Short and medium term measures to clean up the air of Delhi December 2015

Centre for Science and Environment

1. State of air pollution -- how it has grown over the years

Air pollution has remained consistently high and rising in Delhi and has also shown a mixed trend over the years. During the initial years of the last decade the Supreme Court directives have helped to arrest air pollution trend in Delhi. Supreme Court directives in the first phasehelped improve emissions standards, implement largest ever public transport strategy on CNG; capped age of commercial vehicles; improved vehicle inspection programme; and diverted substantial truck traffic. Delhi government also relocated polluting industry, cut power plant pollution and banned open burning.

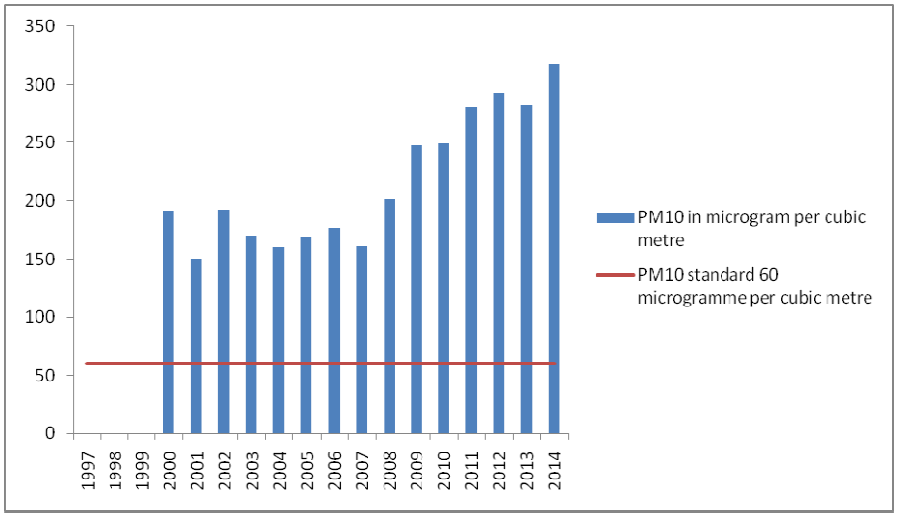
As a result of these measures the annual average PM10 levels reduced by about 16 per cent between 2002 and 2007. But after 2007 only a few steps were taken – expansion of metro, moderate increase in bus numbers; Bharat Stage IV emissions standards; and small network of cycle tracks and footpaths around Commonwealth games venues. But this was too little too late. Delhi has about 8.5 million vehicles and is adding 1400 vehicles a day.

Rising trend in pollution: Particulate levels – key target of policy action, increased dramatically by 75% between 2002 and 2014 (See graph 1: Particulate pollution decline and rise again). In 2014 the annual average ambient PM10 levels reached 5 times the standard, which is 60 microgramme per cubic metre.

On the other hand, the tinier particles, PM2.5 that go deep inside the lungs shows consistently high annual average levels since 2011 and is at least four times the standards. (Graph 2: Trend in PM2.5 levels: Tinier particles go deeper inside the lungs)

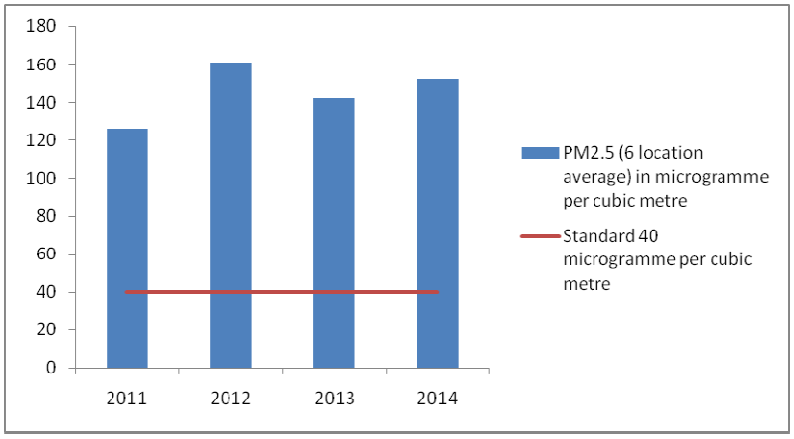
Moreover, between 2002 and 2011 the nitrogen oxide levels have also increased 30%indicating Delhi is in grip of multi-pollutant crisis.

