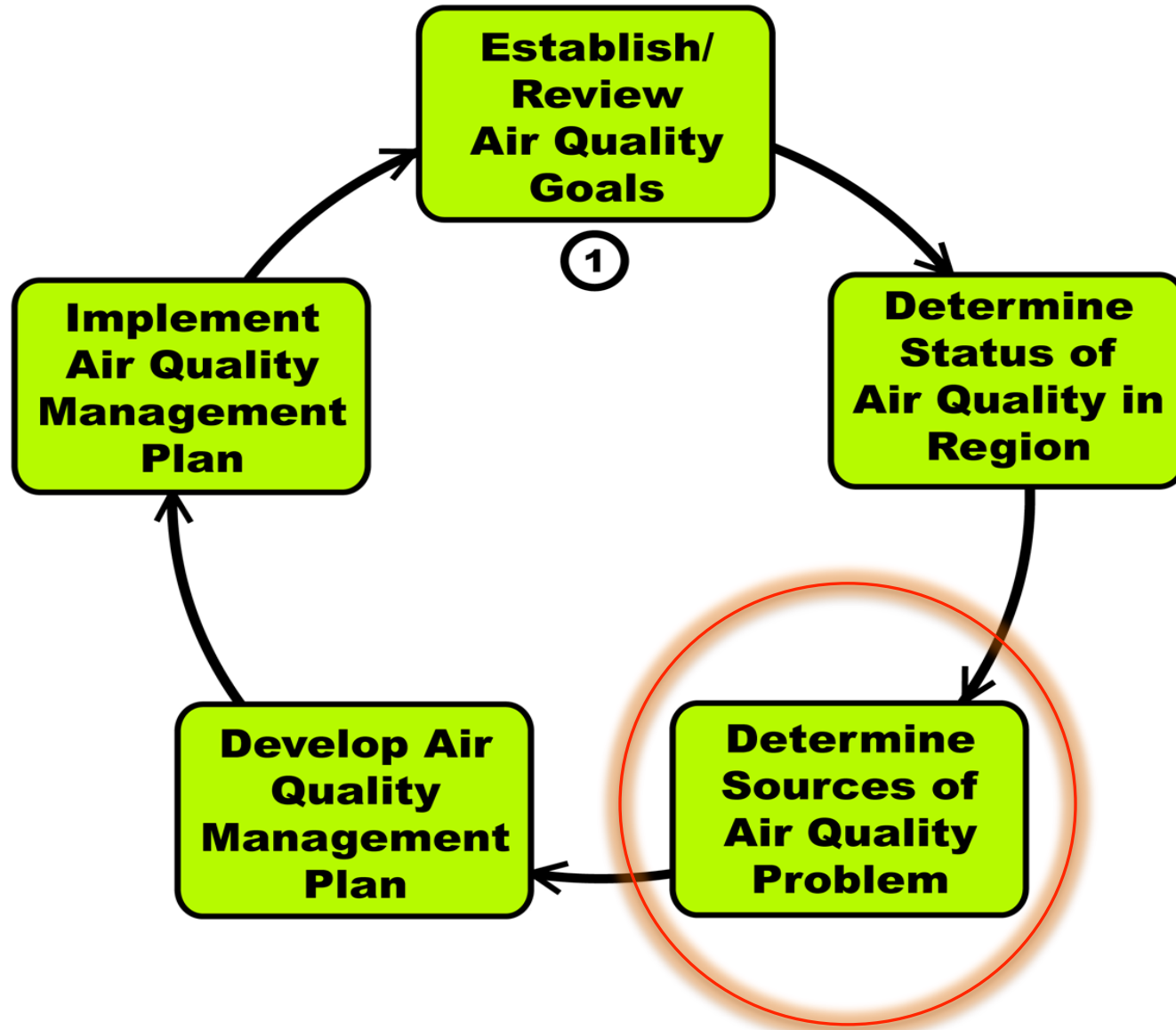


Using PEMs and Local Vehicle Activity Measurements to Improve Inventories and Policy Development in Developing Countries

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 by 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



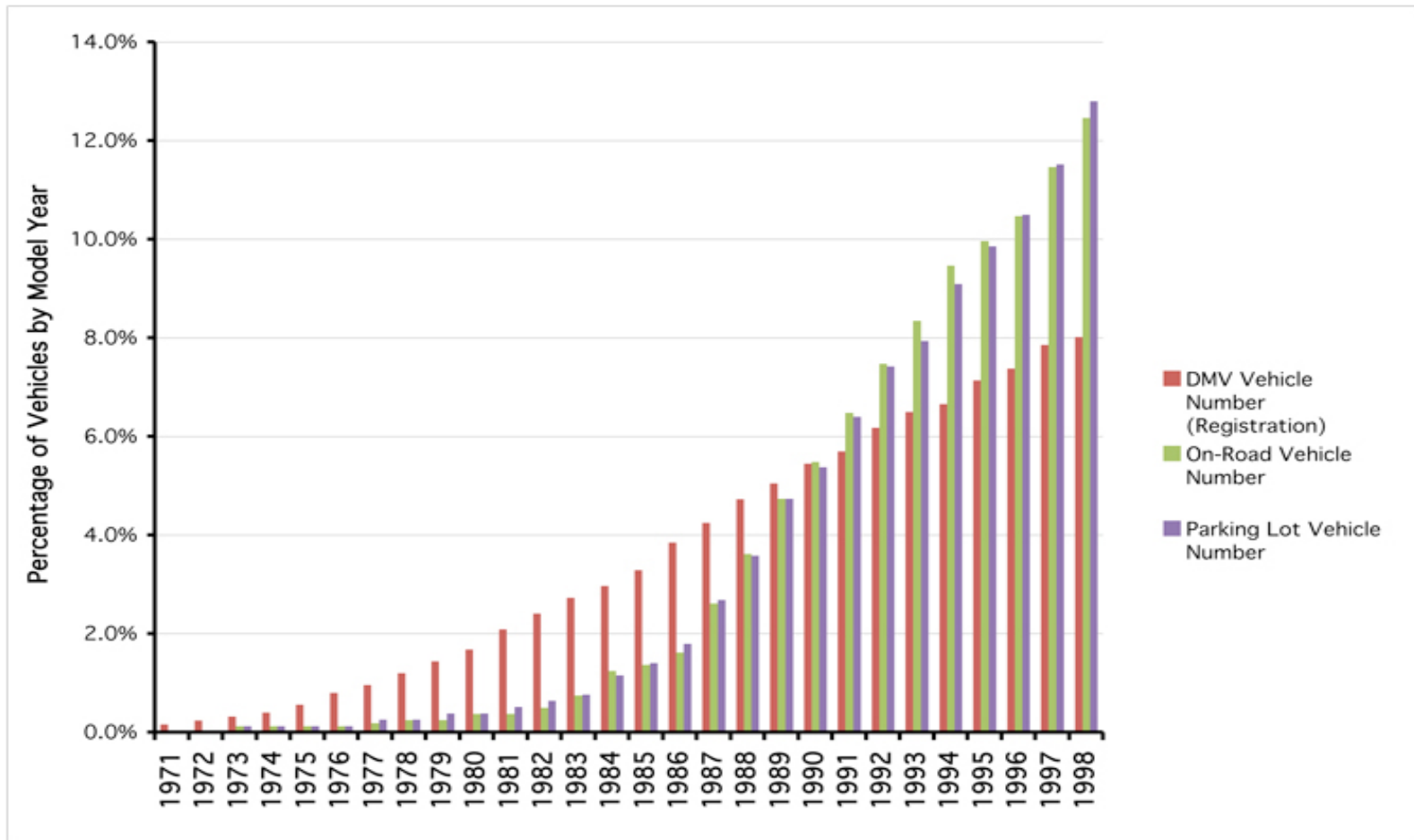
Getting Fleet Distribution Information in India



