# DIESEL

## ON THE TOXIC TRAIL OF DEVIL'S ENGINE

**Writer:** Anumita Roychowdhury

**Research support**: Vivek Chattopadhyaya, Polash Mukerjee, Usman Nasim and Shambhavi Shukla

**Editor:** Arif Ayaz Parrey

**Design:** Ajit Bajaj

**Production:** Rakesh Shrivastava and Gundhar Das


We are grateful to Shakti Sustainable Energy Foundation for its support. The Foundation works to strengthen energy security of India by aiding the design and implementation of policies that support energy efficiency, renewable energy and the adoption of sustainable urban transport solutions. The views expressed and analysis presented in this document do not necessarily represent those of the Foundation and it accepts no liability for the content of this document, or for the consequences of any actions taken on the basis of the information provided.

**Citation:** Anumita Roychowdhury 2017, *Diesel: On the toxic trail of devil's engine*, Centre for Science and Environment, New Delhi




Published by
Centre for Science and Environment
41, Tughlakabad Institutional Area
New Delhi 110 062
Phones: 91-11-40616000
Fax: 91-11-29955879
E-mail: cse@cseindia.org
Website: www.cseindia.org

Printed at Multi Colour Services, New Delhi

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# 1. Introduction

That diesel emissions are harmful and toxic is an old story. But even after 20 year of global action to clean diesel up, it is still throwing up new and more difficult challenges; and that is an unfolding story. US, Europe and Japan have made emissions targets stringent, but diesel vehicles are struggling to lower emissions. Consequently, cities all over the world are beginning to restrict diesel cars to protect the environment, perhaps signalling the death of diesel.

There are valuable lessons for India in this. While misuse of fuel tax policy to keep diesel prices cheap has led to massive dieselization of the car segment, rapid expansion in road-based freight has exploded truck traffic on highways that contribute enormously to pollution in densely populated habitations with serious public health consequences.

Though this is a national concern, policy action on diesel has played out more intensely in Delhi due to Supreme Court (SC) interventions to address air pollution concerns in the capital. Since the late nineties, several directives from SC and subsequent government action have targeted toxic particulate matter (PM) and noxious gases from diesel vehicles in Delhi. In the first phase, key diesel polluters—buses, taxis and small commercial vehicles that operate within the city limits—were asked to move out of diesel. Nearly all of them have now been substituted with compressed natural gas (CNG) vehicles. This was a win-win as the clean fuel programme was conjoined with public transport augmentation plan, as the 28 July 1998 SC order, while directing all buses to move out of diesel, had also ordered increasing bus numbers to 10,000.

Since then, the health gains of replacing diesel with CNG in high mileage vehicles has been compromised by rapid increase in personal diesel car numbers and the growing influx of diesel trucks into the city. In 2000, diesel cars were just 4 per cent of new car sales. This increased to 50 per cent by 2012. Among all other pollution sources, the diesel cars sector has witnessed the most rapid increase in the city. Similarly, the 55,000 trucks estimated to have been entering Delhi daily in 2015 were responsible for 30 per cent of the particulate load from the transport sector in the city. Exposure to direct diesel emissions kept increasing.

Since 2015, SC has once again intervened to monitor and direct air pollution control. This time, it is a more comprehensive approach covering all key pollution sources in the national capital region (NCR) of Delhi. A series of directives have been issued since October 2016 to control pollution from vehicles, waste burning, and construction activities. Power plant pollution is also on the anvil.

Among all the measures initiated so far, the SC directives have had the most impact in curbing diesel emissions. SC has imposed an environmental compensation charge (ECC) on each truck that enters Delhi and has barred pre-2006 trucks from entering Delhi. Trucks that do not have business inside the city are not allowed to enter. To facilitate this process, two bypass roads around Delhi are being constructed. Diesel taxis that are registered under the All India Tourist Permit are no longer allowed to do point-to-point service inside Delhi NCR.

Action on diesel cars has been the weakest part of this new campaign. SC had imposed a temporary ban on big diesel cars with engines of 2,000 cc or more during the winter of 2015–16. This ban was subsequently lifted and a 1 per cent ECC on these big diesel cars was put in place, as offered by the car companies. The proposal of higher ECC on these cars from the Environment Pollution (Prevention and Control) Authority (EPCA) is still pending in the court. The National Green Tribunal (NGT) has banned 10-year-old diesel vehicles, including cars, in the NCR. But otherwise there is no restraint on the misuse of this cheap and toxic fuel by car owners either in Delhi or nationally.

Dieselization is a national concern today. While Delhi is implementing local solutions, there is an urgent need for a national solution as well. One big step that India has taken this year that can help to address this problem is to skip Euro-V emissions standards and go directly to Bharat Stage-VI in 2020, to shorten the time lag with global good practices. Only at this level the gap between petrol and diesel emissions begin to narrow down. But this will still need a national fiscal strategy to negate the existing incentives for diesel car. Policies are also needed to change the freight modal share in favour of railways to reduce road-based freight movement. Otherwise, dieselization is going to be massive during the next five years, and it will lock-in enormous pollution and ill health in cities. Local policies will also be needed in cities to disincentivize dieselization and promote alternatives. Cities also need to ensure that they do not become conduits of transit freight traffic and instead regulate local movement of commercial traffic and adopt appropriate fuel substitutions strategy.

The urgency of these actions stems from the global learning curve on diesel. The Volkswagen scandal has once again cast a shadow on the effectiveness of regulation. Reports are pouring in on the very poor emissions performance of diesel cars on the road. This has alerted the world to the challenge that diesel car manufacturers are facing in meeting the stringent emissions standards in Europe and US—mainly in maintaining real world emissions on road. This is leading to a reversal of policies in many cities of the world where diesel vehicles are being seen as pushing up the local pollution curve. More evidence on harmful cancer and other effects of diesel emissions have also put a question mark on the future of diesel.

It is, therefore, important to tap the global lessons on diesel and understand the special challenges of dieselization in India to inform a new policy roadmap.

# 2. Diesel and health

## Special health concerns around diesel emissions

In June 2012, the World Health Organization (WHO) and International Agency for Research on Cancer (IARC) classified diesel exhaust as Group 1 carcinogen for its definite links with lung cancer, putting it in the same class as tobacco smoking, asbestos, and arsenic. In their release, IARC–WHO stated that the most clinching evidence came from the largest American study in 2012 by the US National Cancer Institute.

In 2014, a WHO–IARC's monograph on the evaluation of carcinogenic risk to humans titled *Diesel and gasoline engine: Exhaust and some nitroarenes, Volume 105* in its evaluation stated that "there is sufficient evidence in humans for the carcinogenicity of diesel engine exhaust. Diesel engine exhaust causes lung cancer. A positive association has been observed between exposure to diesel engine exhaust and urinary bladder cancer. There is inadequate evidence in humans for the carcinogenicity of gasoline engine exhaust." It further states, "Diesel engine exhaust is carcinogenic to humans (Group 1). Gasoline engine exhaust is possibly carcinogenic to humans (Group 2B)."