Graph 1: Particulate pollution decline and rise



Source: Based on air quality data of Department of Environment

Graph 2: Trend in PM2.5 levels: Tinier particles go deeper inside the lungs

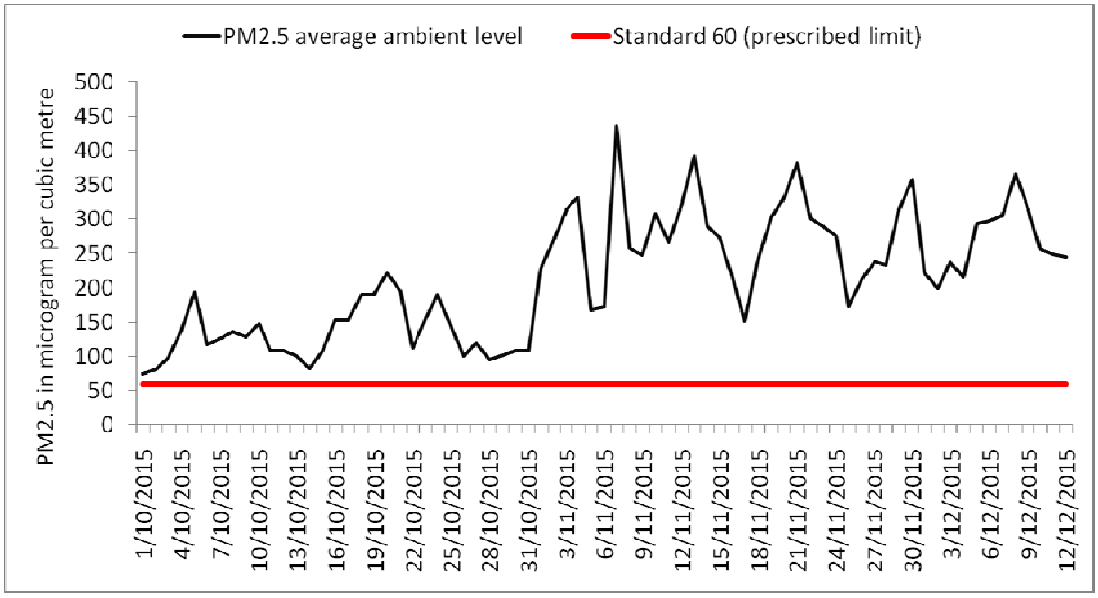


Source: Delhi Pollution Control Committee

Deadly winter pollution: Winter pollution – when wind remains calm, cool and trapped close to the ground level, is more severe. Almost throughout this winter levels of PM25 have remained 2-3 times reaching upto 4 to 7 times the standards and during high smog episodes go even higher. (see graph 3 --- Daily PM2.5 levels during the winter of 2015). When the national air quality

index was applied to daily air quality monitored by Delhi Pollution Control Committee it was found that while in the month of October about 3 per cent of the days were in severe category, the worst category according to the index, by November 63 per cent of days were in that category. This is extremely dangerous for people suffering from respiratory and cardiac problems and also for children and elderly.

Graph 3: Daily PM2.5 levels during the winter of 2015 (Oct 1,–12, December 2015)



Source: Based on realtime data from website of Delhi Pollution Control Committee

Even though Delhi has made exemplary move to generate real time air quality data to track air quality, it is not used to issue public health alert and advisory to people to help them take precaution or enforce pollution emergency measures. In many global cities the pollution level as recorded in Delhi would have led to pollution emergency. On red alert days, Beijing government has contingency plans to close kindergartens, primary and middle schools; take off about 80 per cent of government-owned cars; allow cars on alternate days according to numbers plates; bar freight vehicles; polluting factories have to cut emissions or shut down etc. Similarly, in US cities industrial units have to reduce emissions by at least 20 per cent, cut vehicle miles by at least 20 per cent of normal weekday operations etc. Paris discourages usage of personal vehicles etc.