Parking Lot Surveys for Information

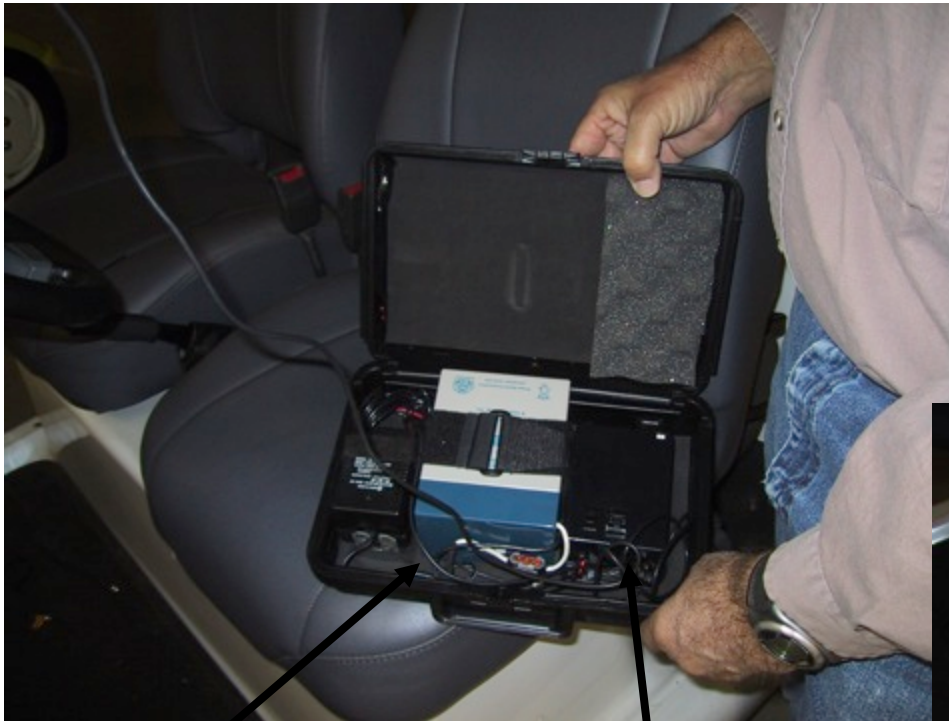


Los Angeles Registration, Videotape, Parking Lot



Driving Patterns: GPS / Microprocessor Unit

Driving
Patterns



Battery good for 40
hours of testing.

GPS/Microprocessor
Module

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

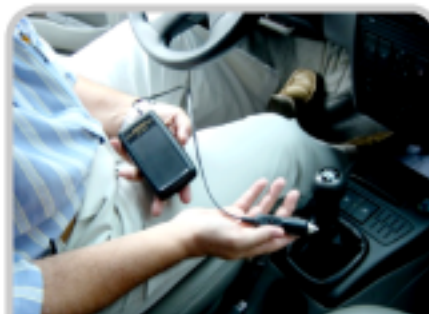


Note: This is the original style GPS used.

Start Patterns



Set-up procedure



Measurement process



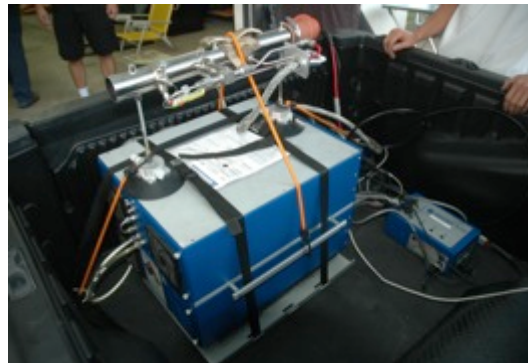
Downloading data

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

EVALUATE DRIVING DATA

PM Adj: 1.0 CO Adj: 1.0 CO2 Adj: 1.0 NO2 Adj: 1.0 THC Adj: 1.0

Select Files to Evaluate

- ☐ All
- ☐ CnstSpd100KPH.txt
- ☐ CnstSpd30KPH.txt
- ☐ CnstSpd50KPH.txt
- ☐ Example001.txt
- ☐ Example002.txt
- ☐ Example003.txt
- ☐ GPS_03_NE_MIC_050905.txt
- ☐ mypemsdata.txt

Clear CALCULATE Sel ALL CALCULATE SAVE RESULTS

Calculation Results (%) File Initials:

Display Parameters: Combined Runs Driving Raw Data Use Combined Runs for Sta... FTP Cal. with IVE Bin C...

Cold Start Emissions: g/200 sec Running Emissions: g/km g/km

Hot Start Emissions: g/200 sec Actual Corrected to FTP

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Low Stress																				
Med Stress																				
High Stress																				

Data Number: Average Speed: km/hr

Results of Interest from Testing Program

How Many Vehicles Should Be Tested?

90% Confidence Intervals

# in Group	CO	CO ₂	NO _x	THC
<5	71%	15%	36%	104%
5-19	44%	11%	40%	50%
20-49	20%	6%	27%	23%
>50	23%	5%	22%	27%

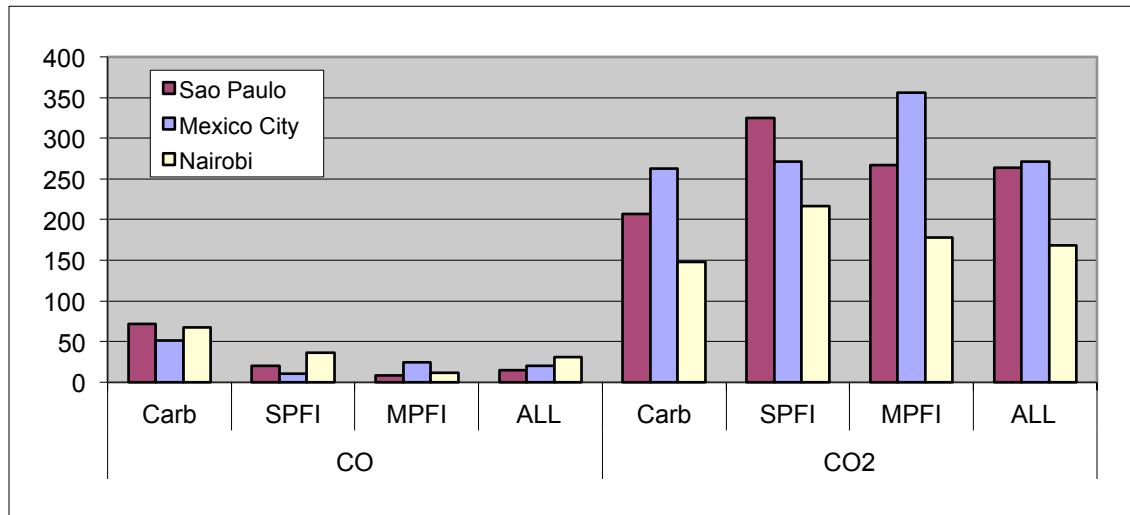
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Testing at least 20 vehicles in a technology group is important!

