

Air Quality Monitoring & Management Challenge in Dhaka

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History of Air Quality Management (AQM)

- AQM in Bangladesh is relatively recent.
- Ambient air quality standards were first introduced in 1997 under the environmental conservation rules (ECR) 1997.
- The Air Quality Management Project (AQMP) implemented by the DoE during 2000-2007. First major project aimed at AQM .
- With support from the World Bank Clean Air and Sustainable Environment (CASE) Project has been continuing since 2010.

Ambient air quality standards in Bangladesh (from July 2005)

Pollutant	Averaging time	Bangladesh standard ($\mu\text{g}/\text{m}^3$)	WHO guideline ($\mu\text{g}/\text{m}^3$)	US standard ($\mu\text{g}/\text{m}^3$)
Carbon Monoxide (CO)	8 hour	10,000 (9 ppm)	10,000	10,000
	1 hour	40,000 (35 ppm)	30,000	40,000
Lead (Pb)	Annual	0.5	0.5	0.15
Nitrogen Oxides (NO_x)	Annual	100 (0.053 ppm)	-	-
Suspended Particulate Matter (SPM)	8 hour	200	-	-
Coarse Particulates (PM_{10})	Annual	50	20	-
	24 hour	150	50	150
Fine Particulates ($\text{PM}_{2.5}$)	Annual	15	10	15
	24 hour	65	25	35
Ozone (O_3)	1 hour	235 (0.12 ppm)	-	235
	8 hour	157 (0.08 ppm)	100	157
Sulfur di Oxide (SO_2)	Annual	80 (0.03 ppm)	-	78
	24 hour	365 (0.14 ppm)	20	365

Source of Air Pollution

Major sources of the individual these global air pollutants are relevant for Bangladesh,

Pollutant	Sources
Carbon Monoxide (CO)	Motor vehicle exhaust, kerosene or wood burning stoves.
Sulfur Dioxide (SO ₂)	Coal-fired power plants, brick kilns, petroleum refineries, sulfuric acid manufacture, and smelting sulfur containing ores.
Nitrogen Dioxide (NO ₂)	Motor vehicles, power plants, and other industrial, commercial, and residential sources that burn fuels (e.g. diesel generators).
Ozone (O ₃)	Vehicle exhaust and certain other fumes. Formed from other air pollutants in the presence of sunlight.
Lead (Pb)	Metal refineries, lead smelters, battery manufacturers, iron and steel producers.
Particulate Matter (PM)	Diesel engines, power plants, brick kilns, industries, windblown and road dust, wood stoves.

Industrial Emission Standard (cont.)

w'wZgvc (Standard)	mg/Nm ³ GK#K Dcw'wZ
e'KYv (Particulate Matter)	
(K) 200 †gMvIqvU ev Zvnvi AwaK ygZvm#úböe (Power Plant > 200MW)	150
(L) 200 †gMvIqvU Gi wb#œygZvm#úböe (Power Plant < 200MW)	350
#K-vwib (Cl)	150
nvB#W#v#K-vwiK GwmW ev'ú I Kzqvmv (HCl Acid vapour)	350
mvwe©K †d-vivBW F	25
mvjwdDwiK GwmW Kzqvkv (H ₂ SO ₄ Acid vapour)	50
#jW e'KYv (Pb Particle)	10
gvK©vix e'ÍvKYv (Hg Particle)	0.2
mvjdvi WvBA-vBW (SO ₂)	#KwR/Ub GwmW (Kg/ton)
(K) mvjwdDwiK GwmW Drcv'b (DCDA * cÖwµqv)	4
(L) mvjwdDwiK GwmW Drcv'b (DCDA * cÖwµqv)	10

Industrial Emission Standard (cont.)

Standard	mg/Nm ³ GK±K Dcw ⁻ wZ
(K) Coal Based Power Plant (1) > 500 MW (2) 200-500 MW (3) <200 MW	275 220 14 (Q)0.3
(L) Boiler (1) <15 ton/hr (2) > 15 ton/hr	11 14 (Q)0.3
(K) Nitric Acid Production (L) Gas Based Power Plant (1) > 500 MW (2) 200-500 MW (3) <200 MW (M) Metallurgical Oven	3 Kg/ton acid 50 ppm 50 ppm 40 ppm 30 ppm 200 ppm

Industrial Emission Standard

$w^{-1}wZ_{gvc}$ (Standard)	mg/Nm^3 GK \nmid K Dcw ^{-1}wZ
Kiln soot and dust	
(K) Blast Furnace	500
(L) Brick Kiln	1000
(M) Coke Oven	500
(N) Lime Kiln	250

Documented Impacts of Air Pollution

Pollutant	Health Effects	Other Welfare Effects
Carbon Monoxide (CO)	Headaches, reduced mental alertness, heart attack, cardiovascular diseases, impaired fetal development, death.	Contribute to the formation of smog.
Sulfur Dioxide (SO ₂)	Eye irritation, wheezing, chest tightness, shortness of breath, lung damage.	Contribute to the formation of acid rain, visibility impairment, plant and water damage, aesthetic damage.
Nitrogen Dioxide (NO ₂)	Susceptibility to respiratory infections, irritation of the lung and respiratory symptoms (e.g. cough, chest pain, difficulty breathing).	Contribute to the formation of smog, acid rain, water quality deterioration, global warming, and visibility impairment.
Ozone (O ₃)	Eye and throat irritation, coughing, respiratory tract problems, asthma, lung damage, leading to premature mortality.	Plant and ecosystem damage. Material (rubber) damage
Lead (Pb)	Anemia, high blood pressure, brain and kidney damage, neurological disorders, cancer, lowered IQ.	Affects animals and plants, affects aquatic ecosystems.
Particulate Matter (PM)	Eye irritation, asthma, bronchitis, lung damage, cancer, heavy metal poisoning, cardiovascular effects, leading to premature mortality.	Visibility impairment, atmospheric deposition, aesthetic damage.

Present Air Quality Monitoring

Fixed Station

Continuous Air Monitoring Station
(CAMS) 5 no.s during AQMP project

Dhaka

1. BARC, Farmgate
2. Shangshad Bhaban

Chittagong

3. TV Station

Other Cities

4. Rajshahi
5. Khulna

Trans Boundry Monitoring Station

- Satkhira, Syamnagar

Six New CAMS under CASE Project from October-2012

1. Darus Salam (Dhaka)
2. Agrabad (C2012)

Other Cities

3. Narayanganj (2012)
4. Gazipur (2012)
5. Sylhet (2012)
6. Barisal (2012)

Central Server at DOE (2012)

Present Air Quality Monitoring

DoE's mobile facility

- High Volume Sampler
 - SPM, SO_x, No_x
- Low Volume Sampler
 - PM₁₀, PM_{2.5}

11 CAMS in Bangladesh



Air Quality Monitoring Network

Dhaka

1. BARC, Farmgate
2. Shangshad Bhaban
3. Darus Salam (2012)

Chittagong

4. TV Station
5. Agrabad (2012)

Other Cities

6. Narayanganj (2012)
7. Gazipur (2012)
8. Rajshahi
9. Khulna
10. Sylhet (2012)
11. Barisal (2012)

Central Server at DOE (2012)