2. Health impact of pollution

Though globally and nationally large number of studies have already proven the sever health risk from air pollution, several studies are also available in Delhi to provide local evidences. Most extensive scary evidences have come from the epidemiological study on children in Delhi carried out by the CPCB and the Chittaranjan National Cancer Institute of Kolkata. This study published in 2012 had covered 11,628 school-going children from 36 schools in different parts of Delhi and in different seasons. It found that every third child has reduced lung function. Sputum of Delhi's children contains four times more iron-laden macrophages than those from cleaner environs, indicating pulmonary hemorrhage. The levels of these biomarkers in children have been found to be higher in areas with high PM10 levels. Also 2010 study of Health Effect Institute, Boston, estimates at least 3000 premature deaths annually due to air pollution related diseases. University of California Berkeley study indicates the extent of exposure to vehicular pollution in Delhi.

The World Allergy Organisation (WAO) Journal also published in 2013, reported high respiratory disorder symptoms in students residing in ChandniChowk (66 per cent) in north Delhi, Mayapuri (59 per cent) in west Delhi and Sarojini Nagar (46 per cent) in south Delhi. Heavy traffic movement has been found to be the factor in the relative difference among the localities. WAO also alerts that allergic problems will increase further as air pollution increases.

Global scientific studies have associated air pollution with a wide range of health effects including respiratory and cardiac problems, stroke, cancer, hyper tension and diabetes, affect on brain and foetus.

3. What are the sources of pollution in Delhi

There are several sources of air pollution in the city – vehicles, industry, power plants, open trash burning, construction, suspended dust from roads etc. The most recent and detailed study of all pollution sources in Delhi has been carried out by Indian Institute of Technology (IIT) Kanpur that was commissioned by Delhi government. This draft report has included wide range

of pollution sources including direct emissions from sources as well as indirect formation of particulate from gases in the air called secondary particulate. Control of secondary particulate requires control of gaseous emissions from all sources. This study has also estimated pollution in the NCR region.

This draft report indicates the top emittersof PM2.5 and NOx that are the pollutants of concern in Delhi:

Top 4 PM2.5sources:

Road dust -- 38 per cent;

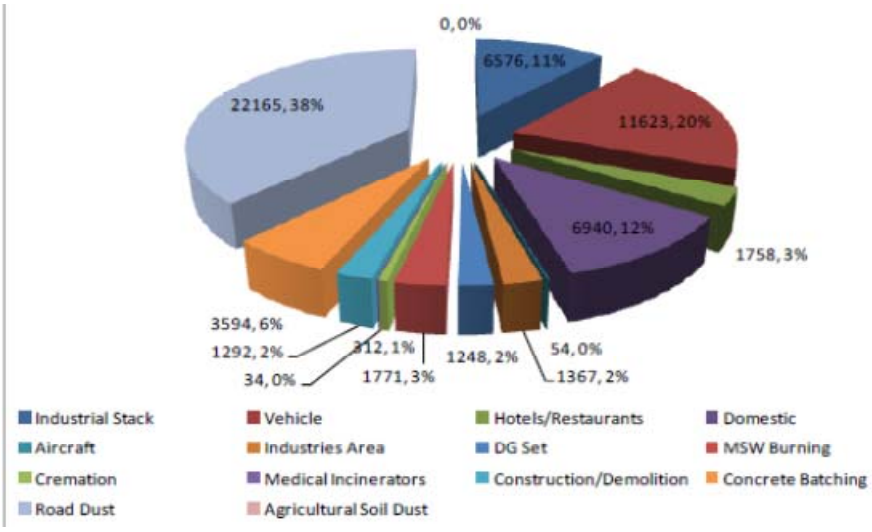
Vehicles -- 20 per cent;

Domestic fuel burning -- 12 per cent;

Industrial point sources -- 11 per cent

(see Graph 4: PM2.5 emissions load from different sources)

Graph 4: PM2.5 emissions load from different sources



Source: Draft Report 2015 - Comprehensive study on Air Pollution and Green House Gases (GHGs) in Delhi (for Delhi Government) by IIT Kanpur