Moreover, it has been found out that even small doses can increase cancer risk substantially. According to the California Air Resources Board, the number of excess cancer cases per million people due to lifetime exposure to only 1 microgram per cubic metre of diesel PM is 300, as against 29 for benzene (that comes predominantly from petrol). The cancer potency of diesel PM is 10 times more than benzene.

The March 2016 Health Canada report, published by the Canadian government, provides evidence of both cancer and non-cancer effects of diesel emissions including respiratory, heart, and immune system. It states that if people spend 6 per cent of their time in micro-environments with high traffic and high pollutant concentrations, it can result in daily exposure to as much as 21 per cent of the black carbon.

The International Council on Clean Transportation has estimated the cancer risk from diesel vehicles in Delhi based on data from an IIT Kanpur study. It shows that cancer risk from diesel cars is four times higher than petrol cars. More than 280,000 avoidable cancer deaths in Delhi have been attributed to diesel exhausts.

A study conducted by the Health Effects Institute, Boston, has found that the maximum effect of vehicular pollution is upto half a kilometre from major road sides. More than 55–60 per cent of Delhi's 17 million people live in that zone.

## Diesel PM is more harmful than other particles

In any city, PM comes from both combustion and dust sources. Studies have now established that the harmful effects of particulate depend on the fuel being burnt. A significant study by the Health Effect Institute, Boston, published in Environmental Health Perspective in December 2015, has found that particles from coal and diesel are more harmful than wind-blown dust. These increase

ischemic heart disease-related deaths. This is dangerous as the Global Burden of Diseases for India attributes half of air pollution related deaths to heart disease.

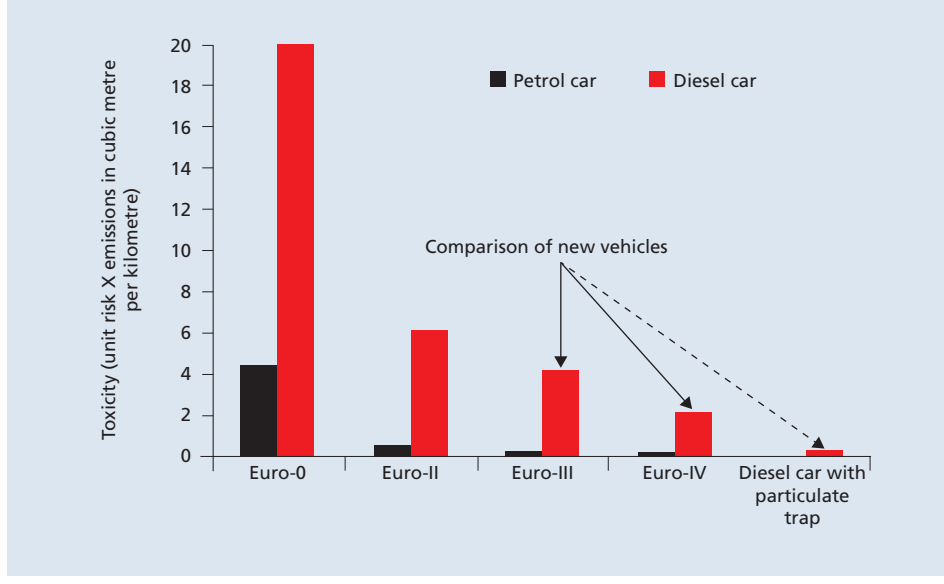
A report by London Assembly Environment Committee in 2015, *Driving away from diesel, reducing air pollution from diesel vehicles* states that gram for gram, PM from diesel vehicles can be more harmful than other particulate emissions (which come from sources that also emit nitrogen oxides ($NO_X$). For example, $PM_{2.5}$ emissions from diesel exhaust contains high levels of black carbon, which has been found to be four to nine times deadlier than other types of $PM_{2.5}$.

The Health Effect Institute study *New Technology Diesel on Low Sulphur Fuels and New Emission Control Technologies* has further shown that advanced emissions control systems and ultra-low sulphur diesel fuel (10 ppm sulphur) that are needed to meet Euro-VI standards, or the US-2007/ 2010 standards can reduce PM by 90 per cent, nitrogen oxide by 94 per cent and other carcinogenic substance substantially as well. But that is not possible in Euro-IV and -V engines. This indicates India will have to quickly move out of Bharat Stage-IV (BS-IV) emissions standards, skip Euro-V and move directly to Euro-VI.

With successive improvements in emissions standards, emissions and cancer potency are reduced, but at any given level, cancer risk of diesel emissions is much higher than petrol cars. WHO–IARC also mentioned in their press communiqué of 2012 that it is not clear how the quantitative and qualitative changes in diesel technology and fuel "may translate into altered health effects" and stated that "research into this question is needed." Hence, uncertainties remain regarding improved diesel emissions (see *Graph 1: Emissions standards and toxicity*).

**Graph 1: Emissions standards and toxicity**

Despite improvements, diesel emissions continue to be carcinogenic




Source: Fraunhofer Institute for Toxicology and Experimental Medicine ITEM, Hannover, Germany

# 3. Dieselization in India

## Why is India in the grip of dieselization?

Diesel fuel is taxed lower than petrol to keep it affordable for farmers. But this has encouraged its use in cars. Diesel car users pay less tax for fuel than petrol cars and two-wheeler users. Data from the Ministry of Petroleum and Natural Gas has shown that cars have emerged as the second highest user of diesel after trucks and are using equal or more than agriculture, buses and taxis individually (see *Graph 2: All-India end-use share of diesel in retail and direct sales combined*). Transport sector as a whole is using up 70 per cent of the diesel fuel.

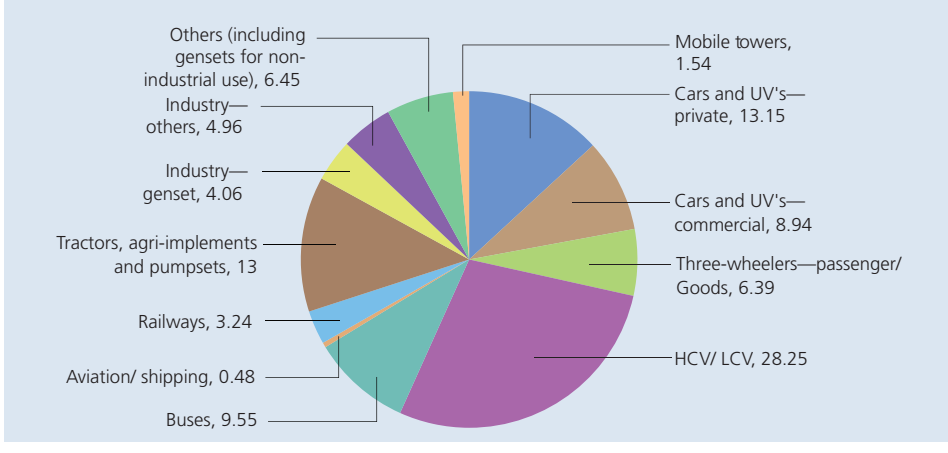
Even though diesel prices were deregulated in November 2014, the price differential between petrol and diesel fuels have been maintained and overall fuel prices have further declined compared to what they were during the global peak oil prices (2012–14). Diesel is not only cheaper than petrol now but its prices are much lesser than what they used to be in 2013–14. This is a strong incentive for consumers. People are less sensitive to absolute level of transport fuel prices in the short run. But they can be immensely sensitive to price differences between fuels to make their choices (see *Graph 3: Prices of petrol and diesel in Delhi*).