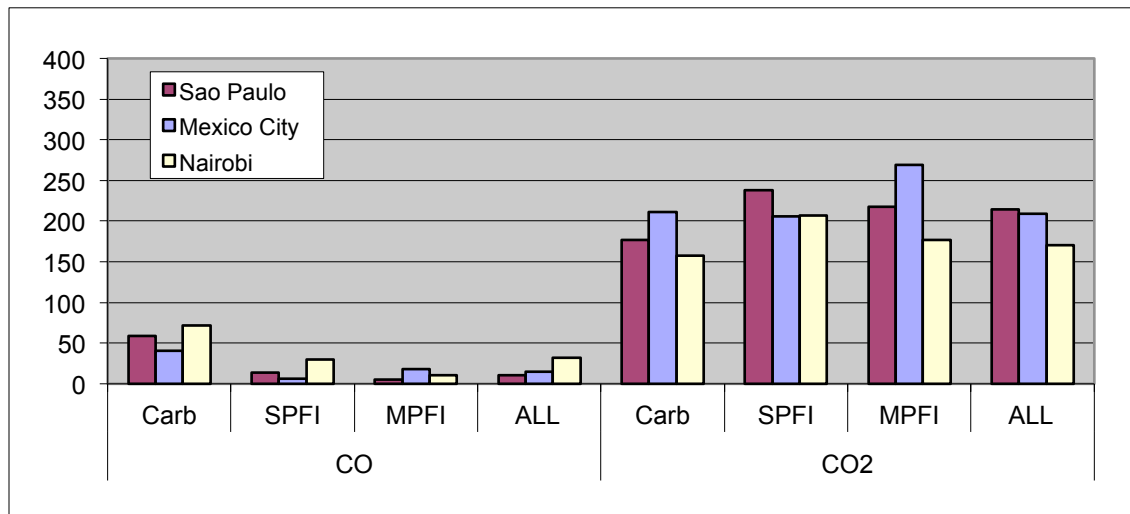
Fleetwide Confidence Intervals

	Ave # per tech group	Total #	CO	CO2	NO_x	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