Monitoring Parameters in CAMS

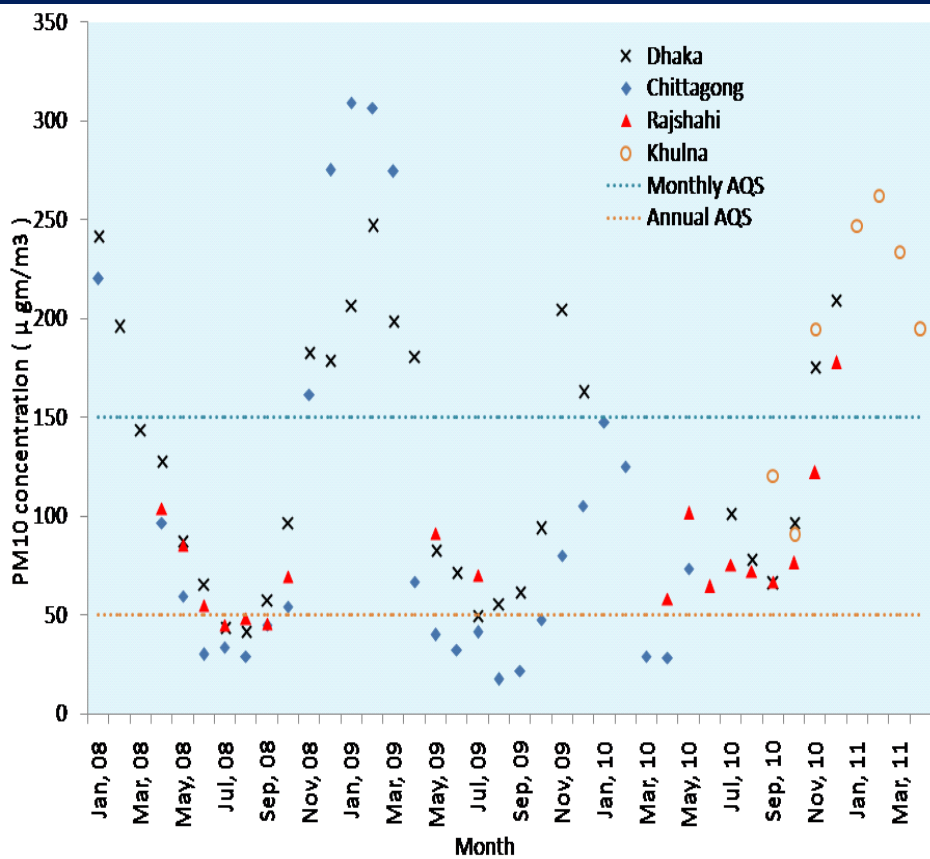
Six Criteria Pollutants (Set by USEPA)

- Carbon Monoxide (CO)
- Nitrogen Oxides (NO_x)
- Coarse Particulates (PM₁₀)
- Fine Particulates (PM_{2.5})
- Ozone (O₃)
- Sulfur di Oxide (SO₂)

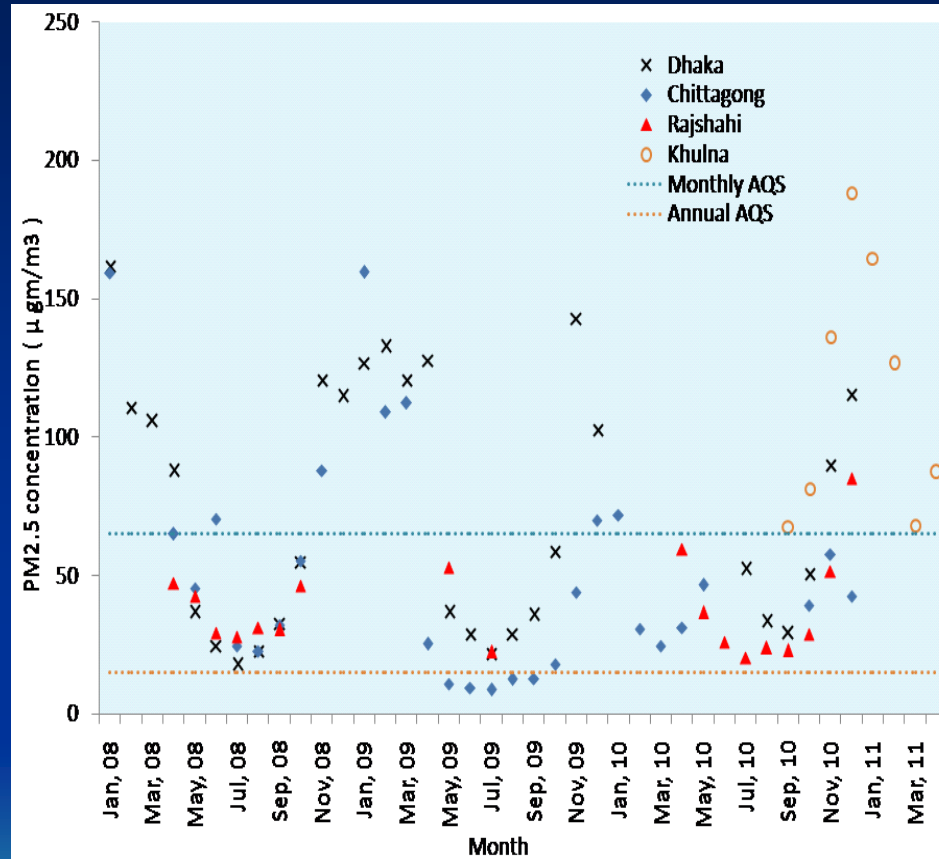
AQ Monitoring Results

- It is widely accepted that particulate Matters (PM) are the major pollutant of Concern in Bangladesh .
- Other Pollutants meet the AQ standard in CAMS Monitoring result.
- In CAMS monitoring, PM standard exceeds on an average 100days annually especially in dry season i.e. within November to April.