Top 4 NOxsources:

Industrial estates (including power plants)-- 52 per cent;

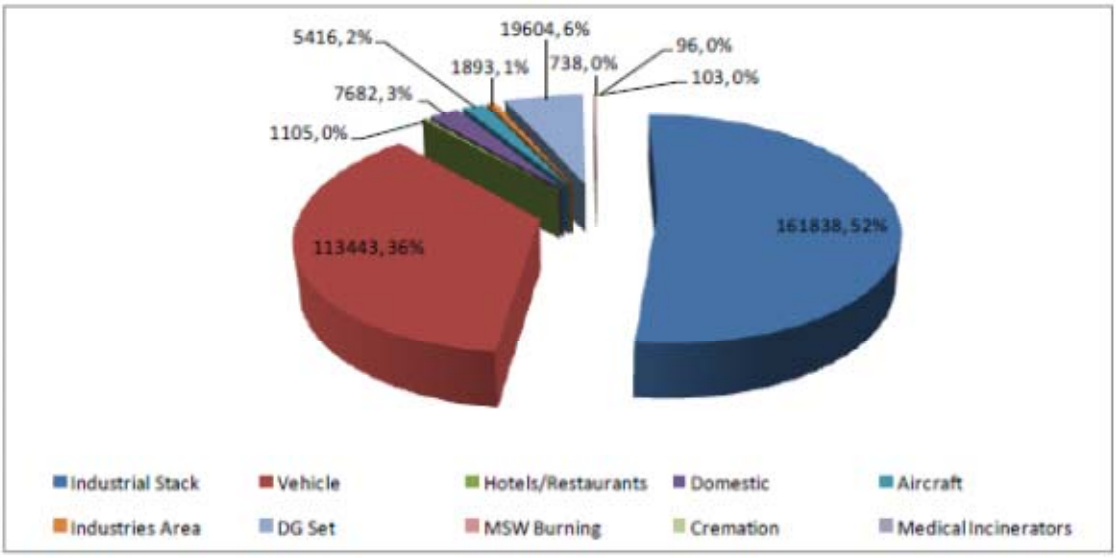
Vehicles -- 36 per cent;

Diesel generator sets -- 6 per cent;

Domestic sources – 3 per cent

If aircraft is excluded from the list of ground sources of pollution vehicles emerge as the top NOx emitter. (Graph 5: NOx emissions load from different sources).

Graph 5: NOx emissions load from different sources



Source: Draft Report 2015 - Comprehensive study on Air Pollution and Green House Gases (GHGs) in Delhi (for Delhi Government) by IIT Kanpur

Variation in pollution sources trend in summer and winter months: The draft report has further found variation in contribution of different pollution sources in winter and summer months.

Winter pollution sources to PM2.5:

Vehicles – 25%,
Biomass burning -- 26%,

MSW burning -- 8%

Secondary particles called nitrates formed by NOx and sulphate formed by SO2 – 30%.

The increased concentration of particulate matter in October-November is also due to the effect of crop burning.

Summer pollution sources to PM2.5:

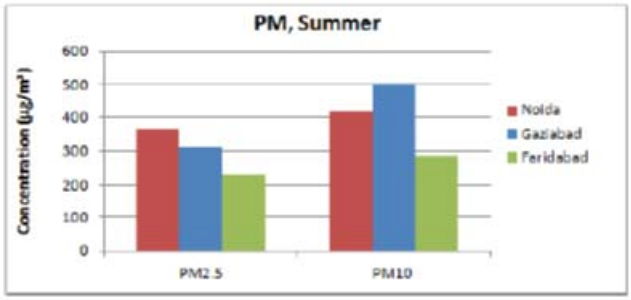
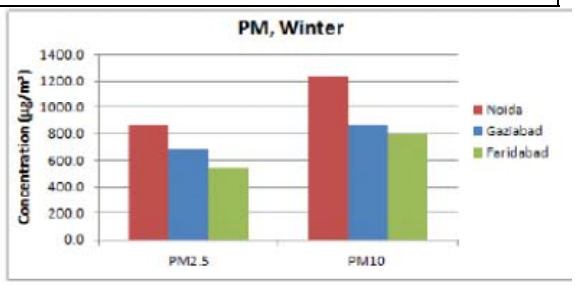
Coal and flyash– 26%;
Soil and road dust – 27%,

