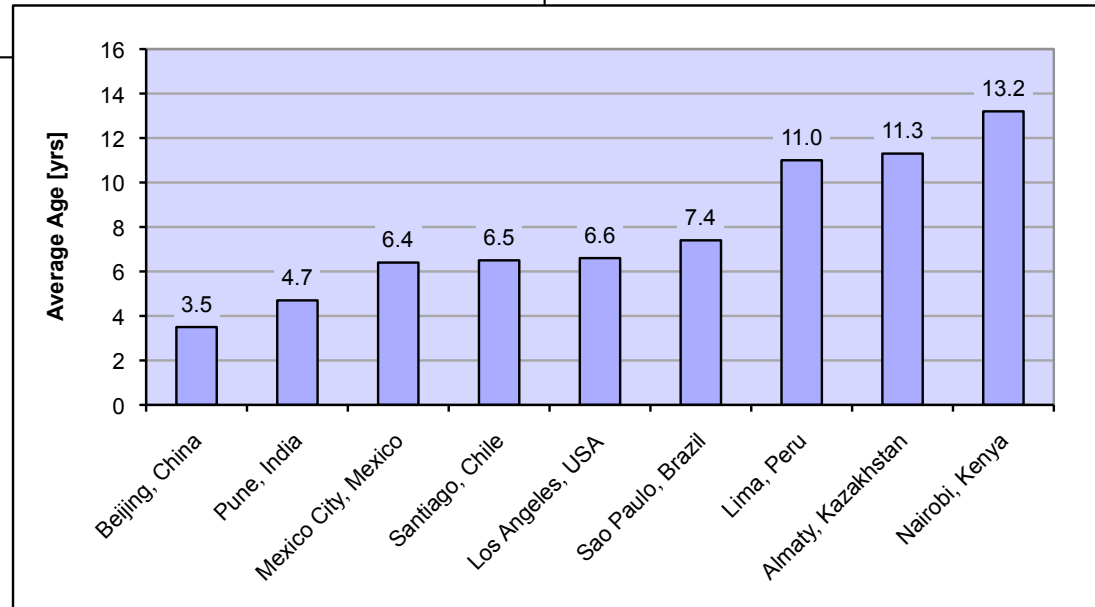Data from Actual On-Road Test
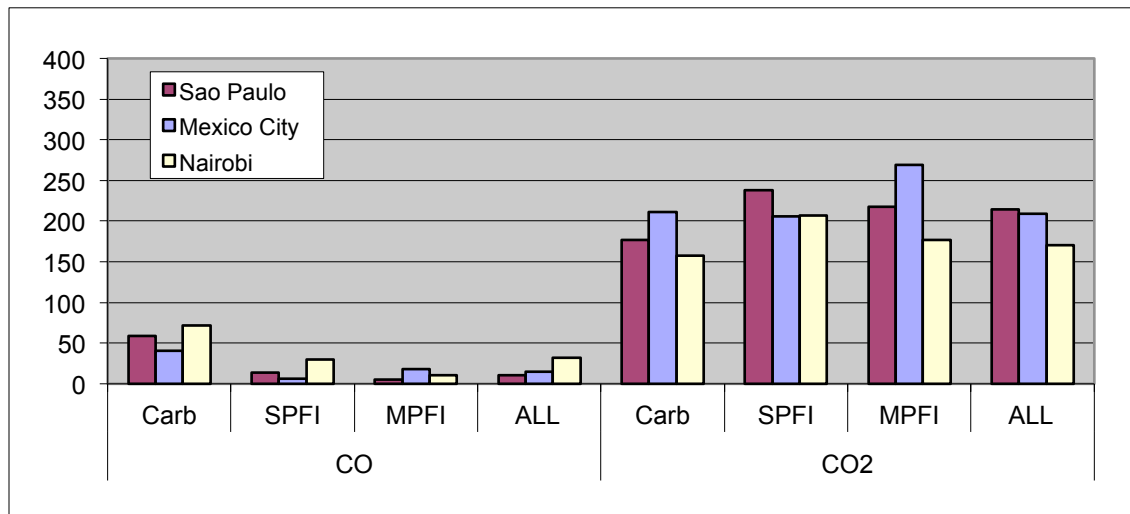
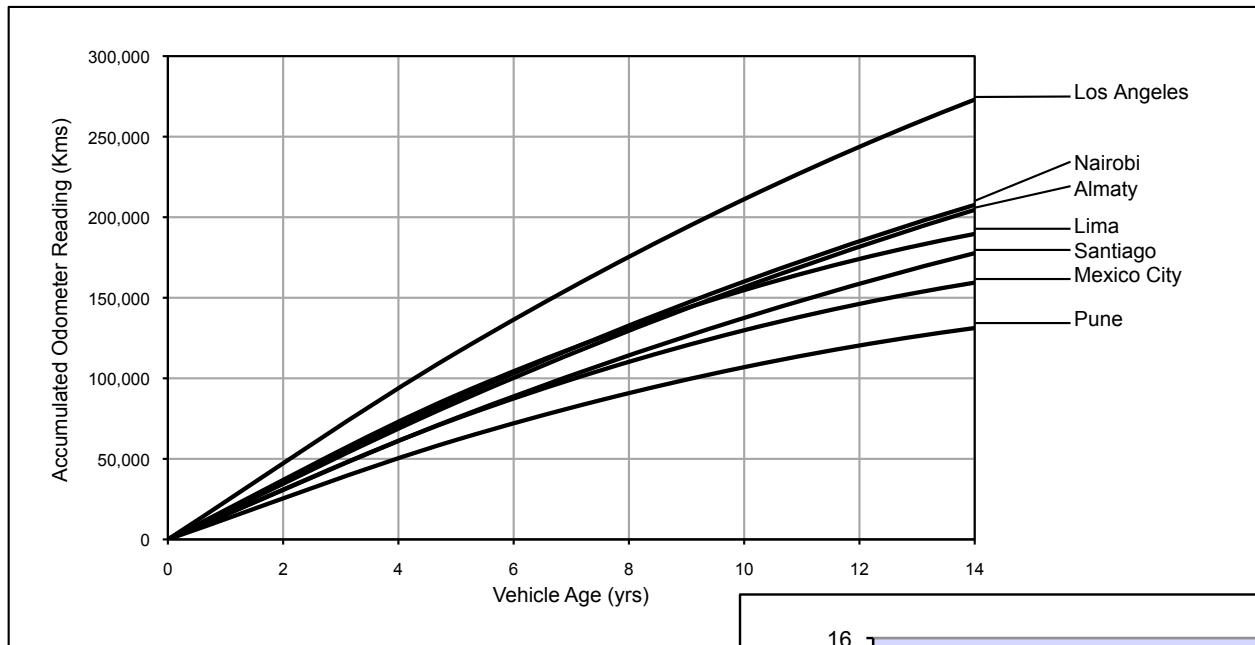Data