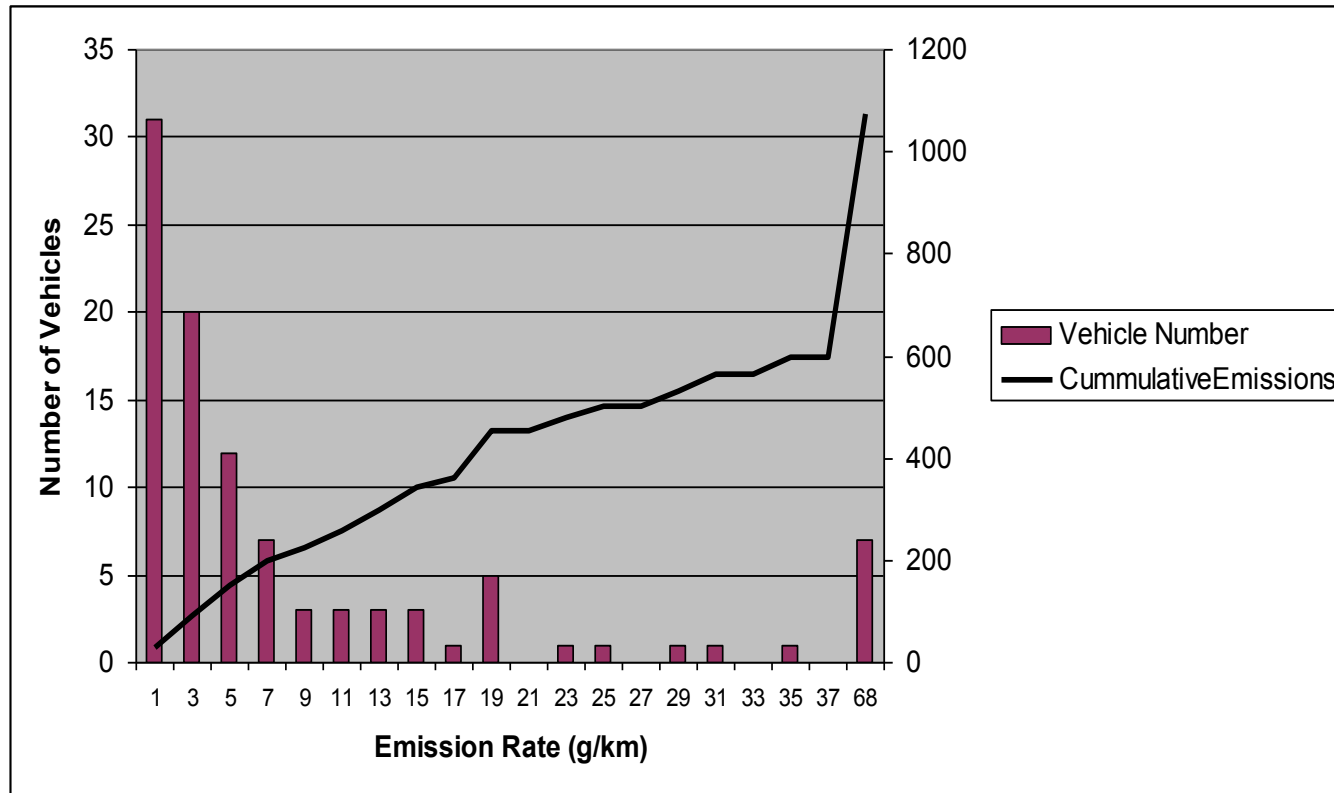


Data from Actual On-Road Test



Data Corrected to LA4 (FTP) Cycle

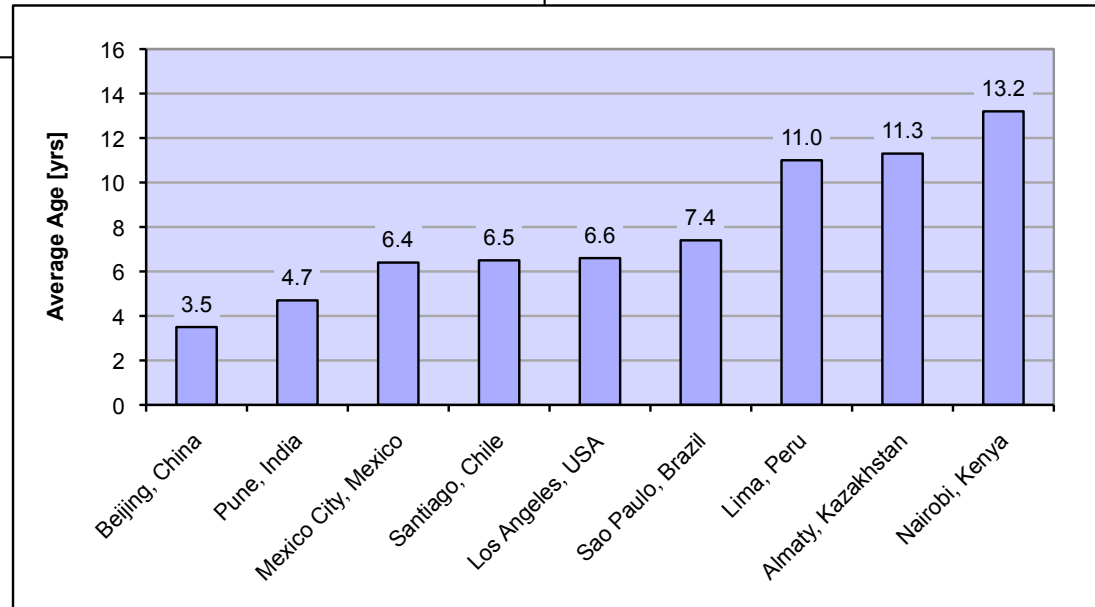
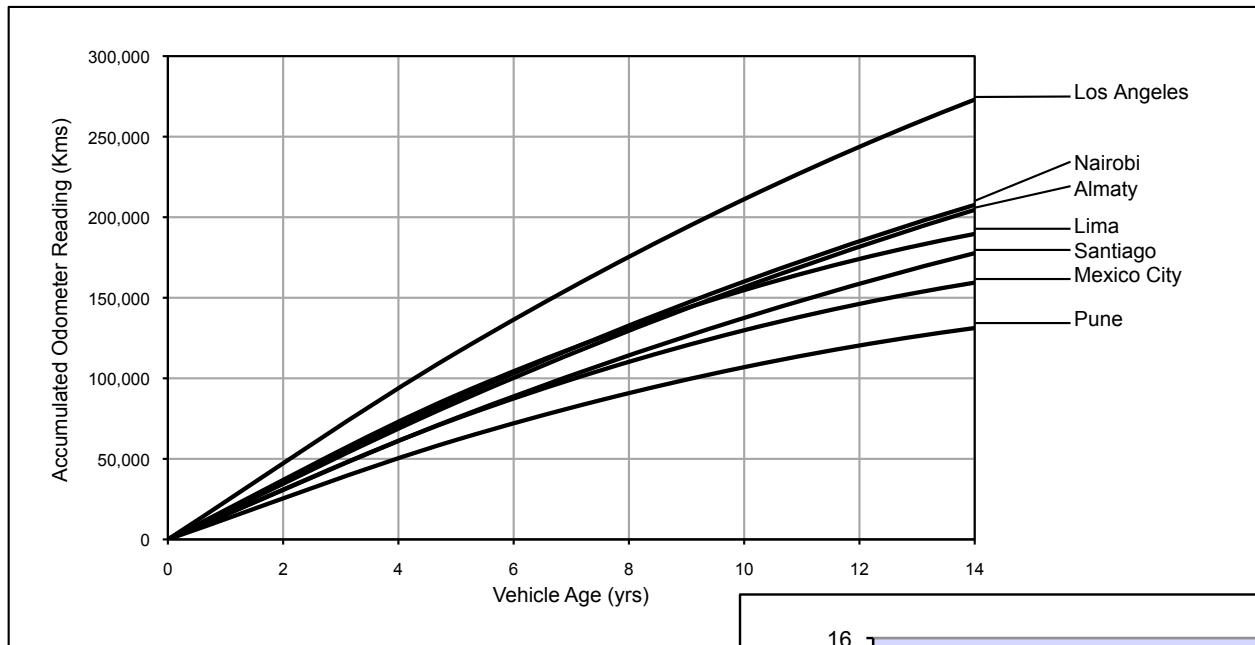
Distribution of Emissions (Sao Paulo)