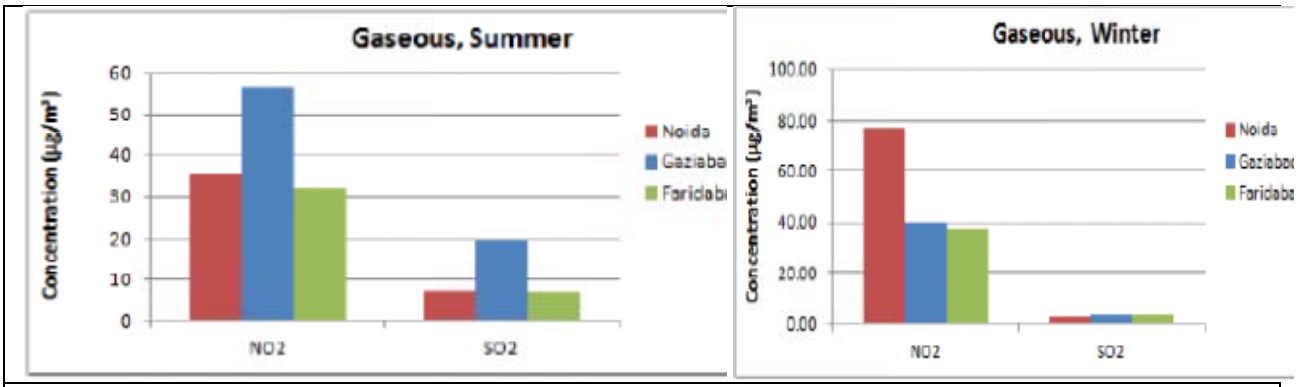
secondary particles – 15%,

Biomass burning – 12%;
Behicles 9%
MSW burning –7%

High pollution levels in NCR towns: The draft report of IIT Kanpur has also found very high pollution in the towns NCR region including NOIDA, Faridabad, and Gaziabad**.** These are not otherwise monitored well by the official monitoring agencies.

Graph 6: Particulate matter, sulphur dioxide and nitrogen oxides levels in NCR – NOIDA, Faridabad, Gaziabad

Particulate matter concentration at three sites in NCR (Summer 2014)	**Particulate matter concentration at three sites in NCR (Winter 2014)**
	
Sulphur dioxide and nitrogen oxides concentration at three sites in NCR (Summer 2014)	**Sulphur dioxide and nitrogen oxidesconcentration at three sites in NCR (Winter 2014)**



Source: Draft Report 2015 - Comprehensive study on Air Pollution and Green House Gases (GHGs) in Delhi (for Delhi Government) by IIT Kanpur

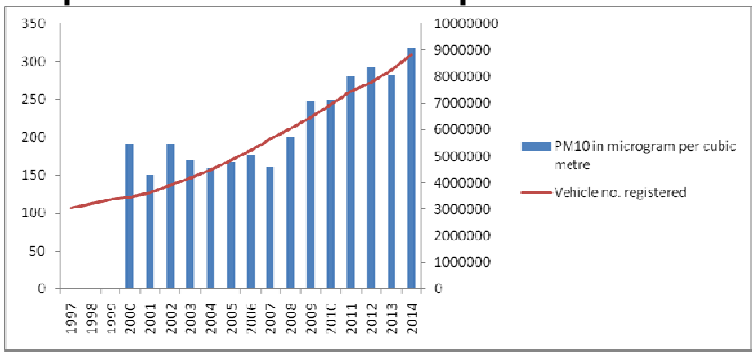
To achieve clean air Delhi will have to implement source-wise action plan in order of priority and also take action on all sources. This assessment brings out that after road dust vehicles are the second largest contributor of PM2.5 followed by domestic fuel burning, and industrial sources. For nitrogen oxide also after aircrafts that will require a separate strategy vehicles are the second largest emitter followed by diesel generator and domestic sources.