If restraints are not put in place, diesel car shares will continue to increase, reflecting the general trend in the car industry, with an increase not only in the number of diesel car models but also introducing more models in smaller and popular car segments (see *Graph 4: Number of diesel car models in different engine size classes*).

To control dieselization of cars, it is important to recover the additional lifetime tax that a petrol car pays from diesel cars to equalize the tax burden for the same usage. Petrol cars pay at least 1.3 times more taxes (central and state taxes combined) for the same usage. As diesel is easily substitutable with petrol in cars, the revenue losses from each litre of diesel that replaces a litre of petrol in a car is enormous and unacceptable.

**Graph 2: All-India end-use share of diesel in retail and direct sales combined**

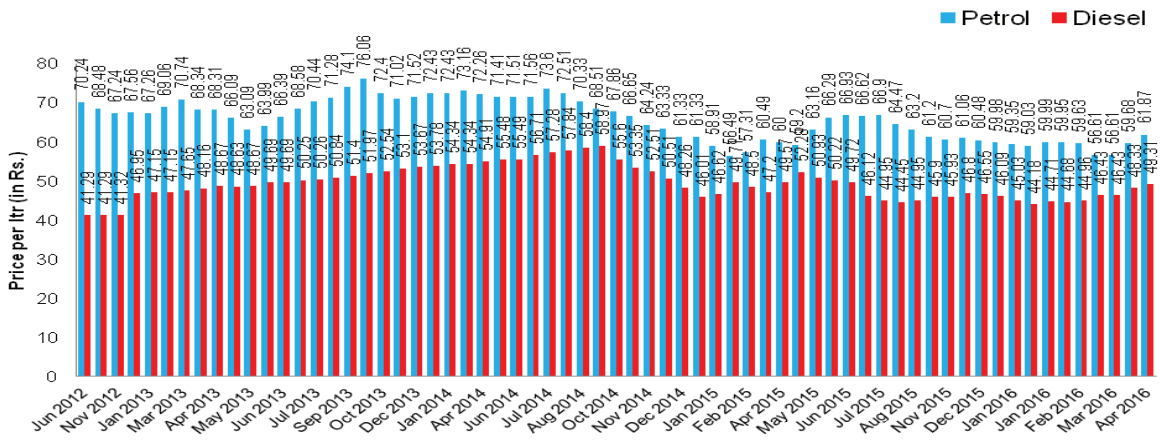
Passenger vehicles account for one-thirds of total diesel usage




Source: Ministry of Petroleum and Natural Gas 2015

### Graph 3: Prices of petrol and diesel in Delhi

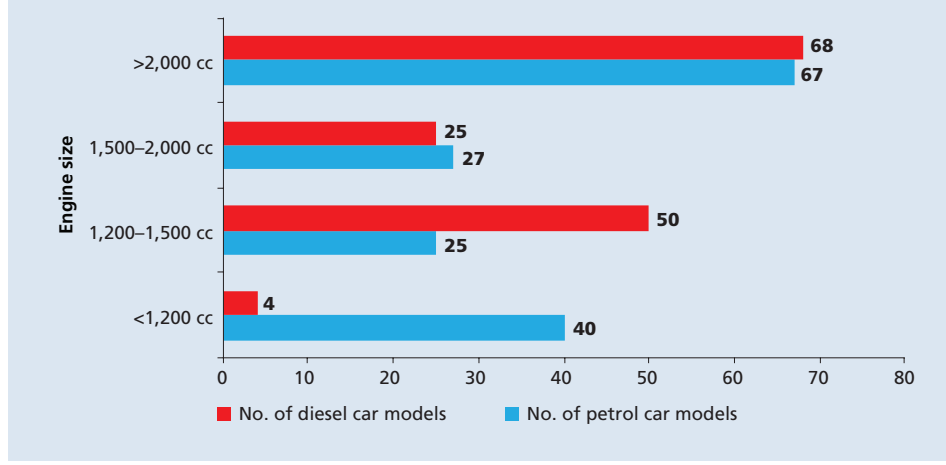
The price differential is still large enough to encourage dieselization




Source: Compiled from data from Indian Oil Corporation–IOCL

### Graph 4: Number of diesel car models in different engine size class

The proportion of diesel cars is increasing in the segments with the most sales




Source: Compilation of market information, April 2016

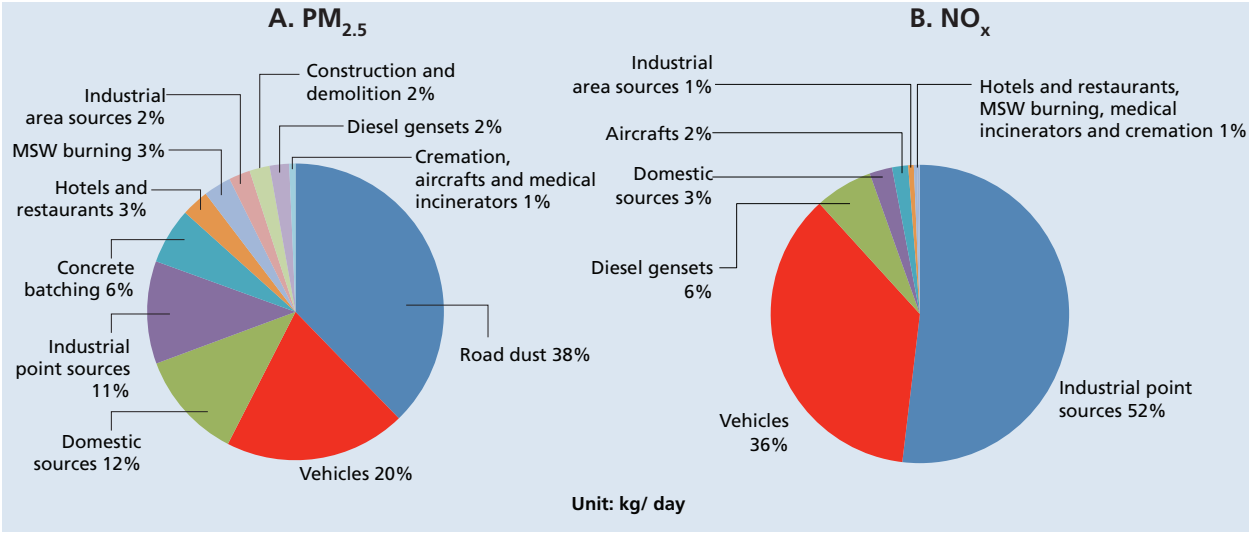
## Why industry numbers on diesel car pollution don't add up