Particulate Matter Monitoring Results of CAMS



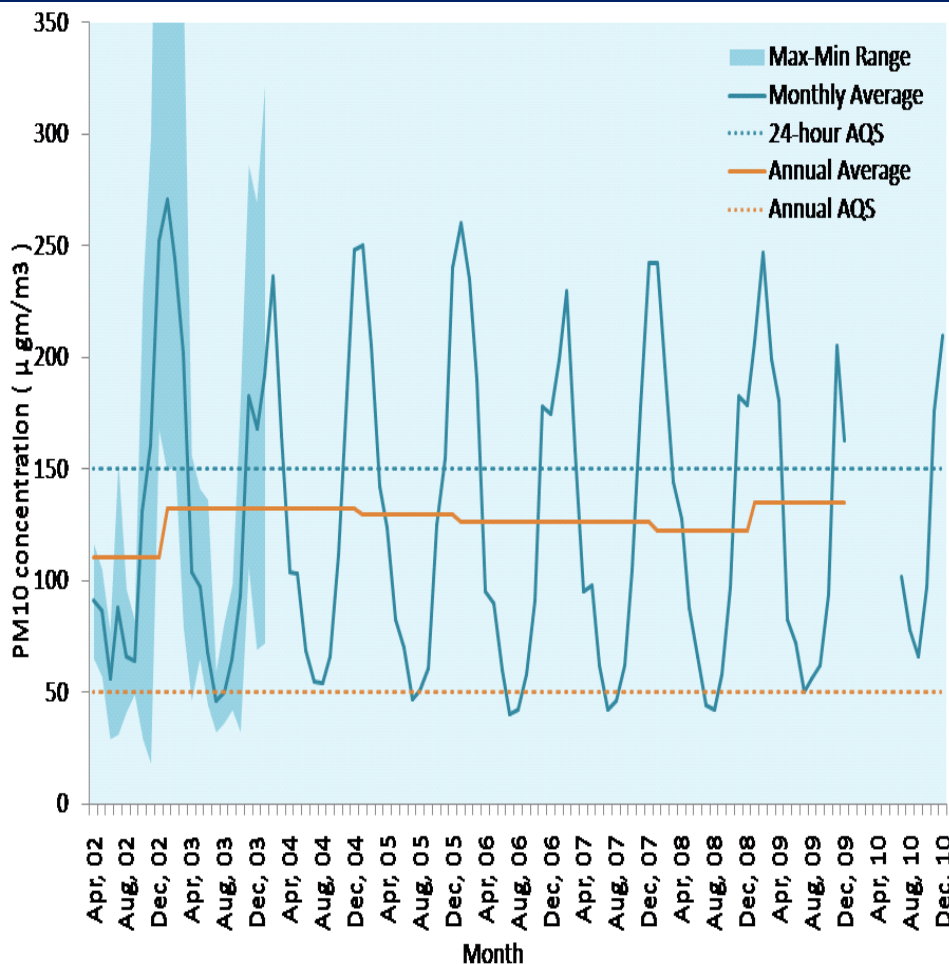
PM-10 Monitoring



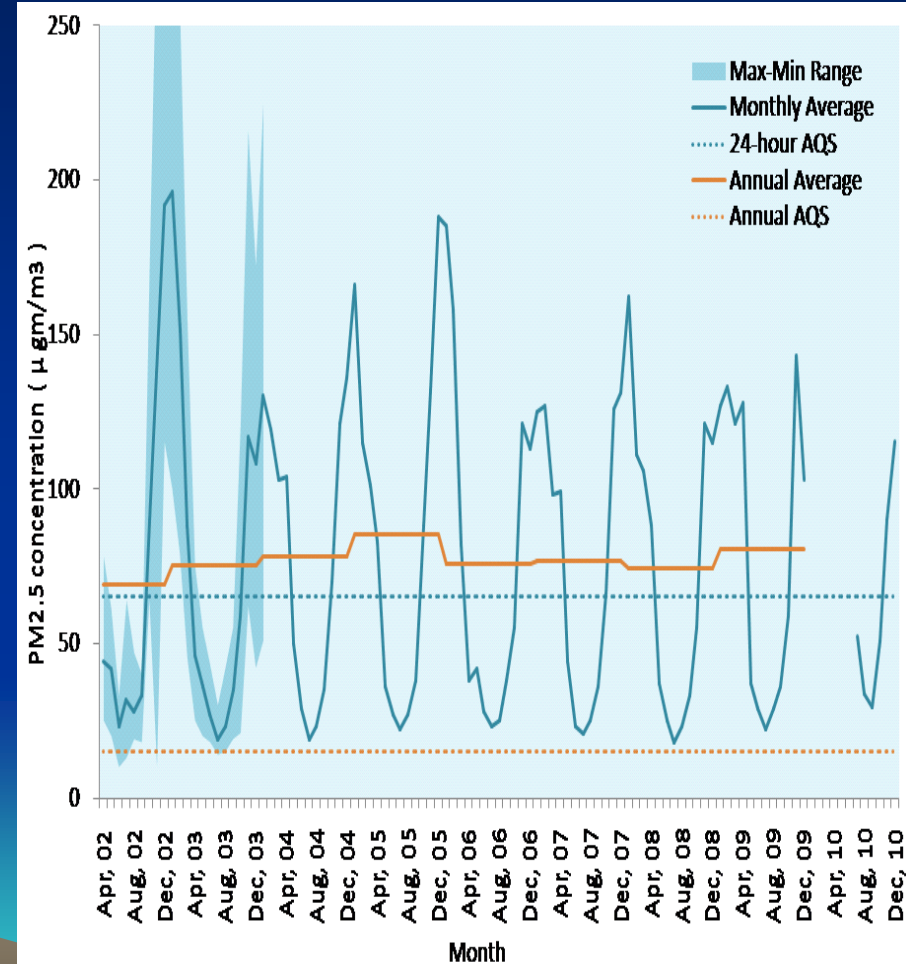
PM-2.5 Monitoring

PM₁₀ and PM_{2.5} concentration in Dhaka

- Higher motorization rate, larger population, larger number of industries and high impact possibilities in Dhaka.