Priority measures for key sources of pollution

Status of vehicular pollution control

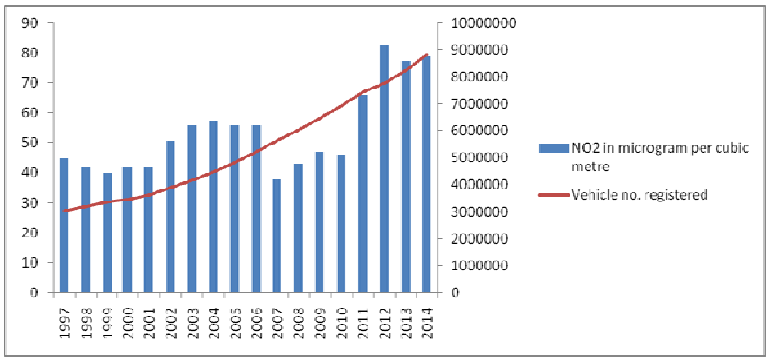
Delhi shows very strong correlation between rising particulate pollution and motorization. Since 2000 vehicle numbers in Delhi have increased by 97%. While particulate levels have increased dramatically by 75% between 2002 and 2014,during the same period the NOx levels have also increased.

Graph 7: Motorisation and particulate matter trend in Delhi



Source: Data from Central Pollution Control Board

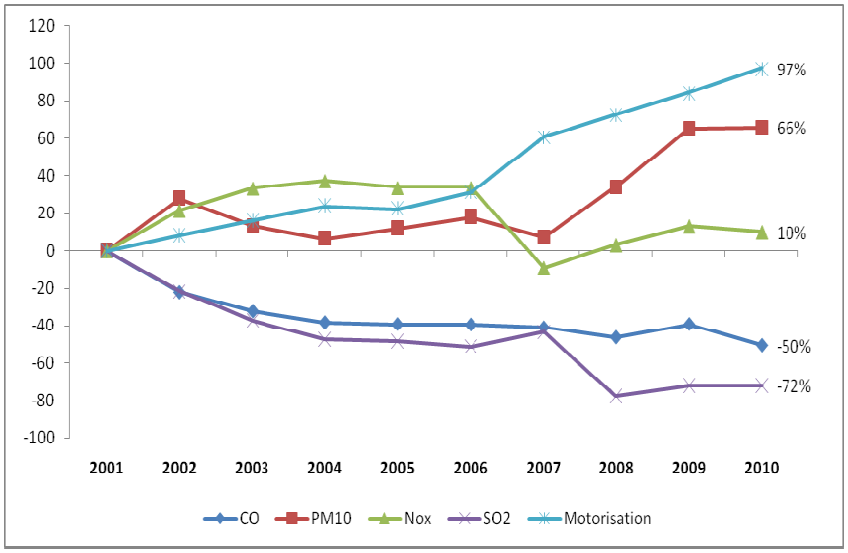
Graph 8: NOx levels are rising with motorization



Source: Data from Central Pollution Control Board

However, carbon monoxide (CO) that comes largely from petrol vehicle has reduced by 50% despite the growing number of vehicles. Sulphur dioxide levels have also declined in Delhi like all other cities due to overall change in energy mix in cities - from coal to other fuels.

Graph 9: Trend in air pollution and motorization in Delhi: PM and NOx correlate with growing motorization, but CO has decoupled

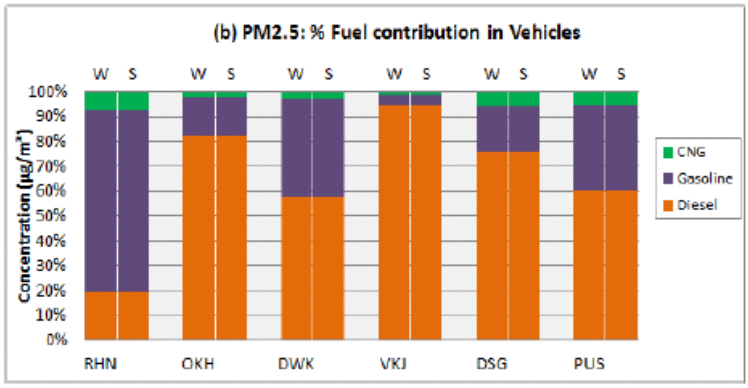


Source: based on Air Quality Monitoring Project-Indian Clean Air Programme (ICAP) -- Draft report on "Emission Factor development for Indian Vehicles " as a part of Ambient Air Quality Monitoring and Emission Source Apportionment Studies, CPCB/ MOEF