Corrected to LA4 (FTP) Cycle
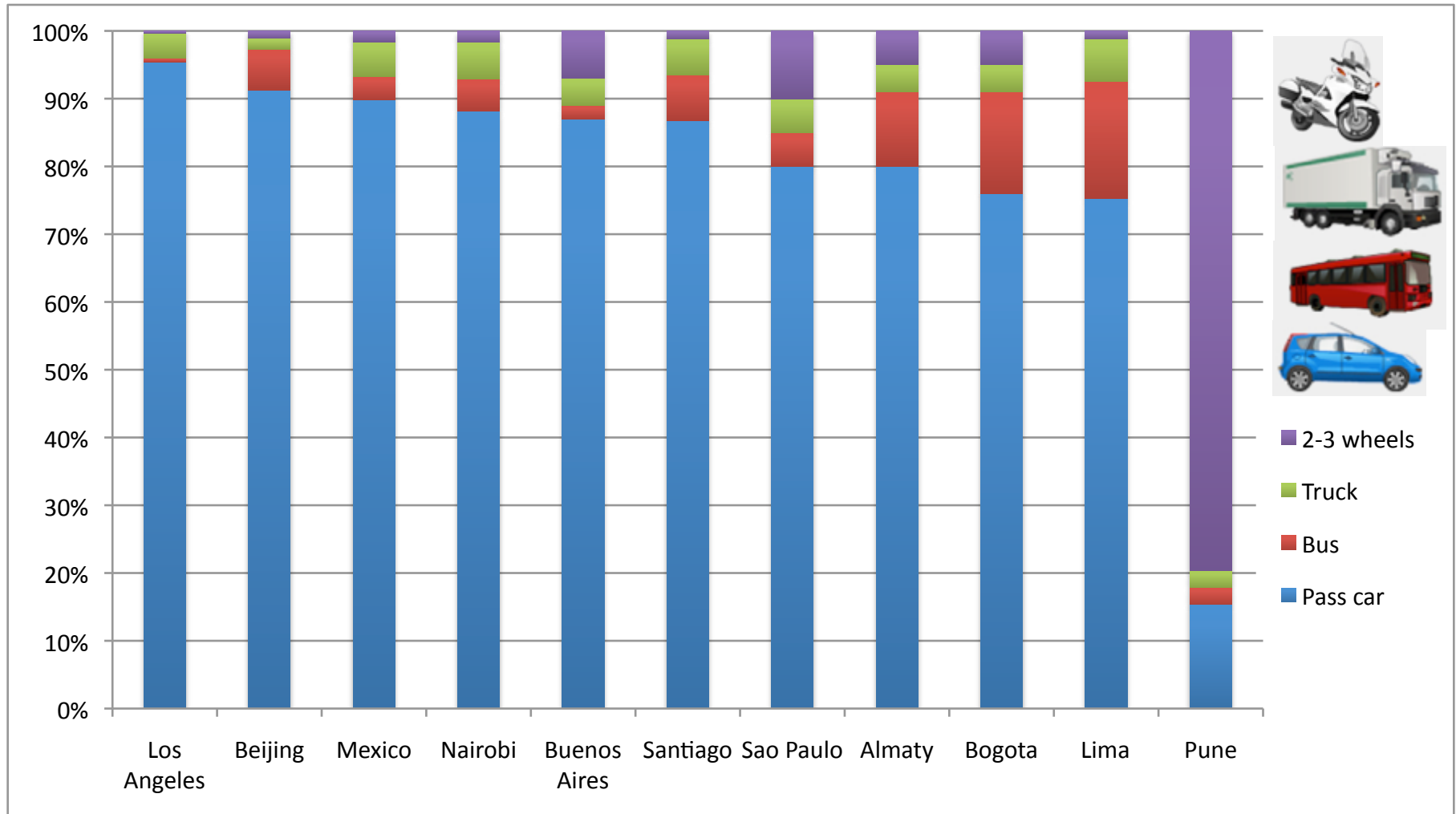
Distribution of Emissions
(Sao Paulo)