Auto industry has resorted to a number game and taken a reductionist view of IIT Kanpur's emissions inventory estimates to claim that if vehicles contribute 20 per cent of $PM_{2.5}$ and cars are 10 per cent of it, then it works out to be only 2–3 per cent of $PM_{2.5}$ from all sources. The share of diesel cars is even smaller. Therefore, they claim that the contribution of cars to particulate load is so small that it does not merit any action.

But the industry fails to convey that cars emit more $PM_{2.5}$ than several other key pollution sources in Delhi. If, as per the IIT Kanpur report, cars are estimated to emit 2–3 per cent and diesel cars 1.6 per cent of $PM_{2.5}$ from all sources, then cars equal or exceed what solid waste burning (3 per cent), hotel and restaurants (3 per cent), industrial areas (2 per cent), construction and demolition waste (2 per cent) and diesel generator sets (2 per cent) emit individually (see *Graph 5: Emissions inventory*).

**Graph 5: Emissions inventory**

Vehicles are second highest emitters of $PM_{2.5}$ and $NO_x$




Source: IIT Kanpur study for Delhi Government

At 36 per cent, vehicles are the second largest contributors of $NO_x$. Just cars emit 6.1 per cent of total $NO_x$ from all sources. This makes them the joint third largest contributor of $NO_x$, alongwith diesel generator sets at 6 per cent. Thus, cars emit substantially more $NO_x$ than domestic sources (at 2 per cent), or industrial areas (1 per cent), or hotels and restaurants (less than 1 per cent), or medical incinerators (less than 1 per cent). Moreover, construction sites, sans dust controlling measures, can be fined upto Rs 50,000 a day or face closure during pollution emergency. Penalties are also slapped on open burning of waste. Farmers in Punjab can be put behind bars if found burning stubble. Therefore, there is no case to make an exception for cars, especially diesel cars that are responsible for high toxic exposure.

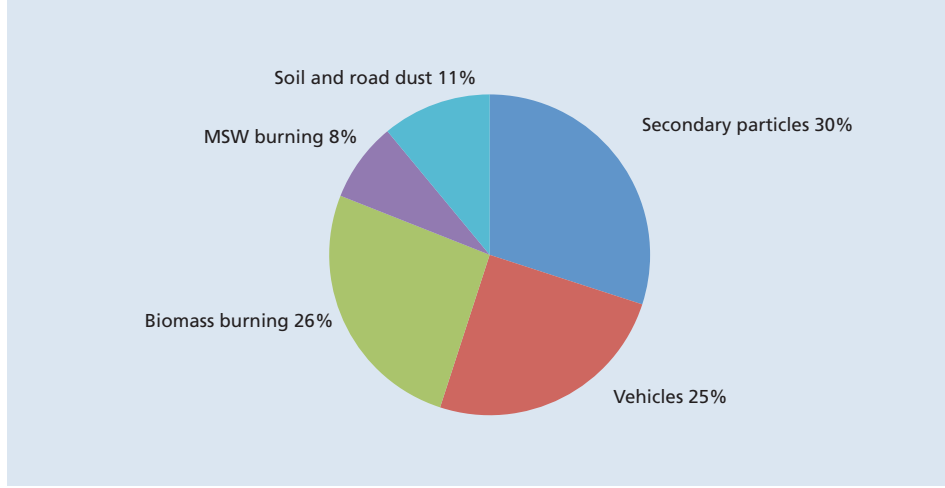
Delhi cannot meet its clean air objectives if stringent action is not taken on cars. Action has already been initiated to control truck pollution, and move buses, three-wheelers and other commercial vehicles to CNG to curb vehicular pollution. The benefits of these actions cannot be allowed to be negated with rapid increase in diesel car numbers.

## Industry ignores vehicle contribution to secondary particulates

The contribution of vehicles to particulate pollution remains underestimated as their share in secondary particulate pollution is not considered. Secondary particulates are formed from the gases—$NO_X$ and sulphur dioxide ($SO_2$)—that come from vehicles and industry. $NO_x$ form nitrate particles and $SO_2$ forms sulphate particles, adding to the total $PM_{2.5}$ concentration in the air.

The IIT Kanpur study has estimated that the share of secondary particles in the total $PM_{2.5}$ concentration in Delhi's air is as high as 25 per cent. If these are accounted for, then share of vehicular PM, especially from diesel vehicles, in the total $PM_{2.5}$ will be much higher (see *Graph 6: Source apportionment of $PM_{2.5}$ in winter*). Thus, to control 25 per cent of $PM_{2.5}$ in Delhi's air, stringent controls are needed on sources of $NO_x$ and $SO_2$.

**Graph 6: Source apportionment of $PM_{2.5}$ in winter**
Vehicles share increases if secondary particulates are considered



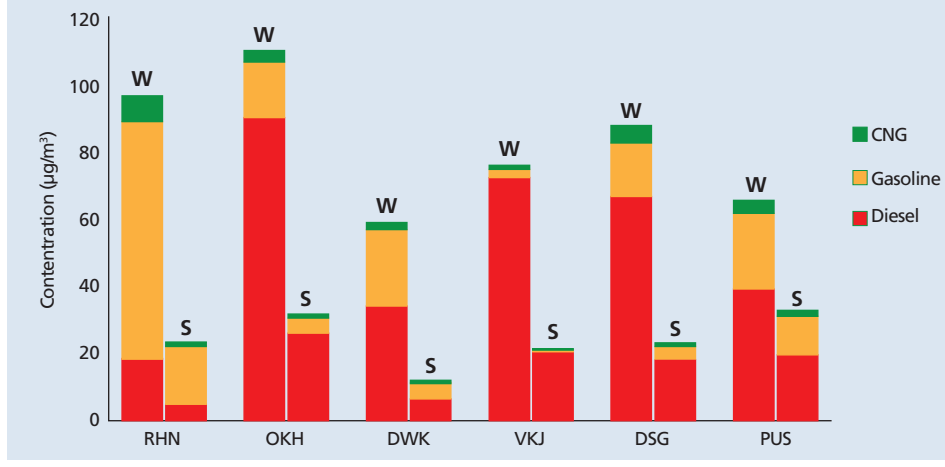

Source: 2015, Comprehensive Study on Air Pollution and Green House Gases (GHGs) in Delhi, IIT Kanpur

Another observation of the IIT Kanpur study is also pertinent here. Vehicles are the most consistent source of pollution throughout the year, while most other sources like waste burning and construction activities are variable and episodic in nature. Control on consistent sources is important to achieve cleaner air.