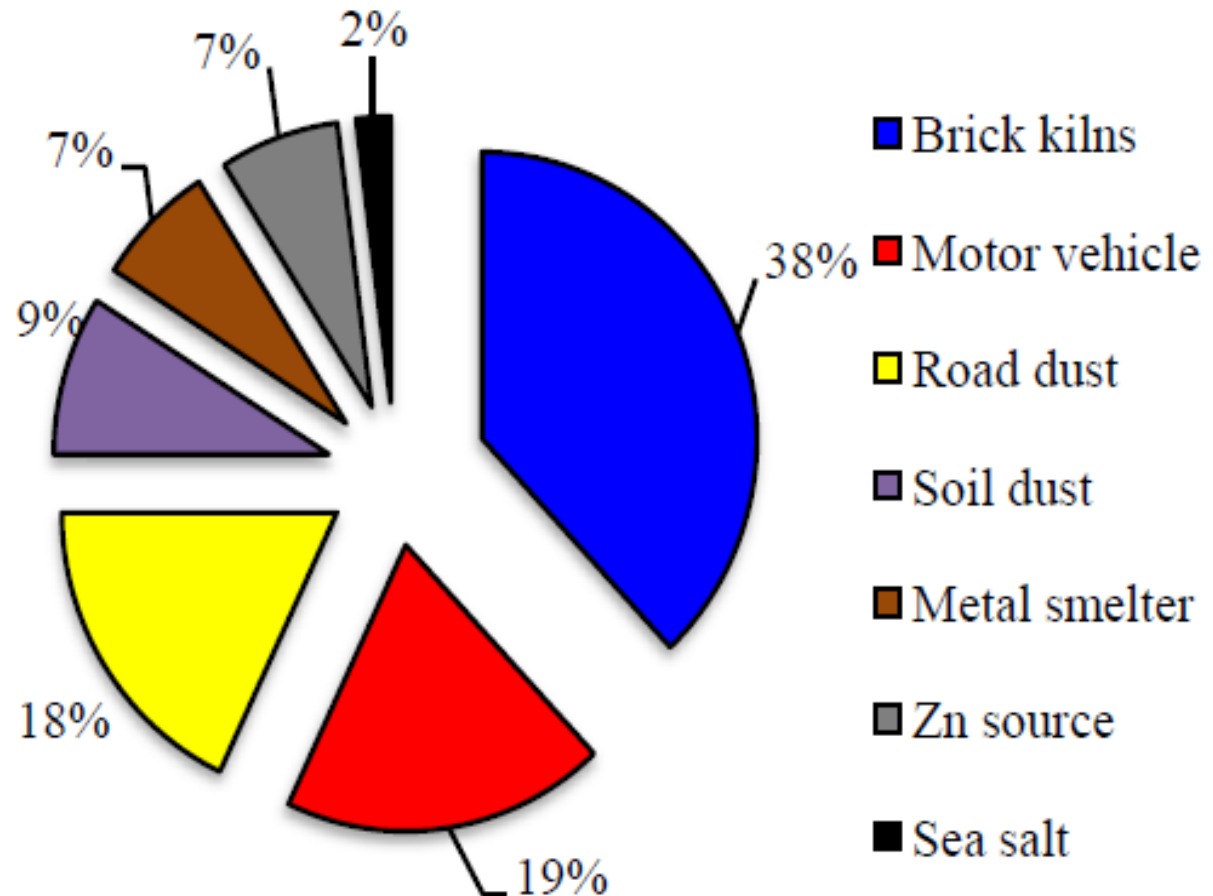
PM-10 Monitoring



PM-2.5 Monitoring 14

Contribution of PM Pollutant in Dhaka

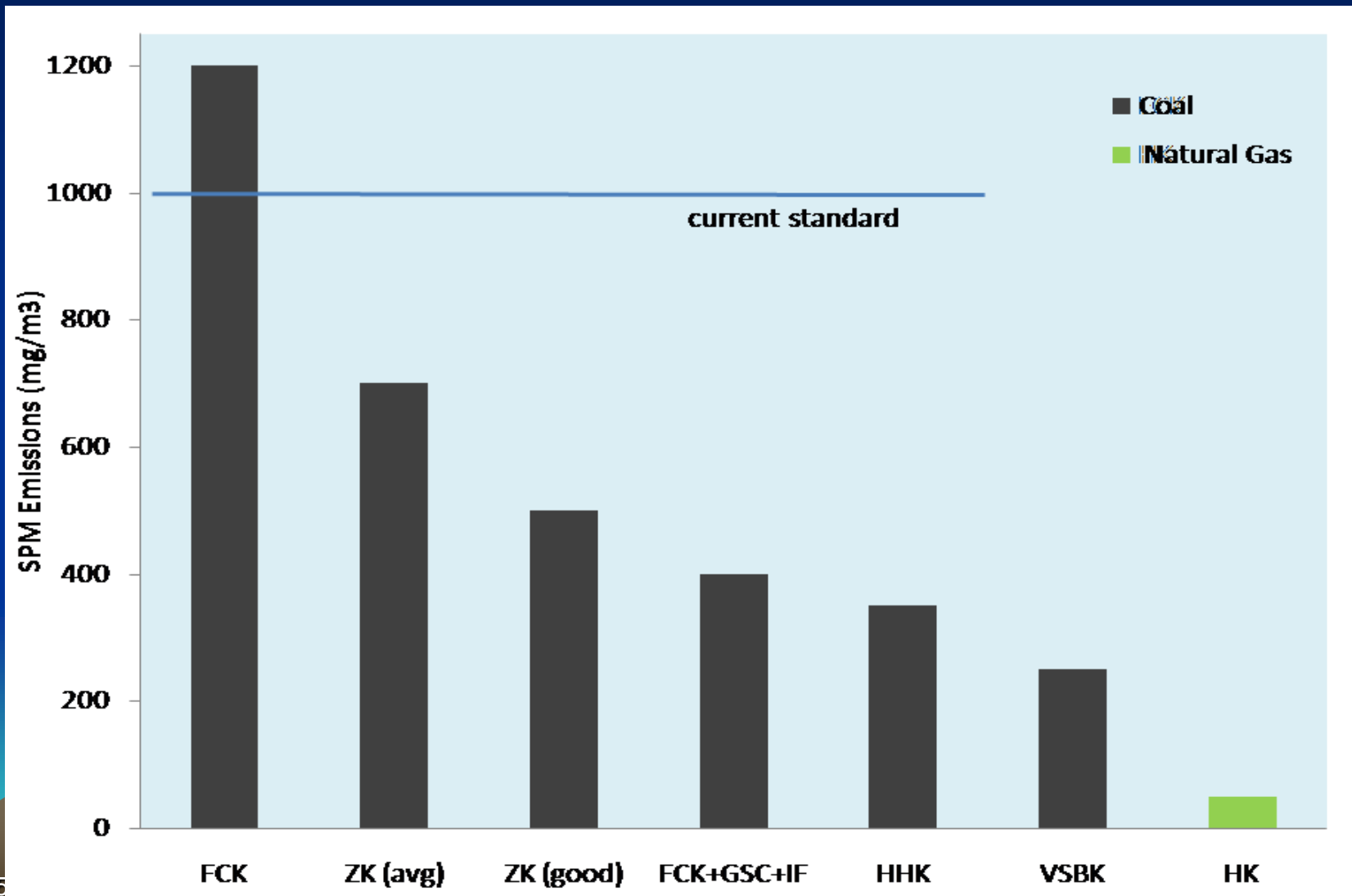
(WB report-2011)



Sources of fine particulate pollution in Dhaka

Source: Begum et al. (2010)

Suspended particulates emissions of different types of brick kilns



Emission Standards for Petrol and CNG Driven Vehicles Registered before September 1, 2004