Contribution of diesel vehicles to PM2.5: There is a serious concern over growing use of diesel in transport sector. While trucks are captive user of diesel, cars are using it by choice due to lower prices of fuel. The Kanpur IIT study has shown that in different locations of their study in Delhi diesel

vehicles contribute hugely to PM2.5. Except Rohini where diesel vehicles were found to be emitting 20%of vehicles contribution to PM2.5, in Okhla, VasantKunj, Dilshad garden it contributed about 70-90% of PM2.5;in Pusa and Dwarka about 60%. (Graph 10: Contribution of fuels in vehicular pollution).

Graph 10: Contribution of fuels in vehicular pollution

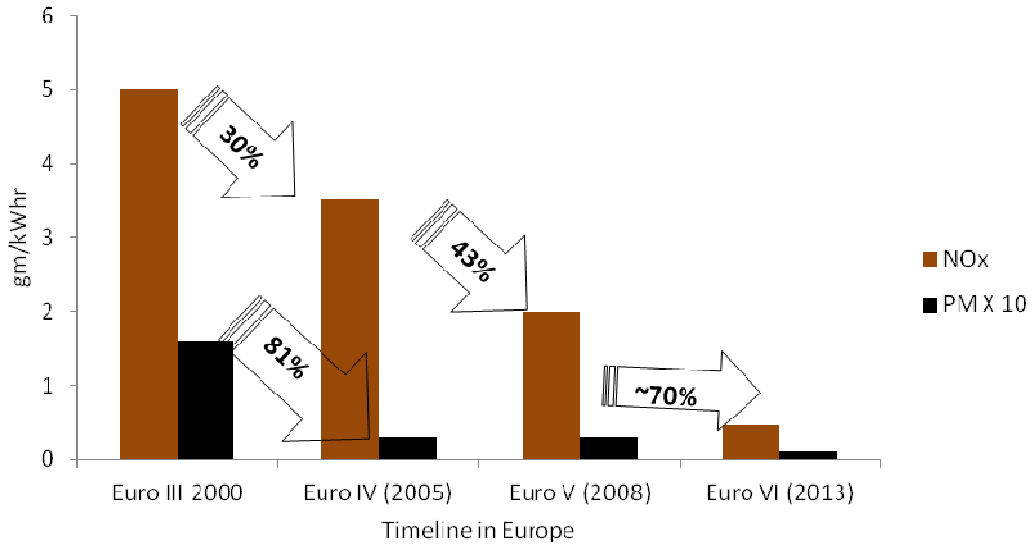


Note: RHN: Rohini; OKH: Okhla; DWK: Dwarka; VKJ: VasantKunj; DSG: Dilshad Garden; PUS: Pusa

Source: Draft Report 2015 - Comprehensive study on Air Pollution and Green House Gases (GHGs) in Delhi (for Delhi Government) by IIT Kanpur

One of the reasons why diesel vehicles are so polluting is the lack of uniform norms across the country. Bharat Stage IV norms have been introduced only in a few cities but the rest of the country has Bharat Stage III that are 15 years behind Europe. As a result of this trucks have not moved to Bharat Stage IV and have remained extremely polluting. Emissions from new trucks can improve by 80% if Bharat Stage IV is introduced nation-wide.