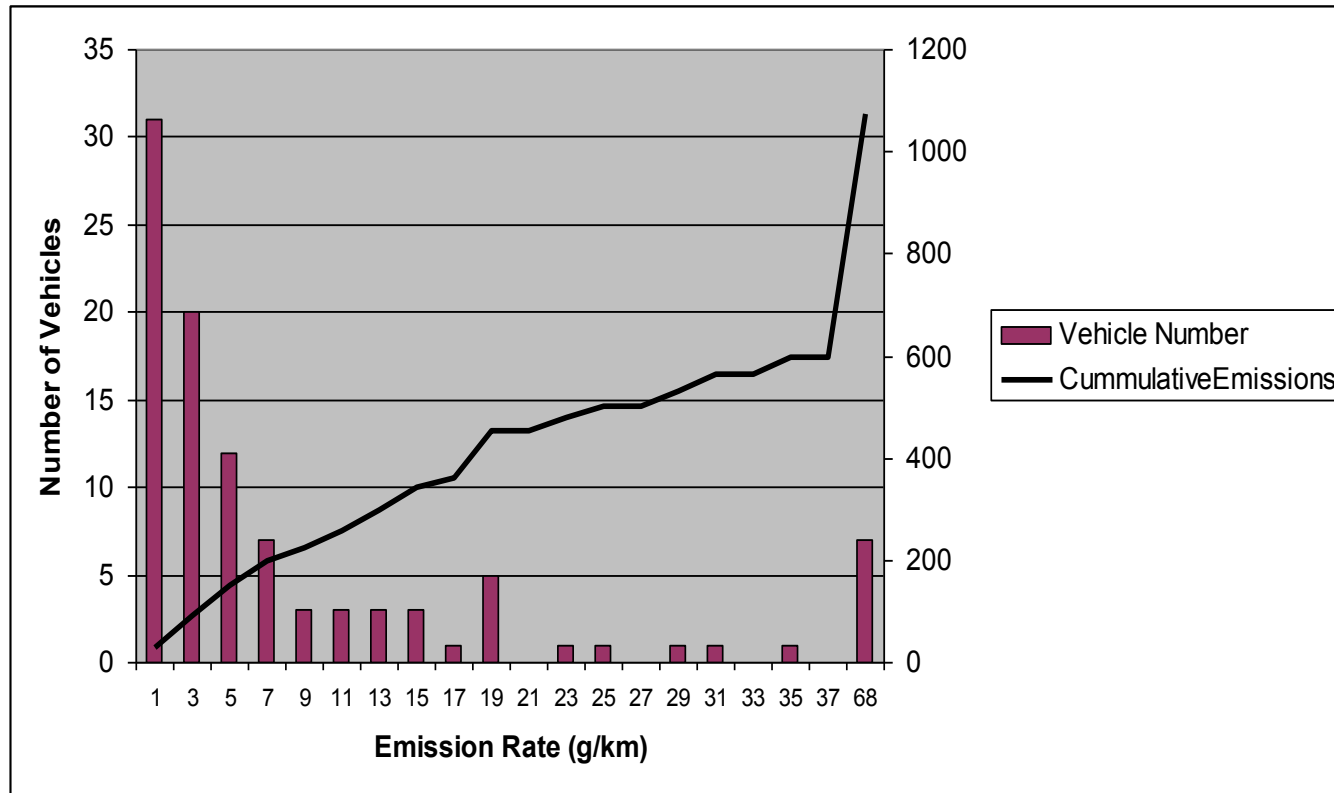
Total Vehicles Successfully Tested: 100
Eight (8) Vehicles (8% of fleet) Contributed ~43% of emissions.