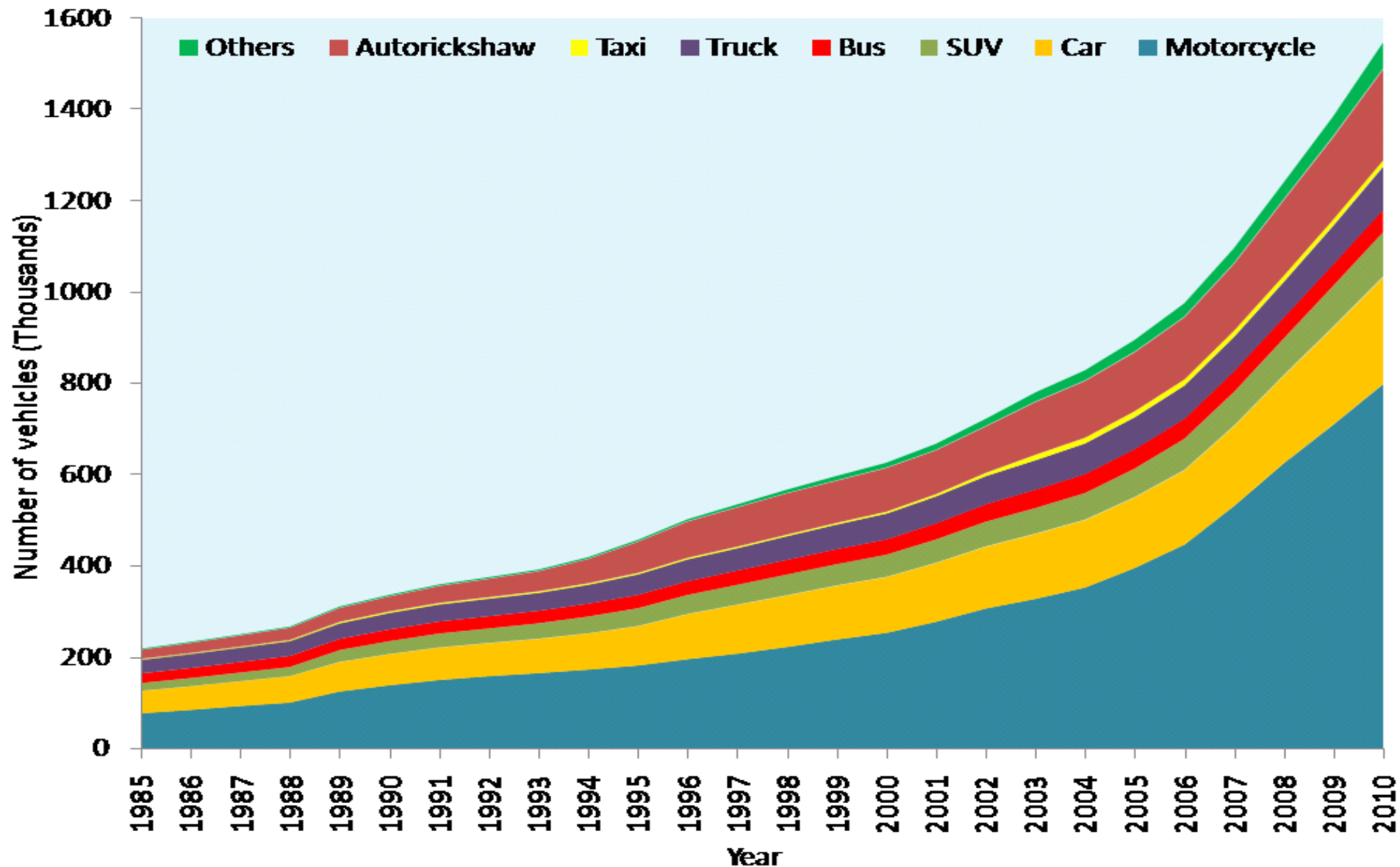
Vehicle Type	Test	CO (% by volume)	HC (ppm)
4-wheeled petrol vehicles	Idle Speed	4.5	1,200
All CNG driven vehicles	Idle Speed	3.0	-
Petrol driven 2-Stroke engine 2 and 3-wheelers	Idle Speed	7.0	12,000
Petrol driven 4-Stroke 2 and 3-wheelers	Idle Speed	7.0	3,000

Emission Standards for Vehicle Registered after September 1, 2004

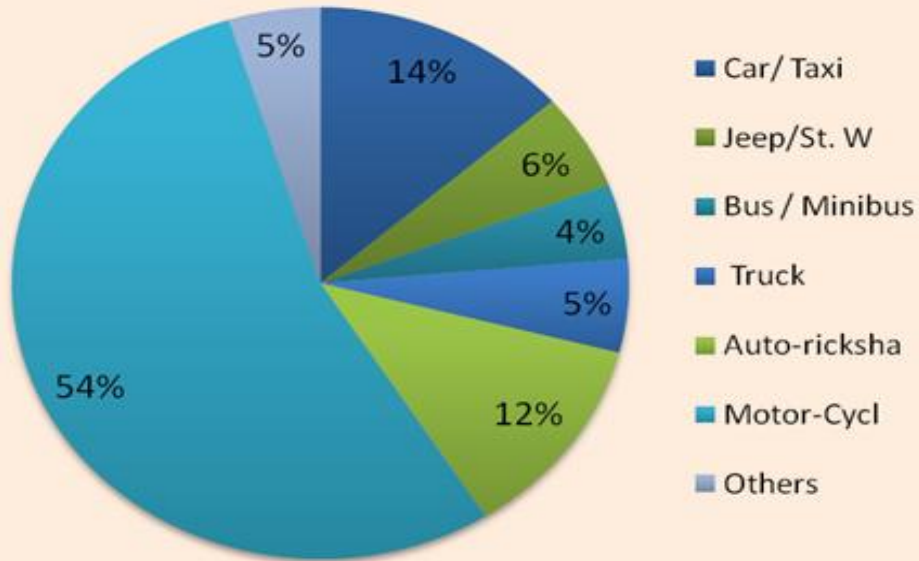
Vehicle Type	Test	CO (% by volume)	HC (ppm)	Lambda (λ)	Smoke
4-wheeled petrol and CNG vehicles.	Idle Speed	1.0	1200	-	-
	No load, 2500-3000 RPM	0.5	300	1.0 ± 0.03	-
Petrol driven 4-Stroke 2 and 3-wheelers	Idle Speed	4.5	1200	-	-
CNG driven 3-wheelers	Idle Speed	3.0	-	-	-
Naturally aspirated diesel vehicles	Free acceleration	-	-	-	65 HSU or 2.5 m^{-1}
Turbo-charged diesel vehicles	Free acceleration	-	-	-	72 HSU or 3.0 m^{-1}

Vehicle growth in Bangladesh during 1985-2010

(source: BRTA)