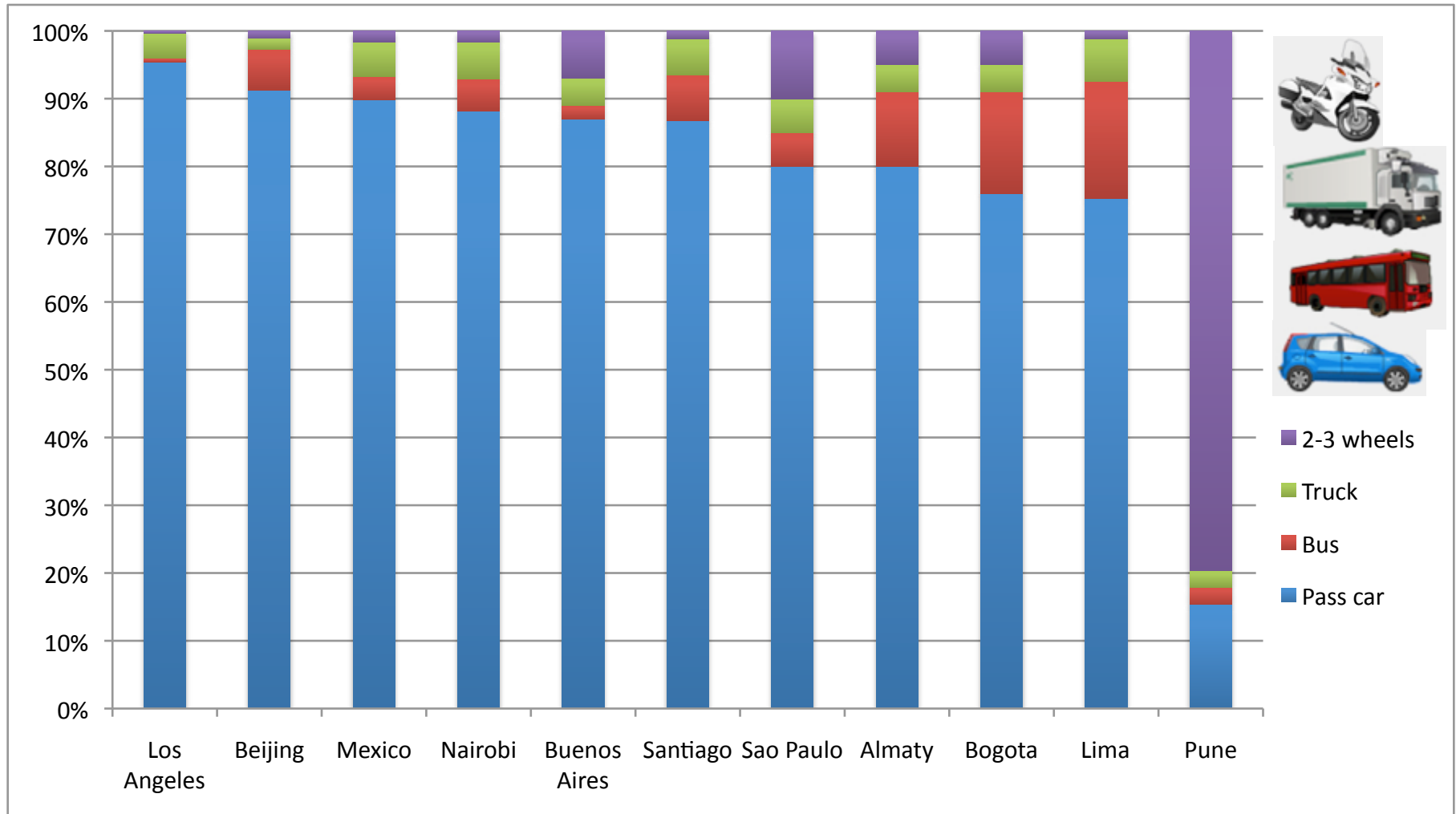
Total Vehicles Successfully Tested: 100

Eight (8) Vehicles (8% of fleet) Contributed ~43% of emissions.