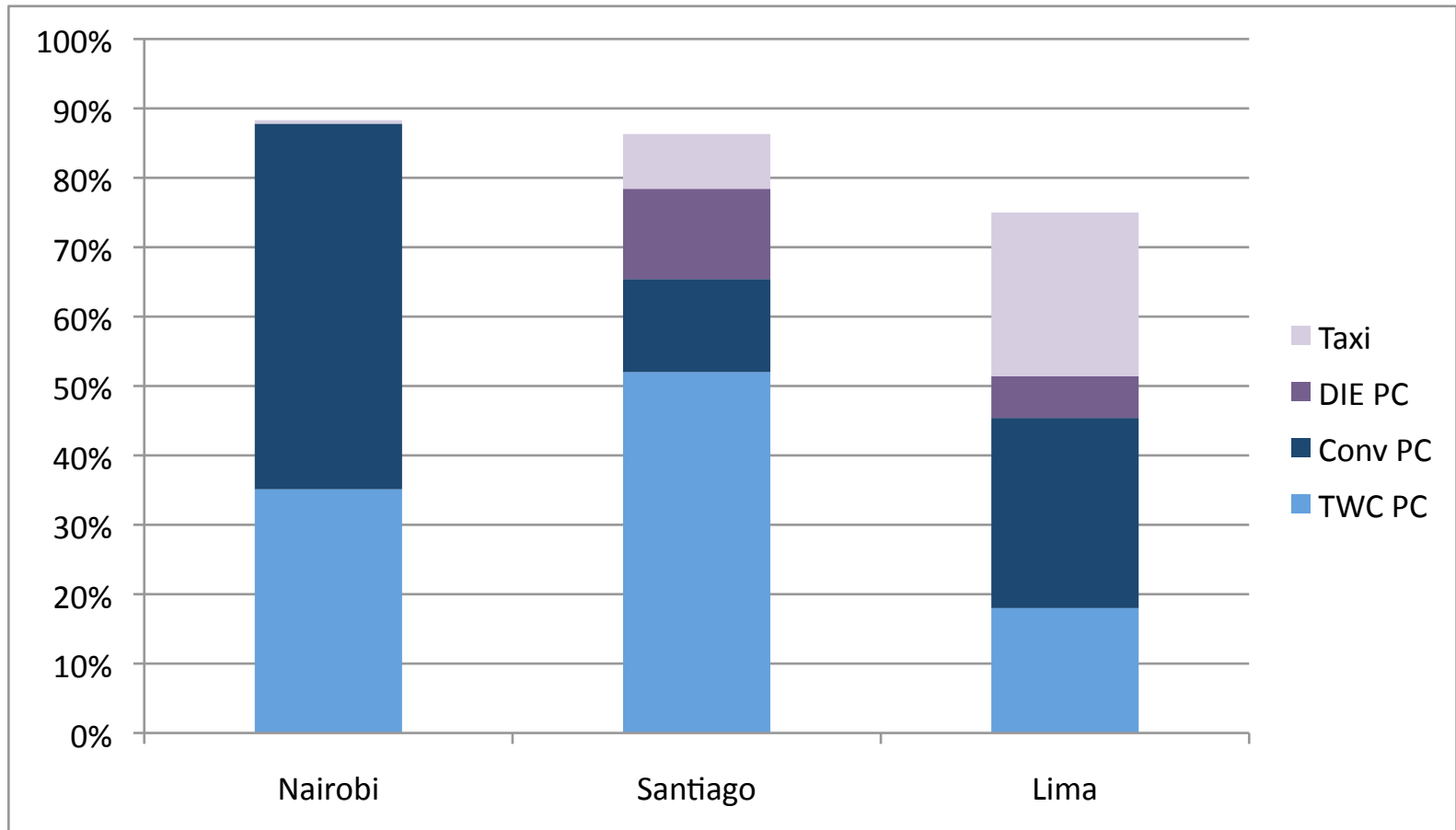
Vehicle Use and Fleet Age
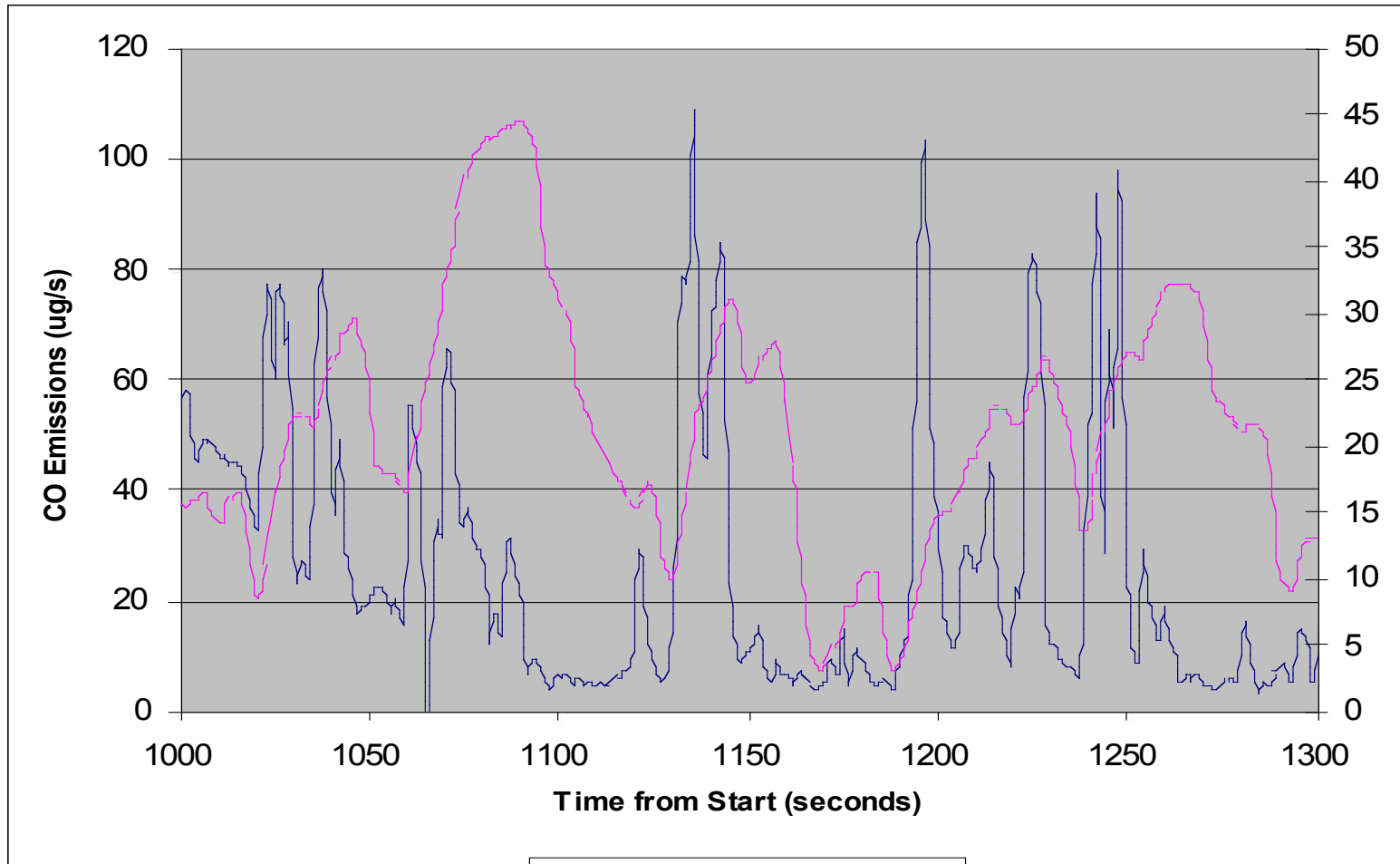
Results: Fleet Composition