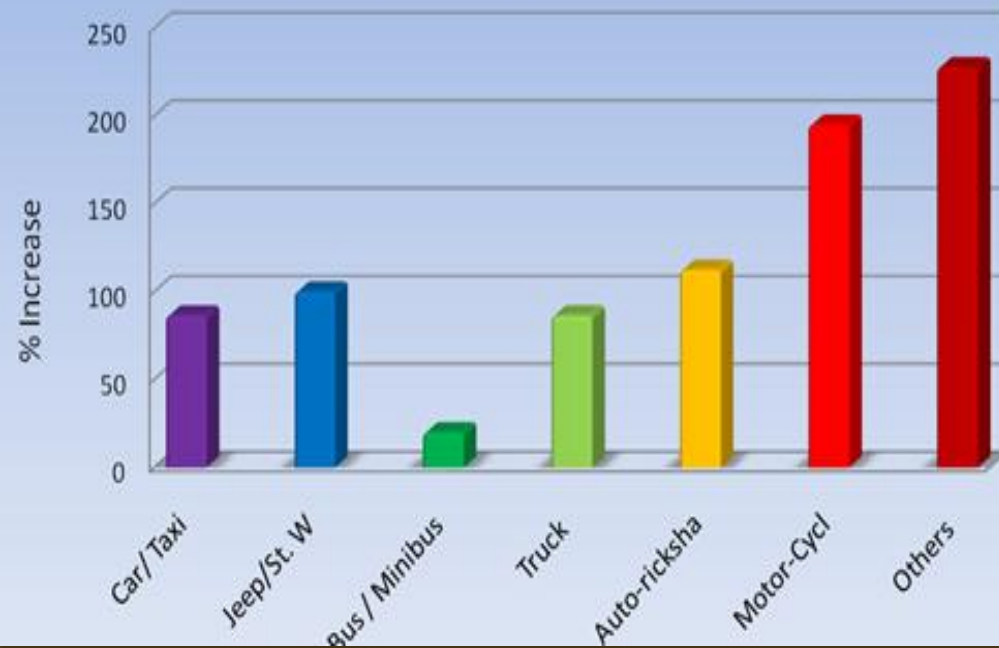


Composition of vehicles population in Bangladesh



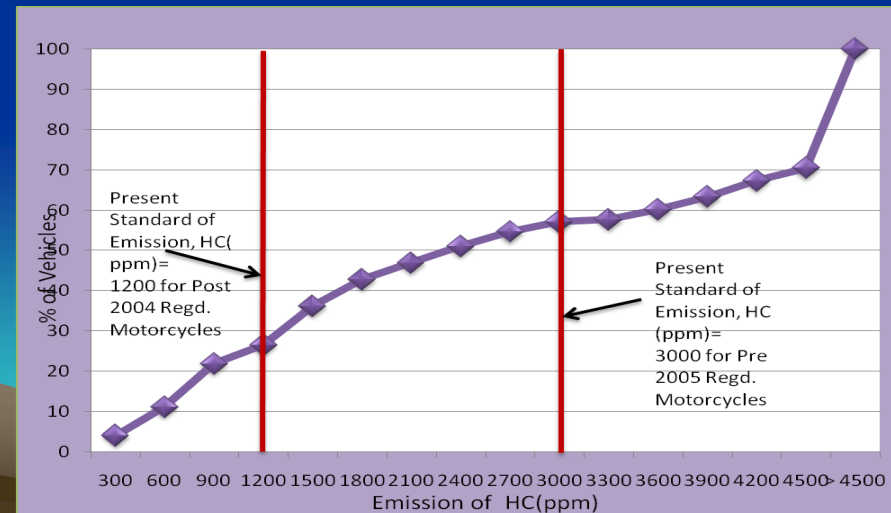
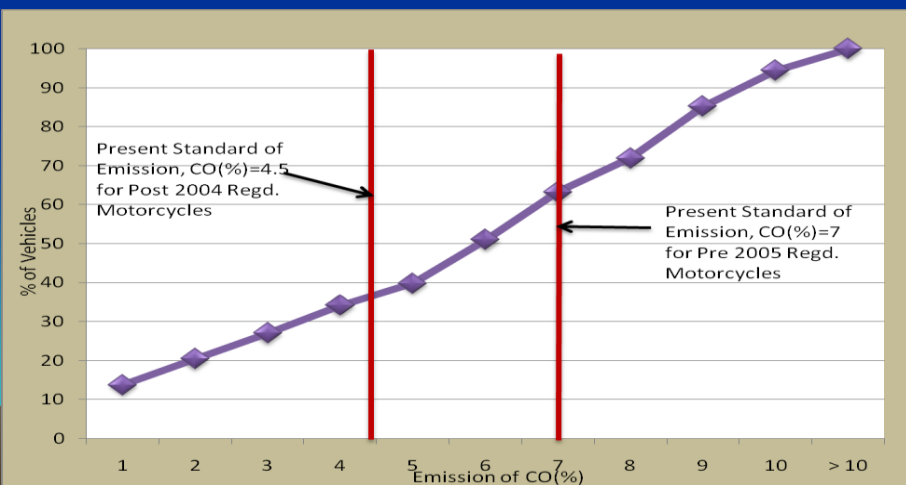
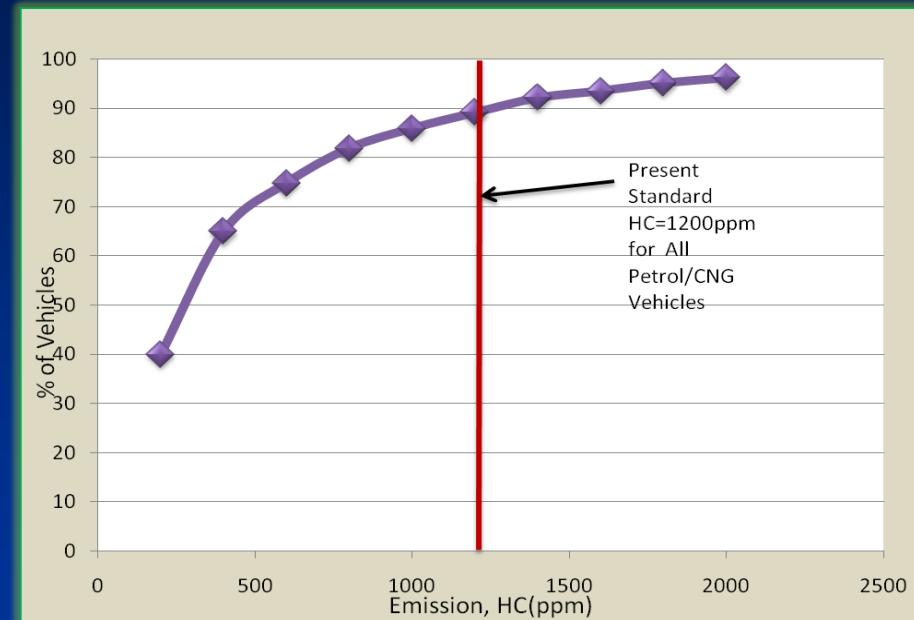
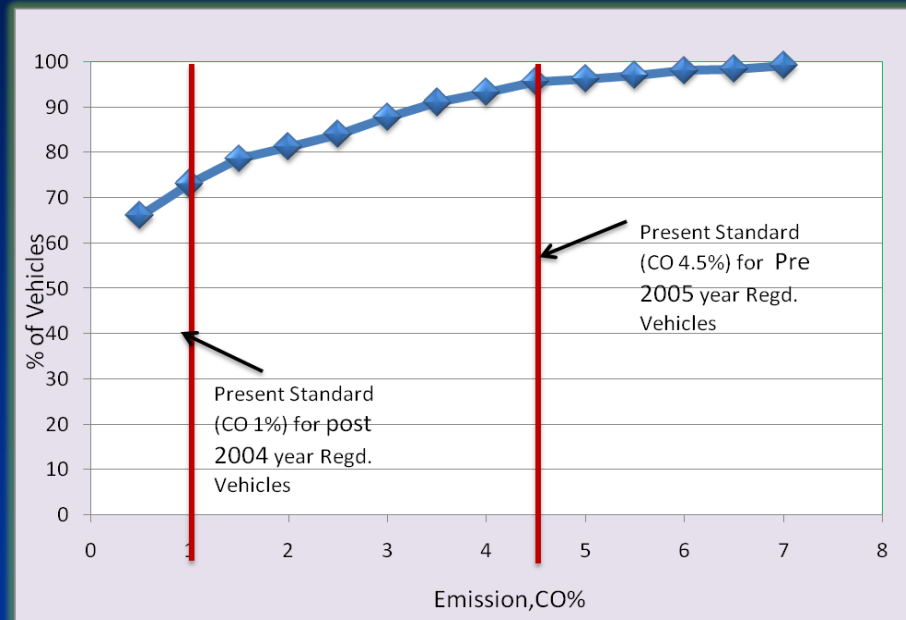
Period 2003- 2012