Vehicle Use and Fleet Age

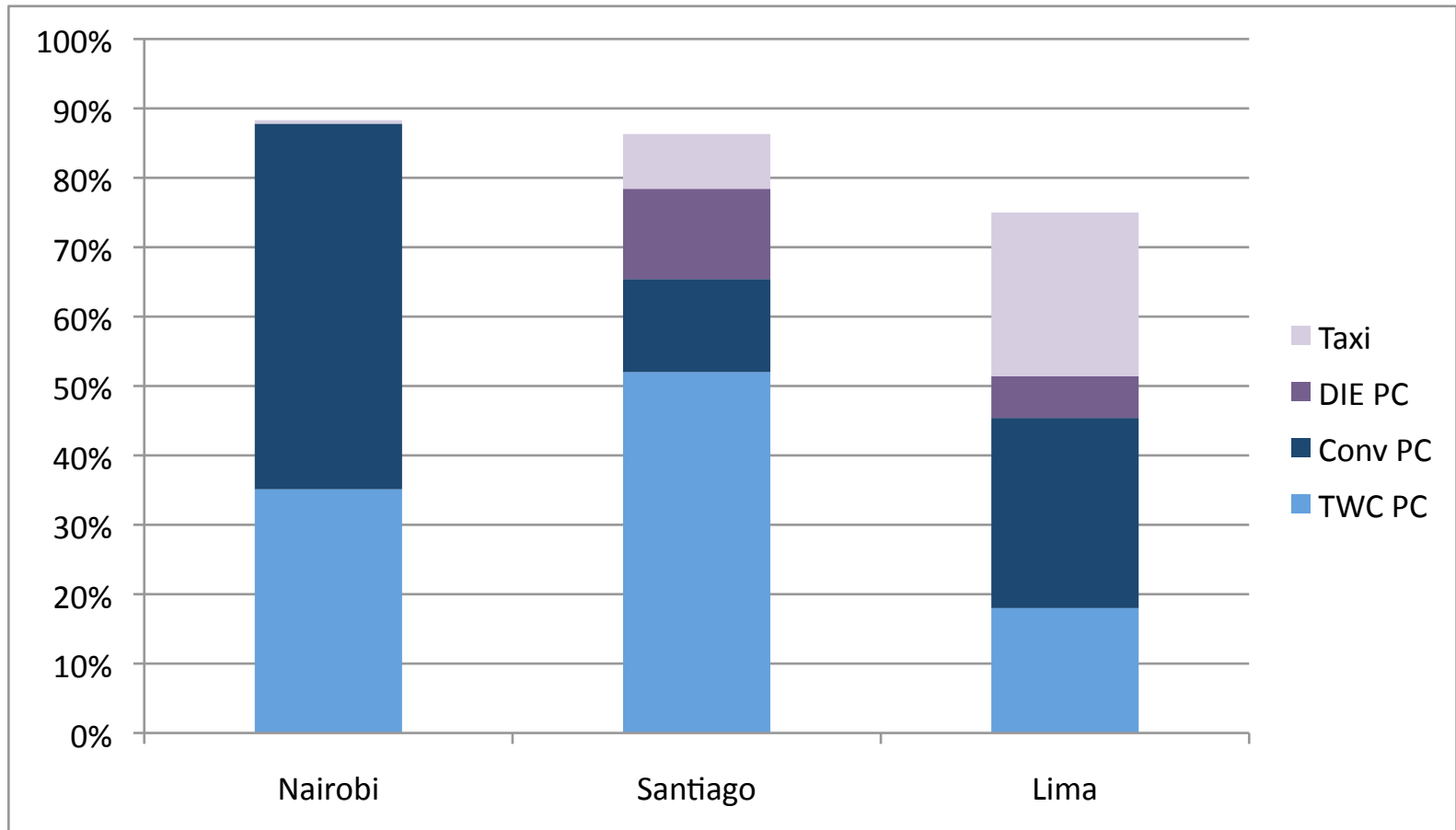


Results: Fleet Composition

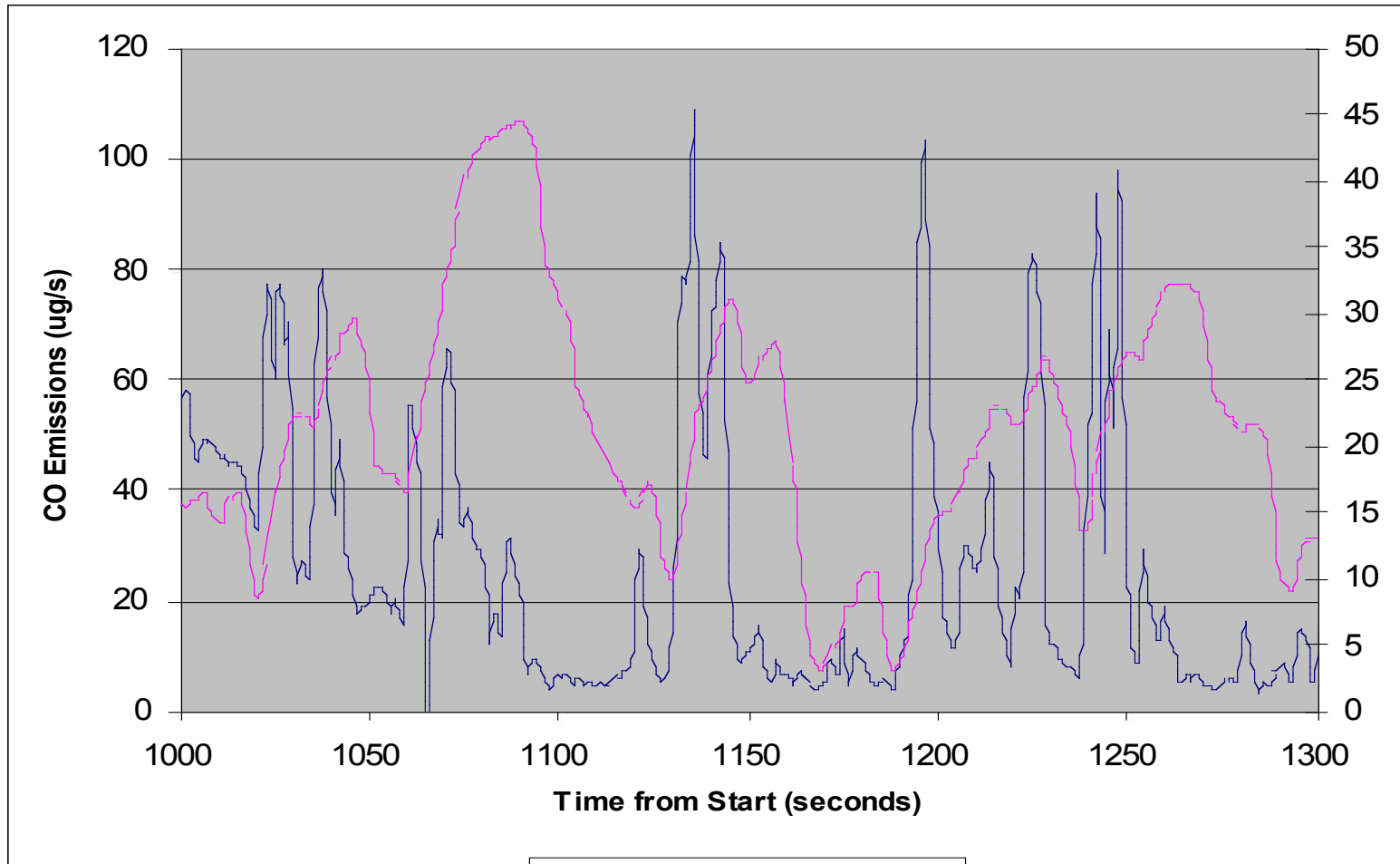


Results: Vehicle technology

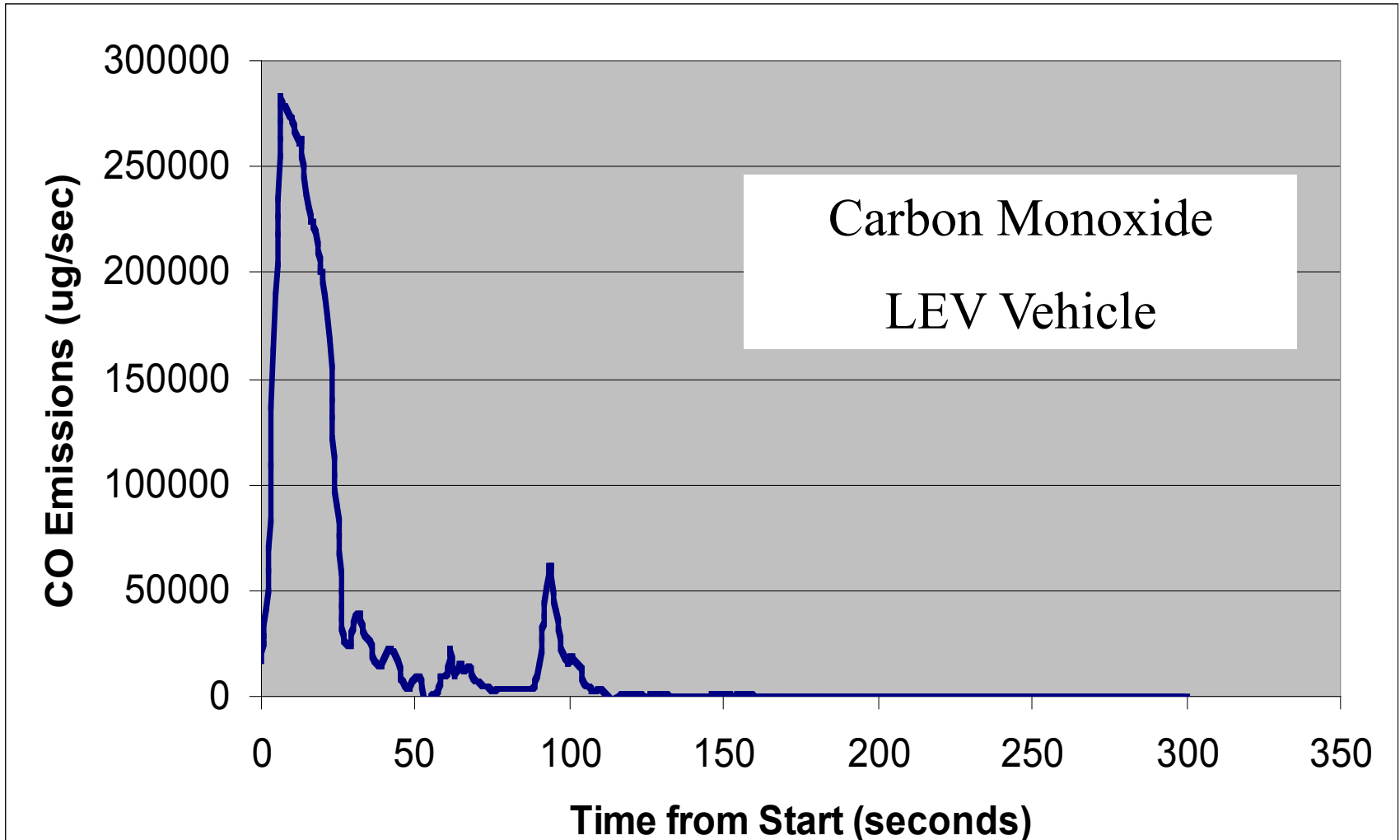
Passenger Cars



Sample Running Emissions



Example of Start-Up Emissions



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 image displays three overlapping screenshots of the IVE Model 2.0 software interface, demonstrating its multilingual capabilities. The top-left screenshot shows the English version, titled 'International Vehicle Emissions Model'. The top-right screenshot shows the Russian version, titled 'ВЫБРОСЫ АВТОТРАНСПОРТНЫХ СРЕДСТВ В АТМОСФЕРУ (международная модель)'. The bottom-center screenshot shows the Chinese version, titled '全球机动车排放模型'. Each interface includes a 'File' menu, a 'Language' dropdown, and tabs for 'Calculation', 'Location', 'Fleet', and 'Base Adjustments'. The 'Calculation' tab is active in all three, showing a 'Location Group' dropdown set to 'single location', a 'Calculate Locations' button, and a list of 'Available Locations' including Istanbul bus, commercial car, dolmus, heavy truck, medium truck, PCAR, and PCARCOE. The bottom-right screenshot also shows a 'Results' table with columns for CO, VOC, VOC enap, NOx, SOx, and PM, and rows for 'Start-up Hour', 'Running Hour', 'Total Hour', 'Start-up Day', 'Running Day', and 'Total Day'.