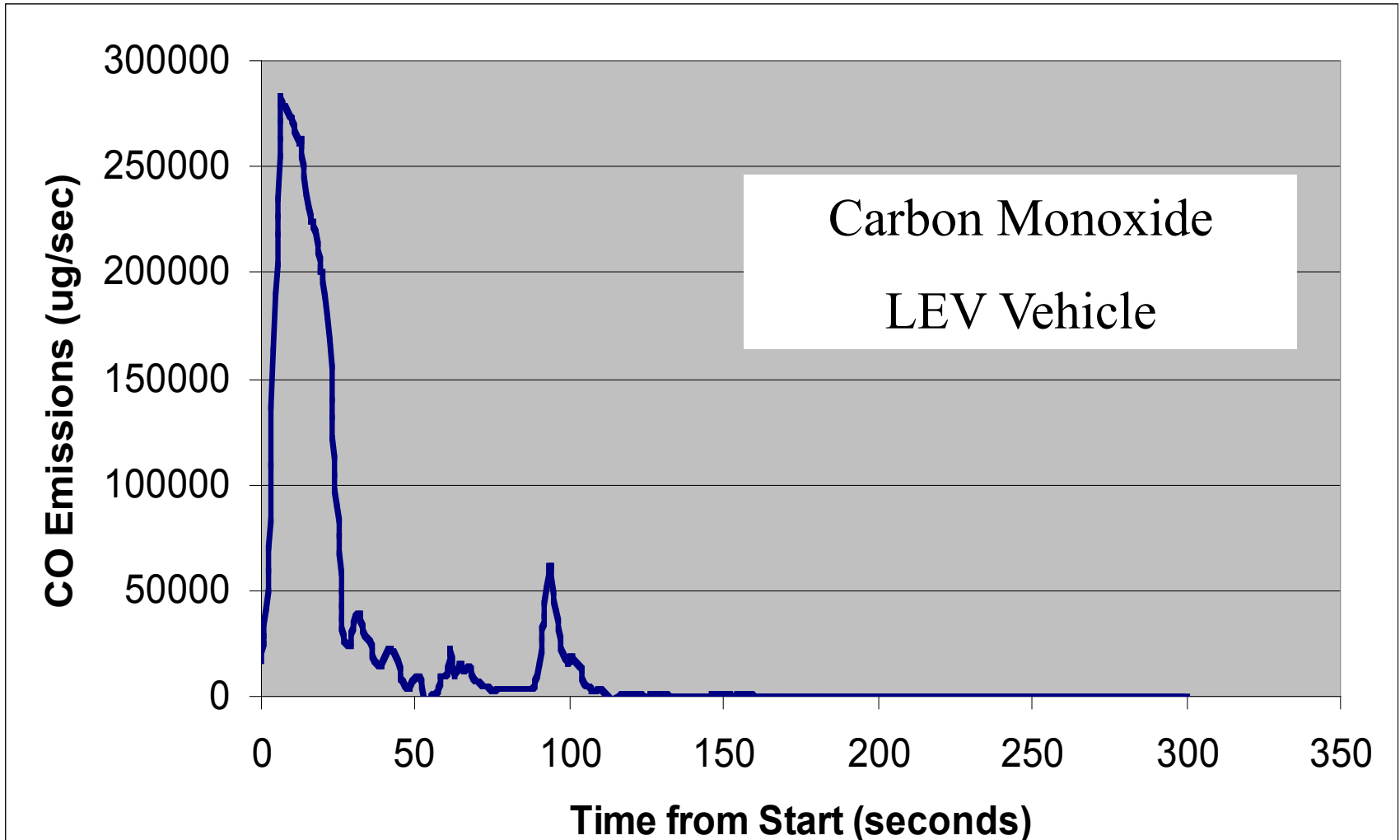|	Los Angeles	Beijing	Mexico	Nairobi	Buenos Aires	Santiago	Sao Paulo	Almaty	Bogota	Lima	Pune