Percent increase in vehicle population for the year 2012 over 2003 in Bangladesh

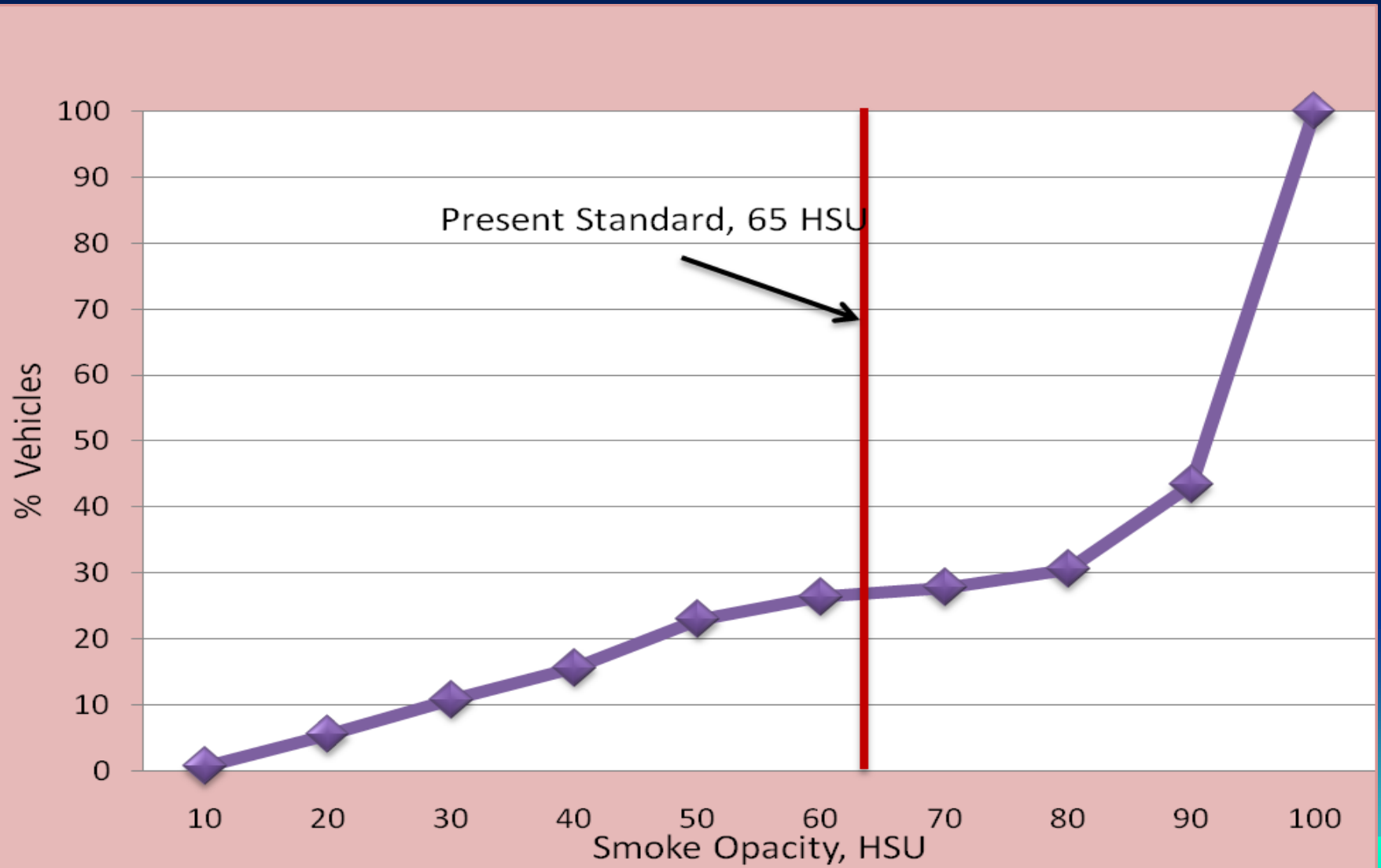


Categorization of Vehicles Tested in Dhaka by Fuel Type (March 2011 to July, 2012; DoE)								
Sl. No.	Vehicle Type	Total number tested	Fuel wise vehicle numbers tested			% vehicles as per fuel used		
			CNG	Petrol	Diesel	CNG	Petrol	Diesel
2	Auto rickshaws	116	112	4	-	97	3	0
3	Cars/Taxis	113	108	5	-	96	4	0
4	Jeeps/micro-uses/St. Wagons	58	47	2	9	81	3	16
5	Delivery Van/mini-truck	188	83	2	103	44	1	55
6	Minibus/Buses	92	56	-	36	61	-	39

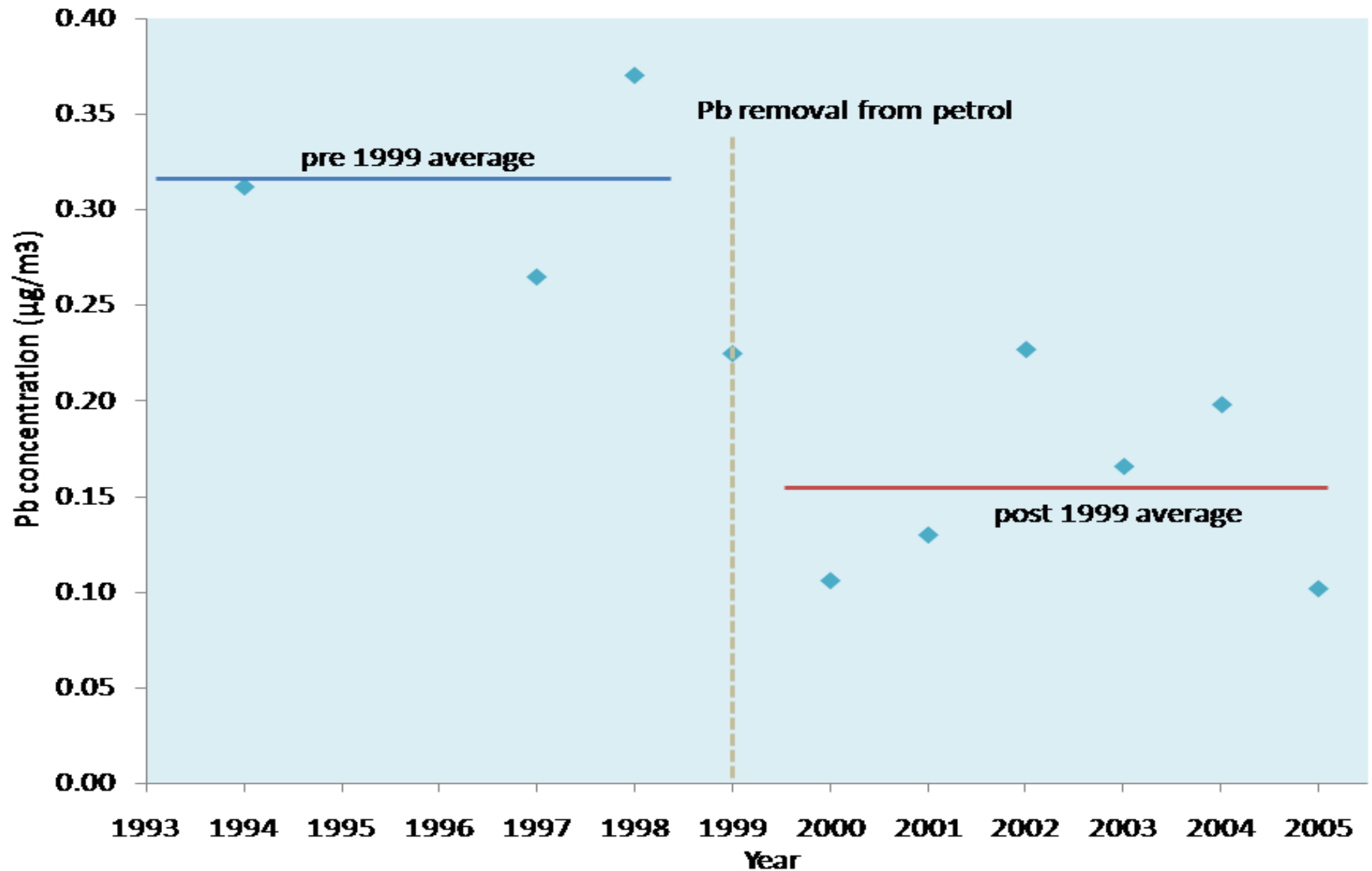
Cumulative Frequency Distribution of Emission for tested Petrol/CNG vehicle & Motorcycles