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

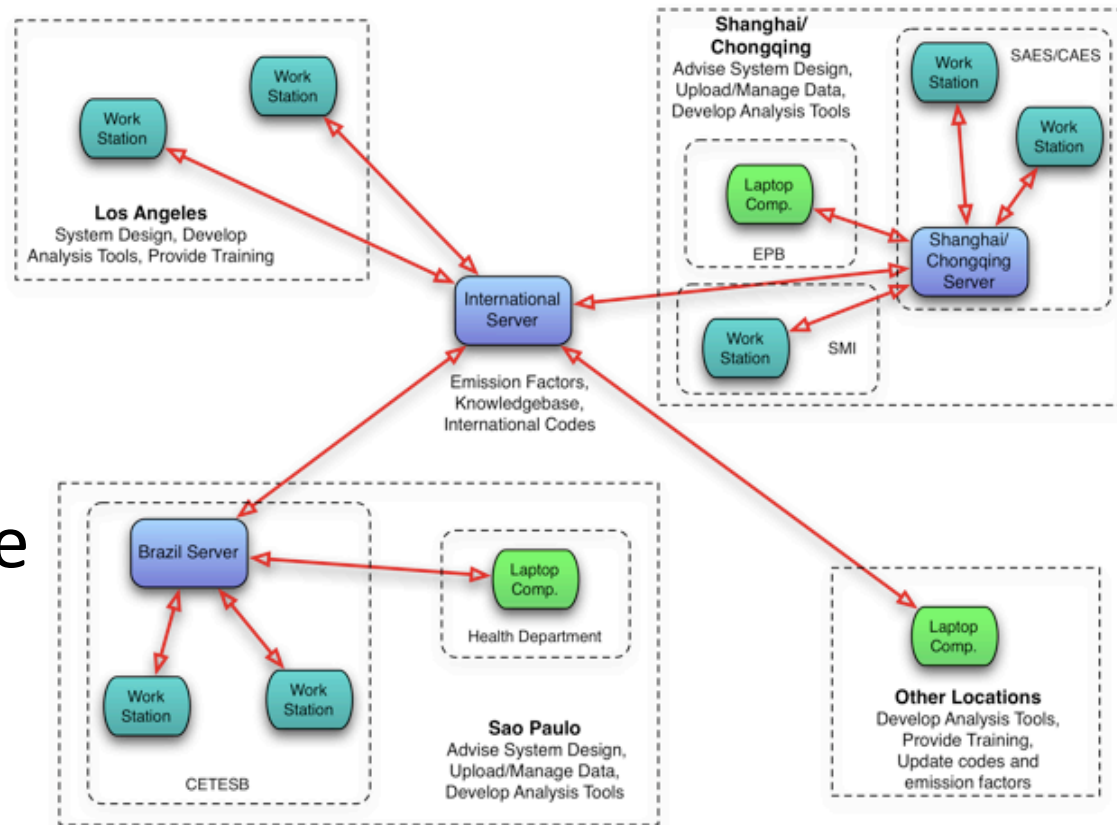


International Environmental Database

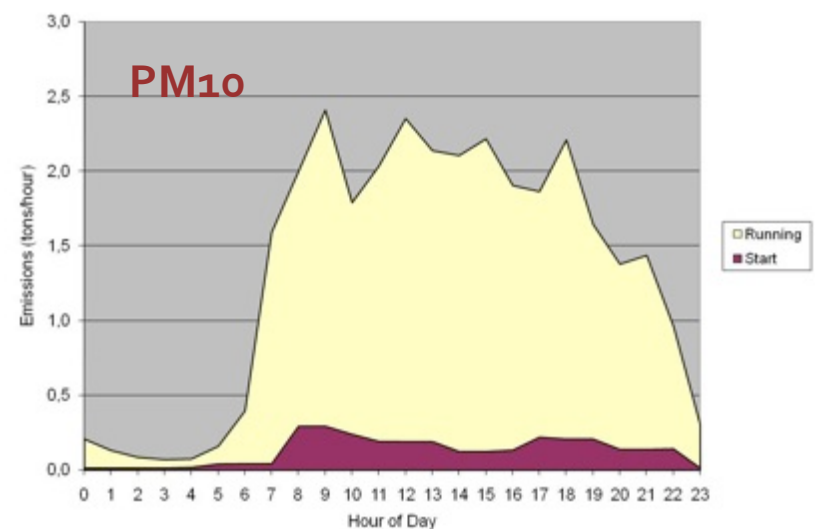
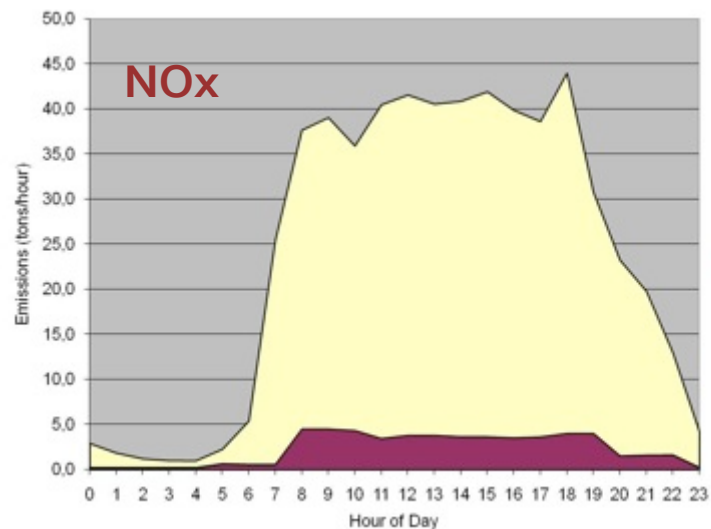
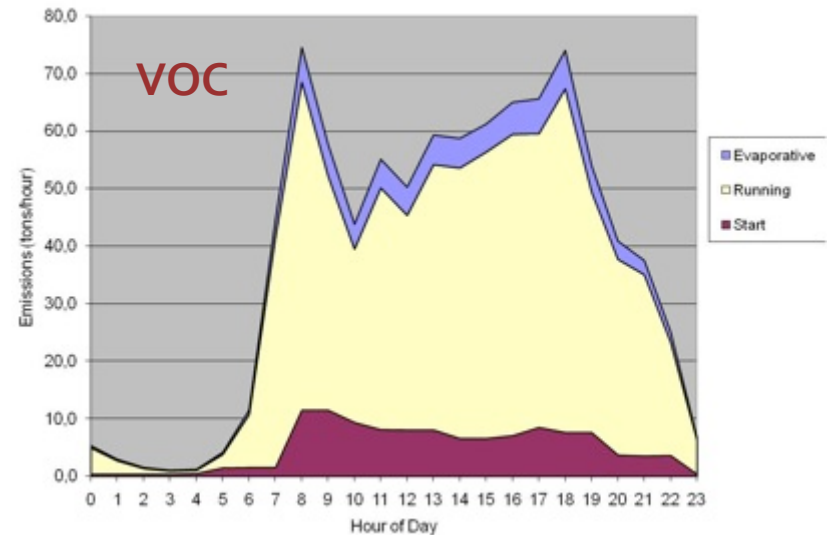
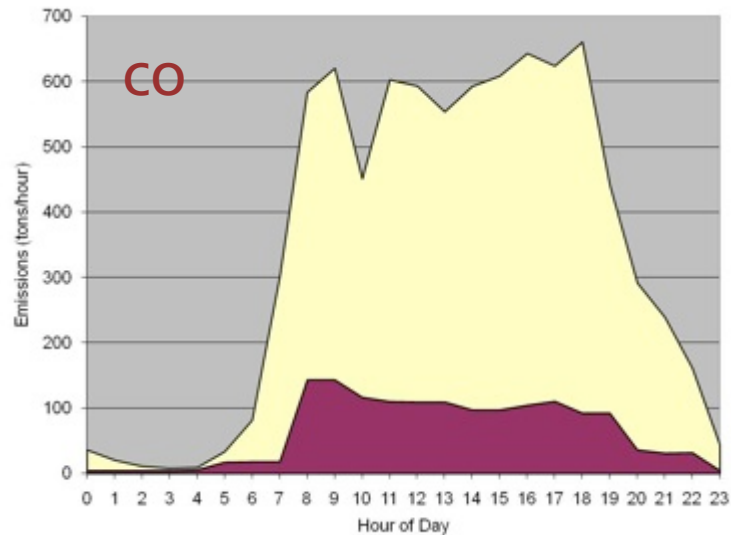
Metropolis