## Diesel cars are a dominant source of PM2.5 in Delhi's air

The IIT Kanpur study carried out real time survey of the on-road fleet in different locations in Delhi and found that petrol cars constitute 64 per cent, diesel cars 25 per cent and CNG cars 11 per cent of the total car fleet. Out of these, diesel contributes 60–90 per cent of PM emissions from vehicles, the contribution of petrol four-wheelers is much smaller and that of CNG cars is negligible. In the category of four-wheeled cars, it is estimated that petrol cars contribute about 22 per cent of PM emissions, and the rest 78 per cent is contributed by diesel cars, the contribution of CNG cars being negligible (see *Graph 8: Fuel-wise contribution to $PM_{2.5}$ levels*).

**Graph 8: Fuel-wise contribution to $PM_{2.5}$ levels**
There is a big contribution of diesel cars



## With similar share of vehicular pollution, other governments are taking stringent action

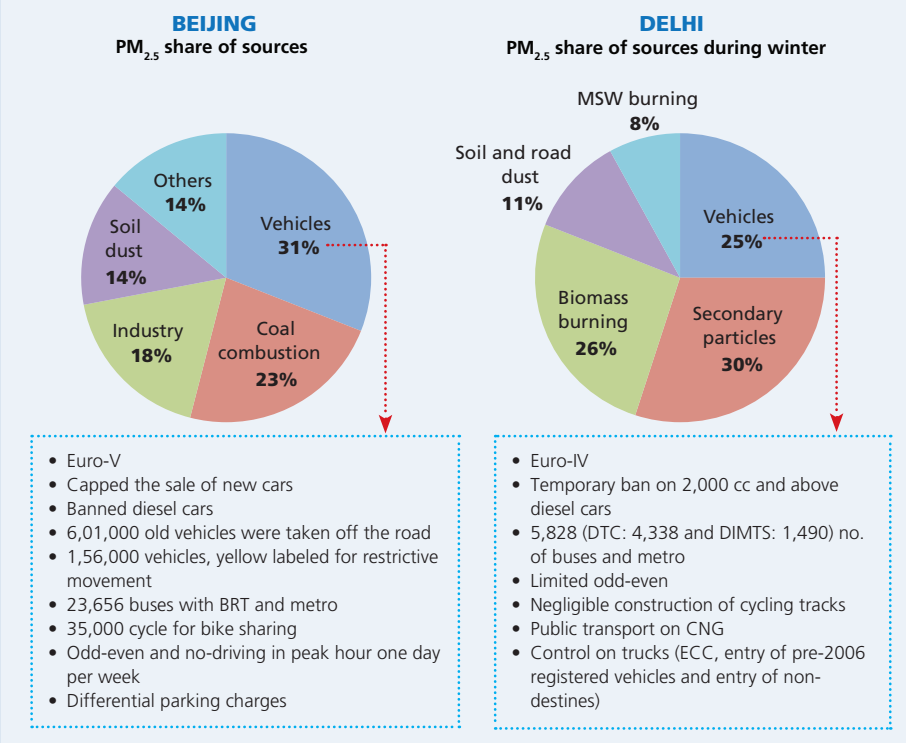
With vehicles contributing 20 to 30 per cent of the pollution, other governments are taking significantly stronger action on vehicles than Delhi.

In Beijing, for instance—which is also battling serious air pollution, vehicles contribute 30 per cent of $PM_{2.5}$, almost the same as Delhi. To address this problem, Beijing has capped the number of cars that can be sold in a year, banned diesel cars, introduced Euro-V emissions standards in 2012, phased out more than 6 lakh old vehicles, restricted movement of more than 1.5 lakh old and polluting vehicles by labelling them yellow, and slapped high and variable parking charges (see Graph 7: *Action on vehicular pollution*).

Beijing is now setting even harsher targets of limiting car numbers below 6 million cars to be able to meet the clean air standards. This is being supplemented by scaling-up public transport.

### Graph 7: Action on vehicular pollution

Other governments taking more stringent action on cars when the share of vehicular pollution is nearly the same as in Delhi




Source: IIT Kanpur study for Delhi Government, 2015

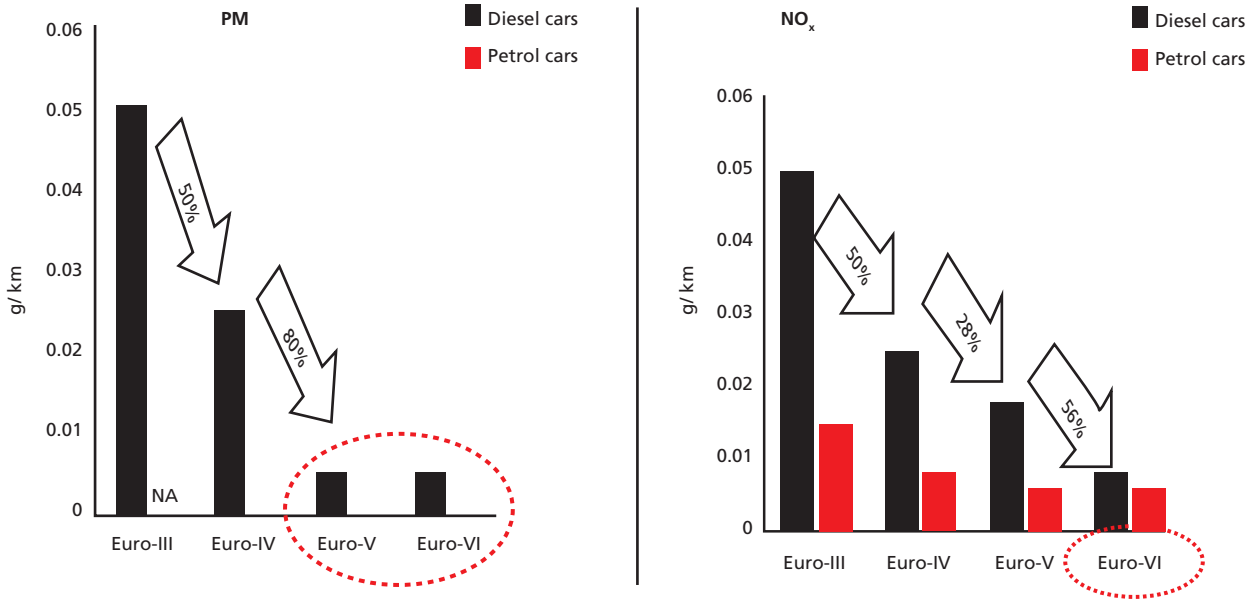
## Diesel cars are allowed to emit more NOX and PM than petrol cars

The current emissions standards of BS-IV legally allow diesel cars to emit three times more $NO_x$ and several times more PM compared to petrol cars (see *Graph 9: $NO_x$ and PM emissions with change in standards*).