Cumulative Frequency Distribution of Emission for Diesel vehicle



Ambient concentration of Pb in Dhaka



Summary of Previous Air Quality Strategies in Bangladesh (Cont...)			
Policy/Strategy	Year	Result	Lessons learnt
Lead phase out from Petrol	1999	Success	Media and public support allow easy implementation, implementation quick and easy if few, government run bodies are targeted
Vehicle emissions Standard	1997, Update 2005	Failure	There is no testing facilities for monitoring vehicle emissions during certification, poor institutional capacity and enforcement hinder implementation
Brick kiln stack height		Success	Benefit to the owners (more efficient burning, better quality bricks) is good for policy implementation, ease of monitoring is also important
Ban on older vehicle import		Success	Small number of vehicle importers, no significant losses to businesses (increased cost of vehicles passed on to buyers) allow easier implementation, somewhat covers vehicle emissions standard initially
Differentiated vehicle import tariff		Success	Although not a perfect, strong public support, smaller points of regulation means easier implementation
Ban on driving older vehicles in Dhaka	2010	Repeated failure	Did not work when many polluters are financially affected, especially when they have a strong lobby. Instruments with active stakeholder engagement during policymaking can be useful

Summary of Previous Air Quality Strategies in Bangladesh			
Policy/Strategy	Year	Result	Lessons learnt
Ban two stroke three wheelers	2002	Success	Extensive public support allows easy implementation, unforeseen practices (smaller diesel vehicles) can erase the benefits, monopoly in new CNG three wheeler supply can make a good policy costlier than necessary, multiple benefits
Promotion of CNG vehicles	2002	Success	Extensive public support, good pricing policy, good incentive to private sector, multiple benefits – all are important for a functioning.
Compulsory use of catalytic converter	Not enacted	--	Proper technical evaluation of a proposed strategy is needed, before implementation
Ban on use of wood in brick kilns		Success – qualified	Fuel choice primarily governed by economics – low sulfur coal is generally cheaper than wood currently (unless in remote areas), monitoring and enforcement lax in rural areas
Lane based traffic	2010	Failure	Not
Carpooling			Unrealistic proposal, met with ridicule by the citizens
Colored kerosene		Failure	Price is an important issue
Ban on import of high Sulfur coal		Failure	Did not work when many polluters are financially affected (fuel choice governed by economics), especially when they have a strong lobby to overturn the ban

Bangladesh and international conventions on Air Pollution

Name of Convention	Convention Year	Bangladesh Sign Year
Convention to Combat Desertification	1994	1996
Convention of the Law of the Sea	1982	2001
Stockholm Convention on Persistent Organic Pollutants	2001	2007
Montreal Protocol on Substances that deplete the Ozone Layer	1989	1990
Vienna Convention for the Protection of the Ozone Layer	1988	1990
Convention on Biological Diversity	1992	1994
Kyoto Protocol to the Framework Convention on Climate Change	1997	2001
Framework Convention on Climate Change	1992	1994
Cartagena Protocol on Biosafety	2000	2004
Male Declaration on Control and Prevention of Air Pollution and Its Likely Transboundary Effects for South Asia	1998	1998
Climate and Clean Air Coalition	2010	One of 6 Founder member

Recommended strategies for air pollution reduction in Bangladesh (Cont.)

Strategy	Area of application
Improve public transport	Large cities
Strengthen vehicle inspection and maintenance	All, especially large cities
Ban vehicles older than 20 years	Commercial vehicles, large cities
Encourage Diesel to CNG switch through incentives	All diesel vehicles, esp. truck & buses in large cities
Emissions (age) based annual registration fees	All vehicles
Stringent emissions standards	All new vehicles
Emissions based import tariff	All new vehicles
Comprehensive land use plan for industry locations	All industries, especially new ones
Cluster management	Cluster of highly polluting industries
Emissions (technology and fuel) based license fee	All kilns
Technology standards	All kilns
Alternate construction material	All country, especially large cities
Ensure adequate power supply	All country

Recommended strategies for air pollution reduction in Bangladesh

Strategy	Area of application
Emissions standards	All new plants
Emissions standard for diesel generators	All new generators
Inspection & maintenance of diesel generators	All existing generators
Technology specification	Existing steel mills, cement and glass factories
Inspection and maintenance	Existing steel mills, cement and glass factories
Emissions standards	All new and existing plants
Import control for quality of coal	Whole country, primarily brick and power industries
Better construction practices on site & during transport	All construction sites
Air pollution mitigation plan and its enforcement	Large construction projects
Timely road maintenance	All roads
Landscaping and gardening	All exposed soil in urban areas
Encourage fuel switch	Urban slums and rural areas
Improved cooking stoves	Rural areas

Relevant capacity building in controlling air pollution in Bangladesh:

- Capacity in monitoring ambient air pollution in major cities and pollution hot-spots (e.g., industrial areas).
- Capacity of laboratories (e.g., in relevant govt. & educational institutions) in measurement/ monitoring of air quality.
- Capacity of relevant organizations/ professionals in developing/ updating emission inventory, air quality models.
- Capacity of relevant organizations/ professionals in assessing health impacts, costs of air pollution and policy design.
- Capacity to retain knowledge and people among policy makers and firms.

THANK YOU