Legend:
- 2-3 wheels
- Truck
- Bus
- Pass car

Results: Vehicle technology Passenger Cars

Sample Running Emissions

Example of Start-Up Emissions

Carbon Monoxide

LEV Vehicle

Application of PEMs/Activity Results to Emission Inventory Development

The International Vehicle Emissions Model (IVE)

◇ Estimate emissions for passenger cars, trucks, buses, three- and two-wheel vehicles for important urban pollutants, toxics, and global warming gases

◇ Includes gasoline, diesel, natural gas, propane, and alcohol fueled vehicles

◇ Incorporates a straightforward methodology to collect the needed modeling information

◇ Allow users a way to update the emission factors when local data is available and adapt to the local situation

IVE Operates in Five Languages

The IED (International Environmental Database)

- ♢ Database system to manage air quality/energy related information

- ♢ Calculate and project air quality emissions, energy requirements, fuel use for urban regions

- ♢ Integrate policy analysis for urban air, water, solid waste, and climate change pollution
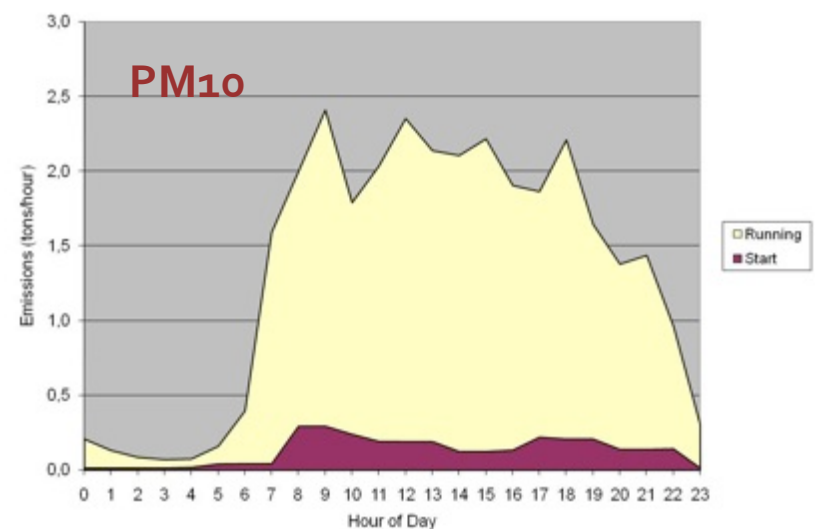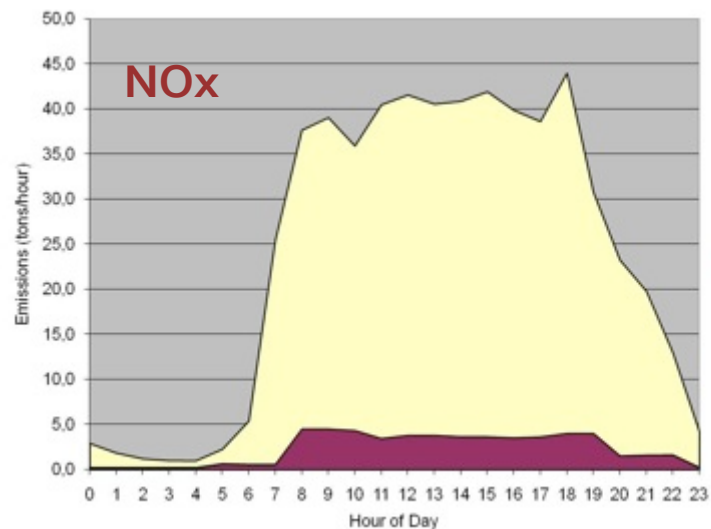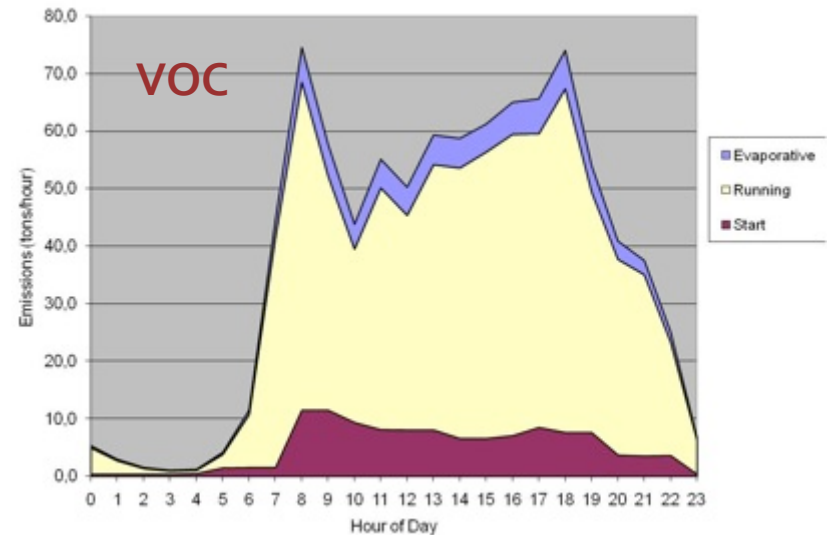
International Environmental Database
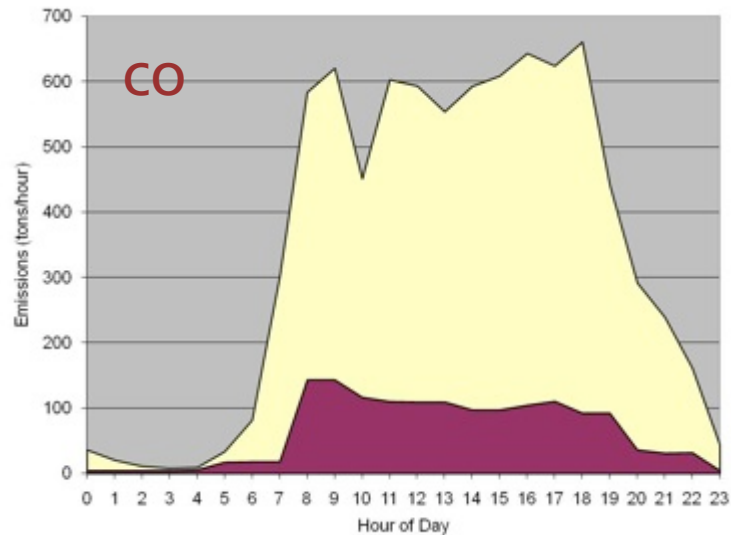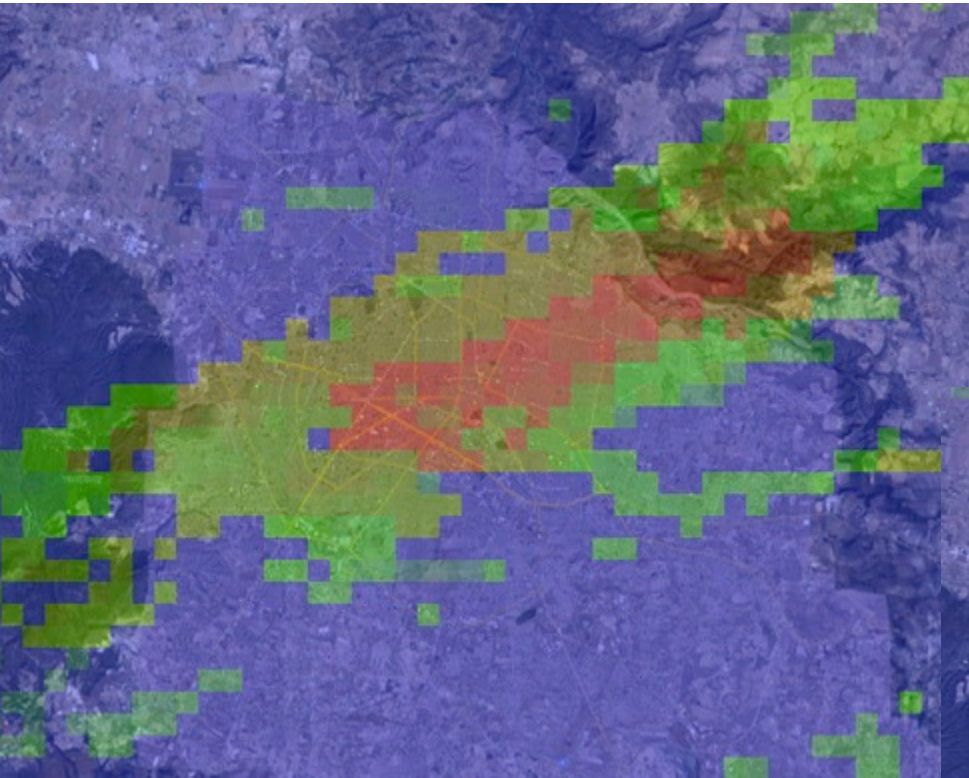
Metropolis