The emissions factors developed by the Automobile Research Association of India (ARAI) shows that a BS-IV diesel car emits 12 times more PM than an

**Graph 9: $NO_x$ and PM emissions with change in standards**

Diesel cars allowed to emit three times more $NO_x$ and several times more PM than petrol cars



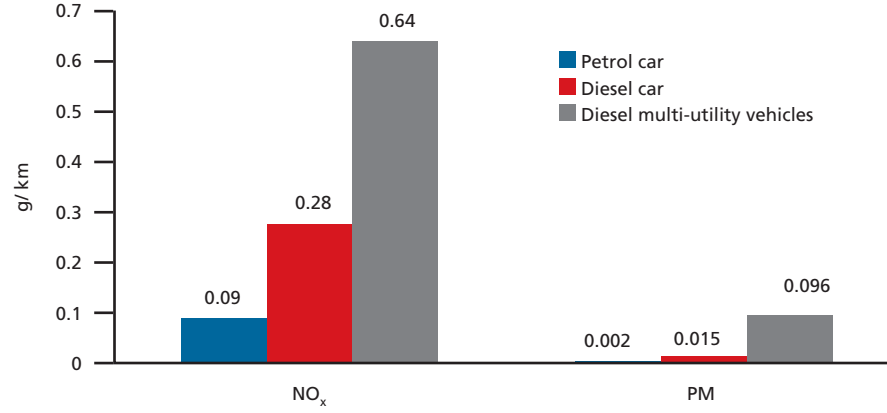

outdated BS-II petrol car. There is also a huge difference in the emissions of PM and $NO_x$ from comparable diesel and petrol cars (see *Graph 10: Emission factors of vehicles of post-2005 vintage*).

## Industry counters: petrol cars emit more carbon monoxide

One industry argument is that petrol cars emit more carbon monoxide that diesel cars. Official air quality data clearly shows that carbon monoxide emissions have been reduced despite petrol cars dominating the fleet. This has been possible due to *en masse* transition from carburettors to multipoint fuel injection system and three-way catalytic converters (see *Graph 11: Vehicle ownership vs pollution levels*).

**Graph 10: Emission factors of vehicles of post-2005 vintage**

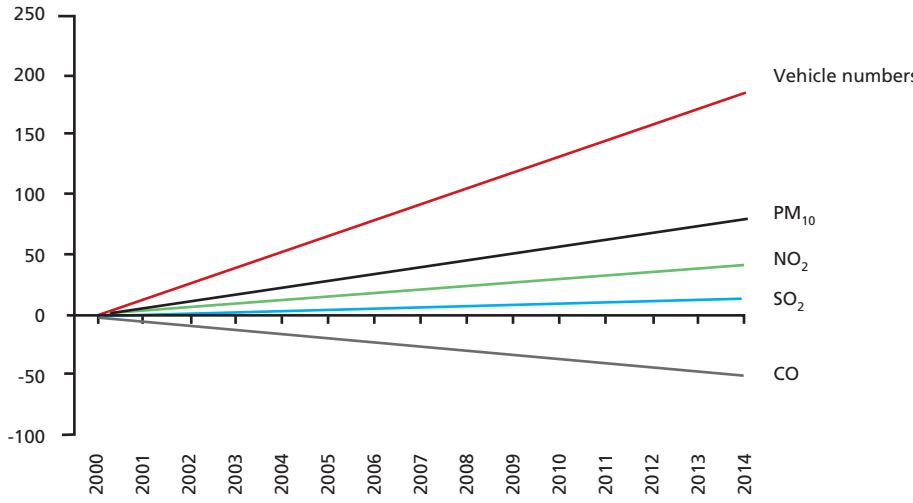
Diesel multi-utility vehicles exceed petrol cars by a factor of seven on $NO_x$ and 48 on PM




Source: ARAI, Pune

**Graph 11: Vehicle ownership vs pollution levels**

Carbon monoxide levels have decoupled from motorization. But $NO_x$ and PM strongly correlate




Source: CSE's estimation based on long-term pollution data provided in Economic Survey of Delhi 2014–15

Moreover, a report published in the journal Science for Environment Policy in January 2016 states that emissions inventory in United Kingdom shows that hydrocarbon emissions from diesel are grossly underestimated by a factor of four to 70. There is no reason to believe that diesel vehicles emit less hydrocarbons.

## Diesel cars negating the benefit

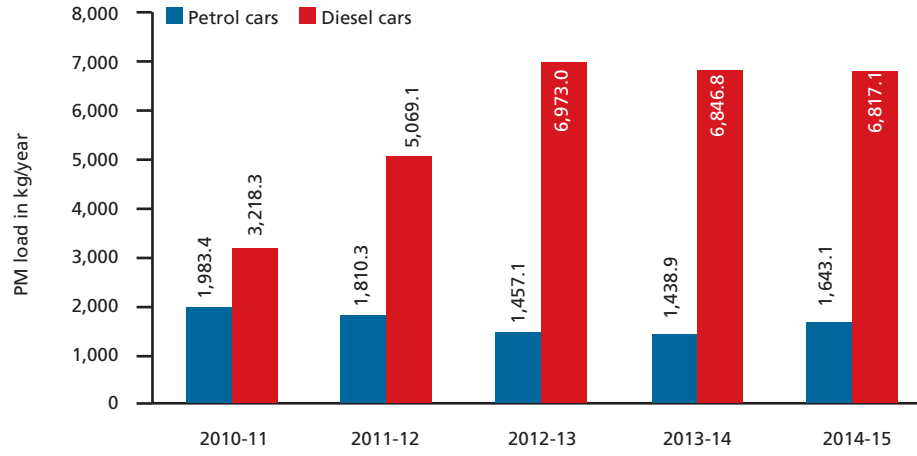
The air quality gains from controlling diesel emissions from commercial and public transport is being negated by rapid and uncontrolled growth of private diesel cars taking advantage of the cheaper diesel fuel prices. In terms of PM and $NO_x$ emissions, the total diesel cars registered in Delhi in 2014–15 are equal to pollution from several times more petrol cars and many diesel buses and trucks. This virtually means that what the city has gained by reducing diesel bus and truck numbers are coming back through the car route.

The emissions factors available from Automotive Research Association of India for BS-III vehicles show that one diesel car emits PM equivalent to five petrol cars, nine diesel cars emit equal to one diesel truck, and six diesel cars emit equal to one diesel bus. The total number of diesel cars (68,384) that got registered in Delhi in 2014–15 has virtually brought back more than 3.4 lakh petrol cars, or about 7,598 trucks, or about 11,397 diesel buses to pollute the air of Delhi.