Graph 11: Emission norm for heavy duty vehicles



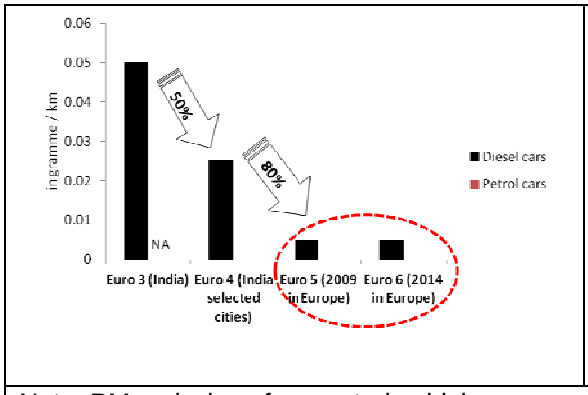
Note: PM values to be multiplied by 10 to show the values of PM emissions norms in the graph.

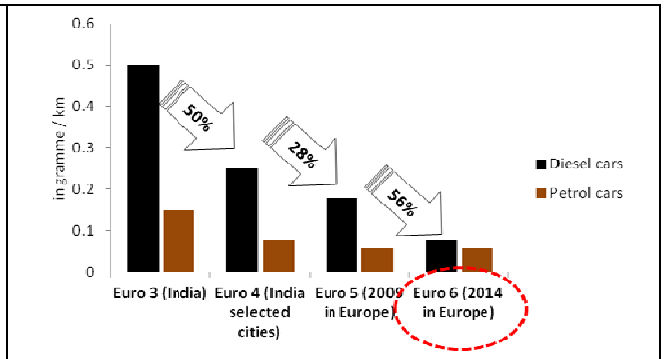
Source: Based on data available in www.dieselnet.com

At the same time rapid dieselization of cars is of special concern as it is contributing to the pollutants of concern in Delhi – PM2.5 and NOx. Under the current norms diesel cars are legally allowed to emit seven times more particulate matter and three times more nitrogen oxides than petrol cars. Moreover, the WHO has classified diesel emissions as class I carcinogen putting it in the same category as tobacco smoking for its strong link with lung cancer.

Graph 12: Comparison of norms for petrol and diesel cars

Particulate norms for diesel car	**NOx norms for petrol and diesel cars. (Diesel emissions equalize with petrol only at Euro VI level)**





Note: PM emissions from petrol vehicles are so negligible that these are not regulated in petrol vehicles

Source: Based on data available in www.dieselnet.com

Action on vehicles

- **Introduce Bharat stage IV emissions norms nation-wide by January 2016 and leapfrog in one step to Euro VI in 2020.** Only at Euro VI level norms for both particulate matter and nitrogen oxides become effectively stringent andthe gap between petrol and diesel norms begin to close gaps. (*See Annex 1 on Auto-Fuel policy roadmap*)
- **Scale up integrated public transport and last mile connectivity** including walk, cycle, and para transit, to reduce dependence on personal vehicles in the entire NCR.
- **Adopt parking policy as a congestion reduction measure in the entire NCR**

Status of pollution from power plants

Delhi has five power plants (excluding Rithala that is not operational) with a total installed capacity of 2,940MW. Two plants Badarpur and Rajghat are coal based and the rest are gas based. Although plants located in Delhi can meet almost half of Delhi's power needs (peak load 6,000MW), they supply only 20% of the demand during April to October 2015 (30% during FY 2014-15). This is because of inadequate supply of gas. This is inexcusable since gas-based generation is lot cleaner than coal and can play an important role in controlling Delhi's pollution.

National Thermal Power Corporation Limited (NTPC) plant in Badarpur supplies a relatively small share of Delhi's power needs (7.9% during Apr-Oct 2015) but it has been important to Delhi's grid as this serves parts of South Delhi. But, it has substantial impact on Delhi's air pollution as it is coal based. NTPC Badarpur generates almost 40% of electricity generated by all power plants located in Delhi. However, this plant has been found to be one of the most polluting plants in the country. Cost of power from this inefficient plant is also expensive. It is ironical that Delhi remains dependant on Badarpurwhich is among the most inefficient plants in the country, but the gas based plant in Bawana in Delhi which is the cleanest plant remains constrained by gas supply.

Action on power plants (See Annex on Power Sector: Contribution to Delhi Air pollution)

- For pollution emergency action shut down Badarpur power plant for three months during winter.
- In the medium to longer term move all power plants in the NCR to natural gas.