IED Design Requirements

✧Allow businesses to update their own information

✧Support source enforcement

✧Support emission caps and credit trading

✧Remotely accessible

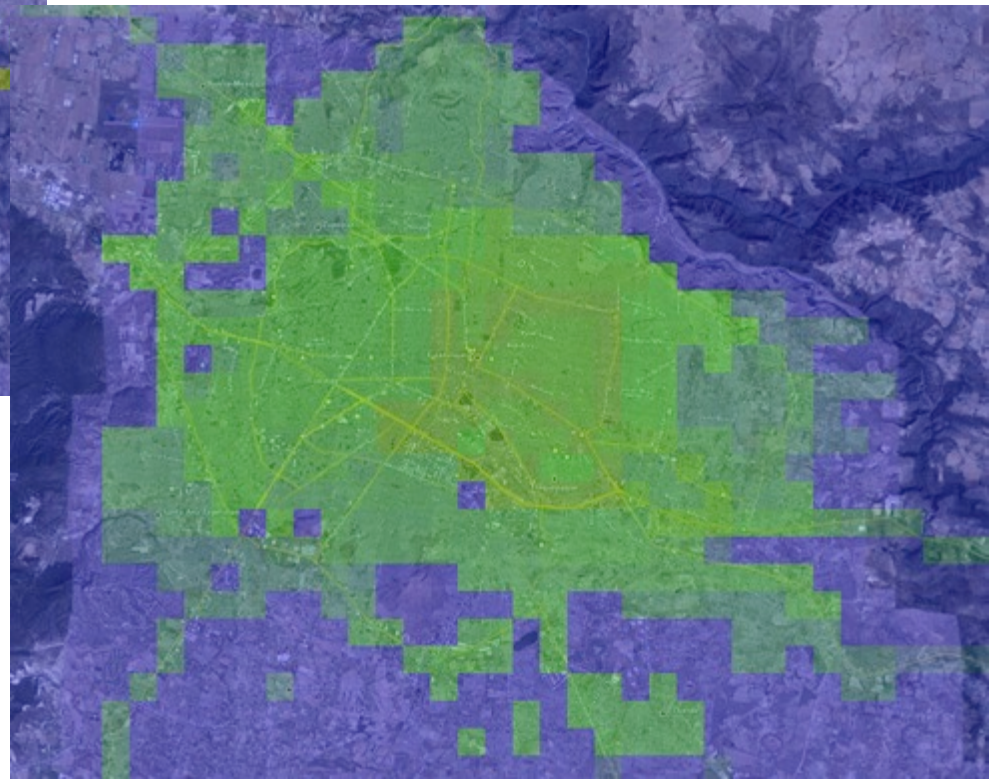✧Available free

✧Secure & Flexible
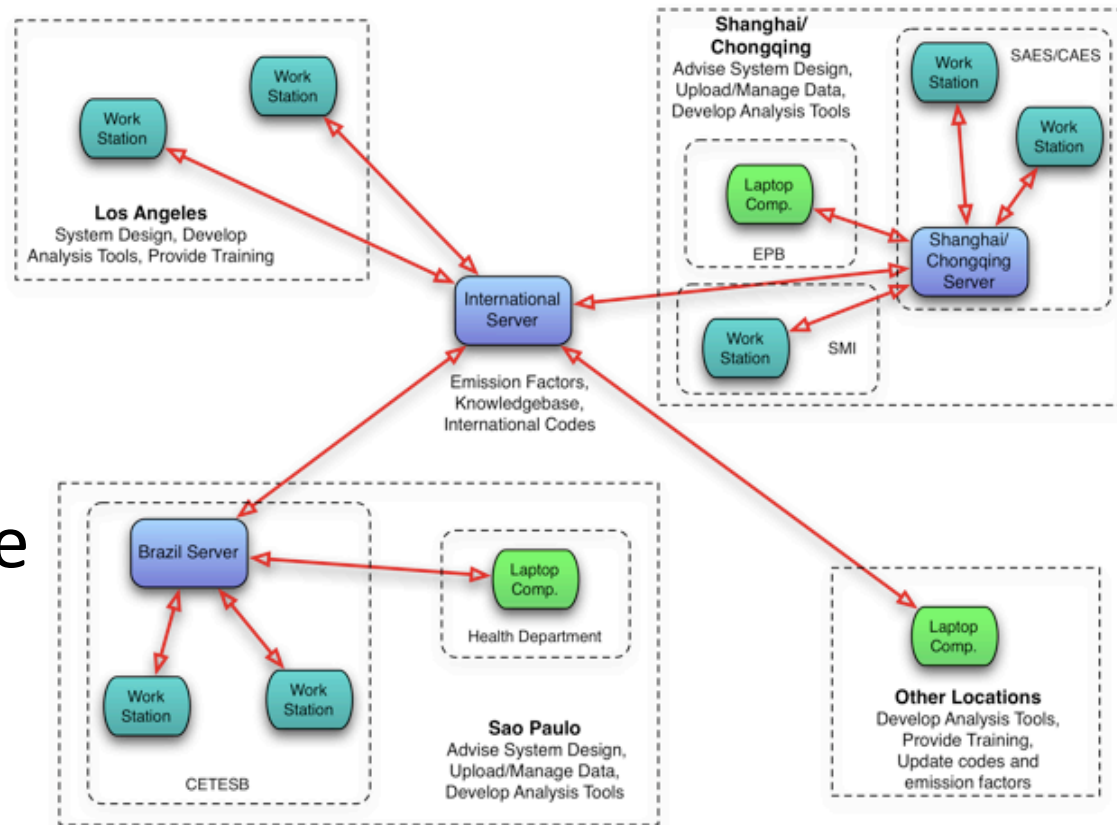
Daily Emissions in Sao Paulo

Spatial Distribution of NOx in Guadalajara from On-Road

2015-Annual

2010-Annual

Integration of Data

- PEMs emission measurements combined with Vehicle Activity can be integrated into an inventory result

- Can produce spatial and temporal resolution of urban on-road emission sources

- Allows development effective air quality management policy