Moreover, diesel cars that have been registered in Delhi since 2011 have added several times more PM and $NO_x$ compared to petrol cars. In any given year, diesel cars, though lesser in numbers than petrol cars, have added four to five times higher PM load and close to three times more $NO_x$ compared to petrol cars (see *Graph 12: PM emissions—petrol vs diesel* and *Graph 13: $NO_x$ emissions—petrol vs diesel*).

### Graph 12: PM emissions—petrol vs diesel

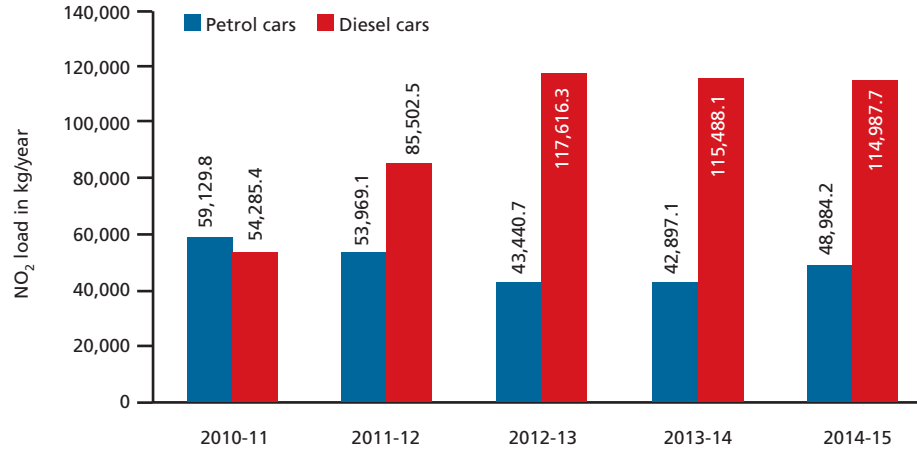
How lesser number of diesel cars have added several times more particulate load annually since 2010




Source: CSE analysis based on data from department of transport, Delhi government

### Graph 13: $NO_x$ emissions—petrol vs diesel

How lesser number of diesel cars have added several times more $NO_x$ annually since 2010




Source: CSE analysis based on data from department of transport, Delhi government

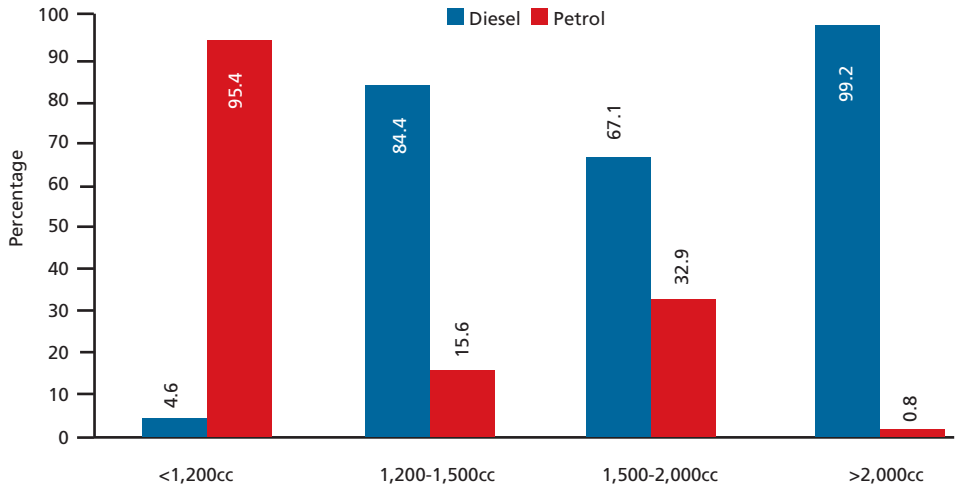
## Dieselization of cars increasing average mass of vehicles

Increase in diesel cars is steadily shifting the market towards bigger cars. Data available for 2012 shows that 82 per cent of petrol cars had engine capacities below 1.2 litre, more than half of petrol cars had engine capacities less than 1.5 litre and above (see *Graph 14: Sale of cars by fuel type within engine size categories*).

The emissions factors for 2005-models collected by Automotive Research Association of India shows that PM emissions from a 3,000 cc engine multi-utility vehicles is six times higher than a diesel vehicle with 1,600 cc engines. A petrol car with 1,400 cc engine emits 48 times lower PM and seven times less $NO_x$ compared to a diesel multi-utility vehicles.

**Graph 14: Sale of cars by fuel type within engine size categories**

Diesel dominates the large car segment, increasing its share in entry level segment




Source: Domestic sales for 2012–13

# 4. Stringent standards vs real world emissions

## New diesel car models failing in real world emissions performance in Europe and the US

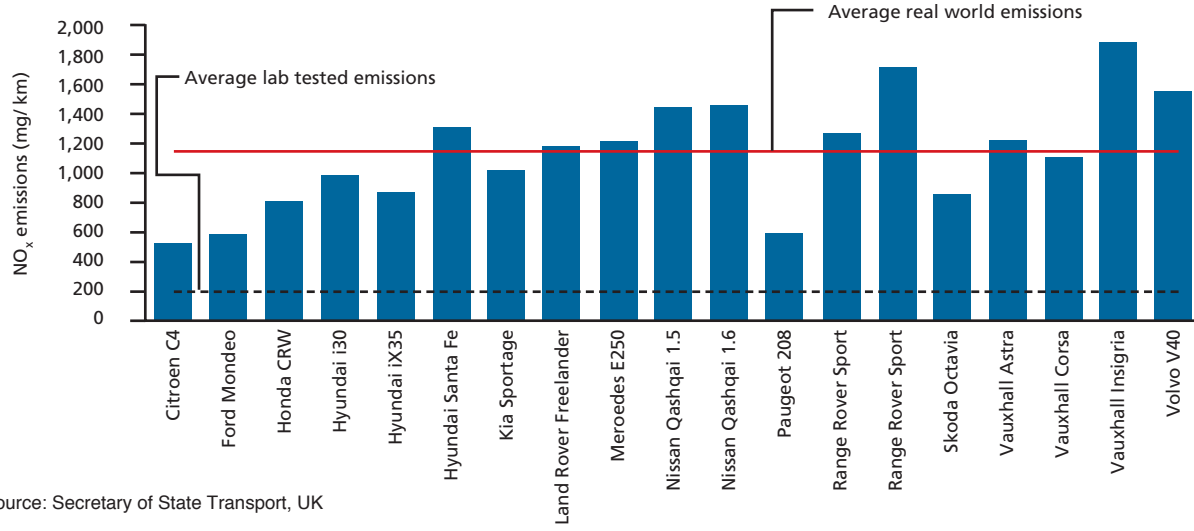
While hard selling diesel, car industry is silent on the new emissions results that regulatory authorities have put out in Europe and US. Even after meeting Euro-V and Euro-VI emissions standards, $NO_x$ pollution is increasing in European cities. The central government in United Kingdom was dragged to its Supreme Court for violating $NO_x$ standards. European cities are failing to meet clean air targets. A 2015 report of the Environment Committee of the London Assembly *Driving away from diesel: Reducing air pollution from diesel vehicles* states that petrol cars at Euro-IV and -V emit less than a tenth of $NO_x$ as compared to their diesel equivalents and at Euro-IV, a tiny fraction of the PM. For this reason, the ultra-low emissions zone treats Euro-IV petrol and Euro-VI diesel as equivalent. Even with Euro-VI standards, diesel cars and vans remain a problem. Their $NO_x$ levels are still six times higher than Euro-V or Euro-VI petrol vehicles (see *Graph 15: Real world $NO_x$ emissions of Euro-V vehicles* and *Graph 16: Real world $NO_x$ emissions of Euro-VI vehicles*).