IED Design Requirements

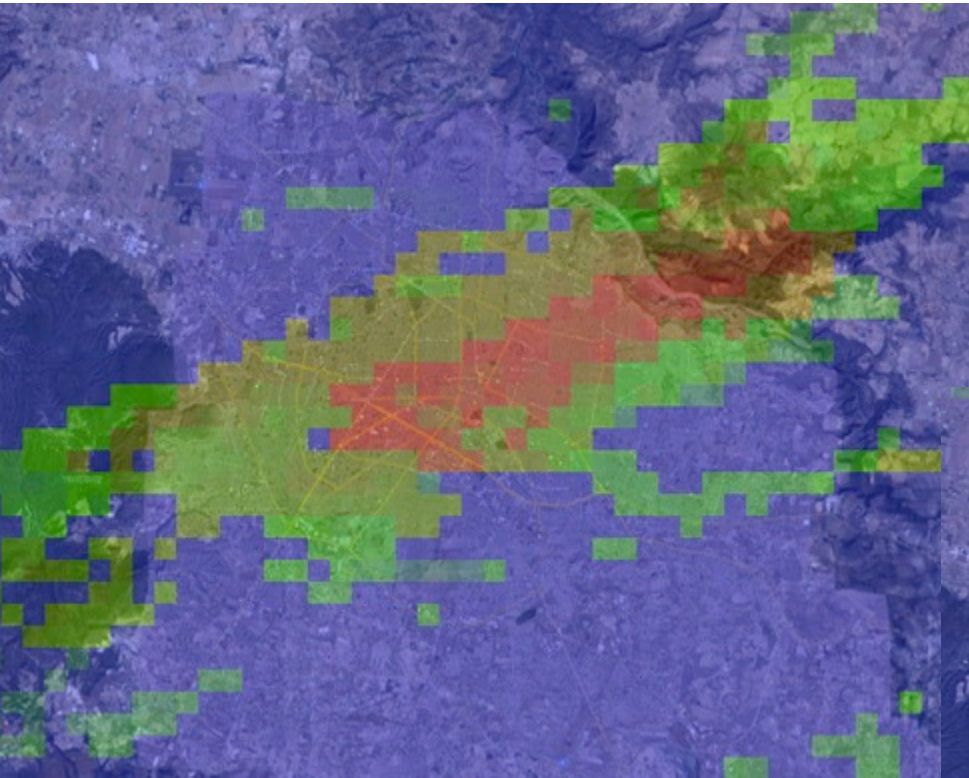
- ✧ Allow businesses to update their own information
- ✧ Support source enforcement
- ✧ Support emission caps and credit trading
- ✧ Remotely accessible
- ✧ Available free
- ✧ Secure & Flexible



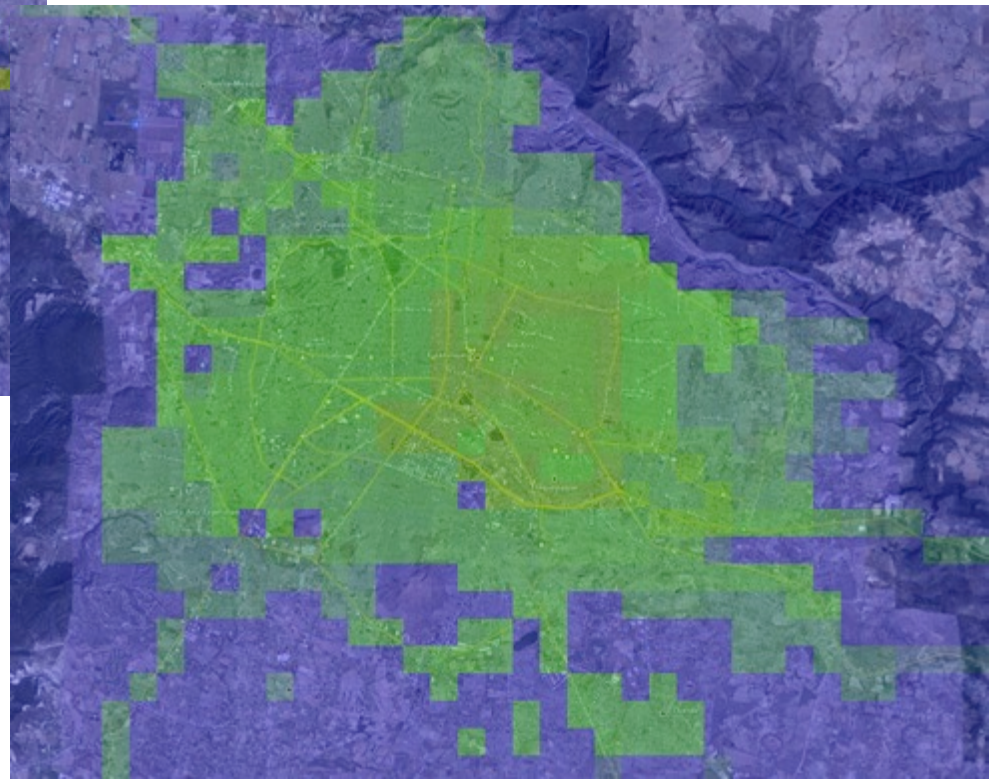
Daily Emissions in Sao Paulo



Spatial Distribution of NO_x in Guadalajara from On-Road



2010-Annual



2015-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