A spate of emissions testing results coming from British, German and French authorities in the month of April 2016 show how a large number of popular diesel car models have failed to meet the official limits and are emitting six to 12 times higher than estimated real world projections. This has led several governments to come up with policies to restrict diesel cars and further tighten the emissions regulations. The expectations of lower warming gases from higher fuel efficiency has not been delivered in Europe because of greater usage of diesel cars, higher warming potential of black carbon emissions and higher life cycle emissions of heat trapping $CO_2$ emissions.

In 2016, emissions testing carried out by TNO, a technical research body in Netherlands, and supported by the Dutch Ministry of Infrastructure and

**Graph 15: Real world $NO_x$ emissions of Euro-V vehicles**

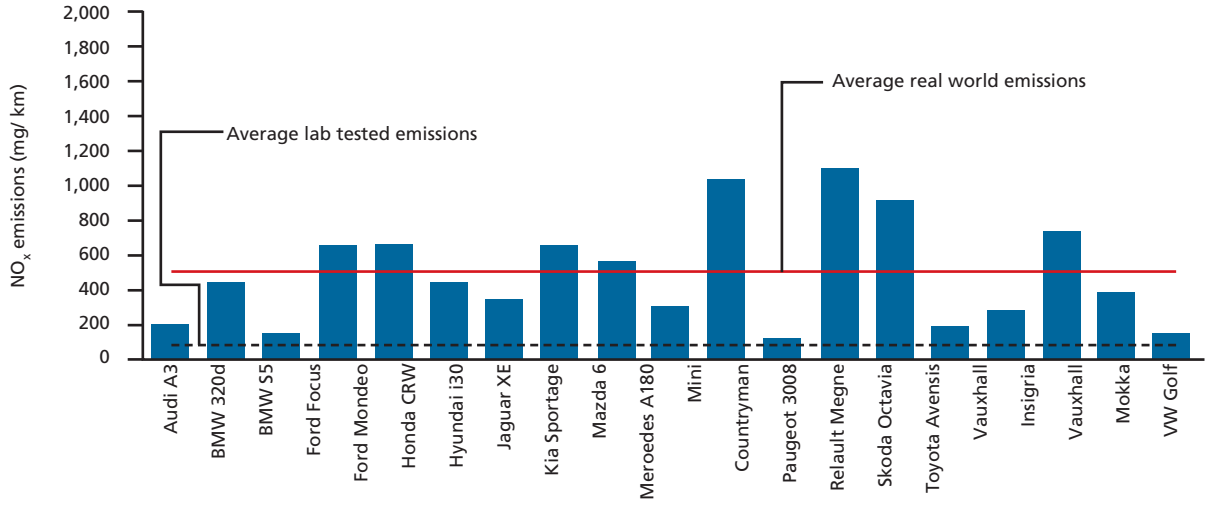
Exceeds norms by several times




Source: Secretary of State Transport, UK

## Graph 16: Real world $NO_x$ emissions of Euro-VI vehicles

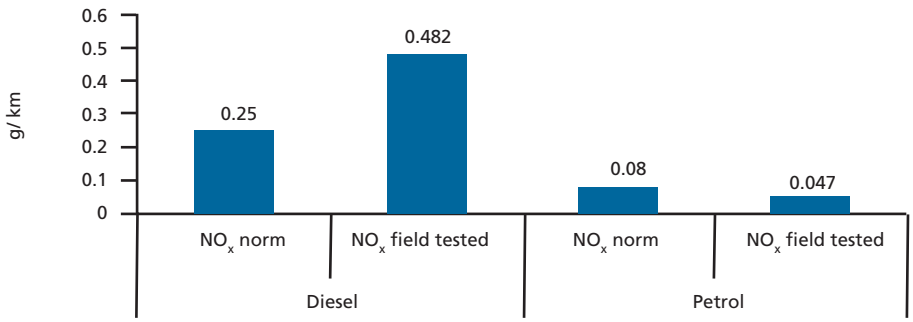
Continues to exceed norms by several times




Source: Secretary of State Transport, UK

## Graph 17: Real world $NO_x$ emissions vs norms in diesel and petrol cars in UK

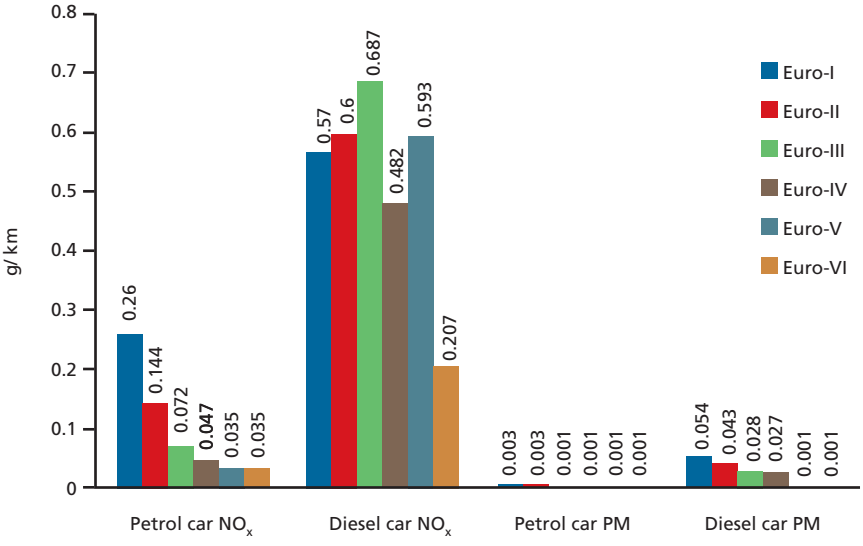
Real world diesel emissions are twice that of norms




Source: Environment Committee, 2016

## Graph 18: Real world $NO_x$ emissions—evidence from UK

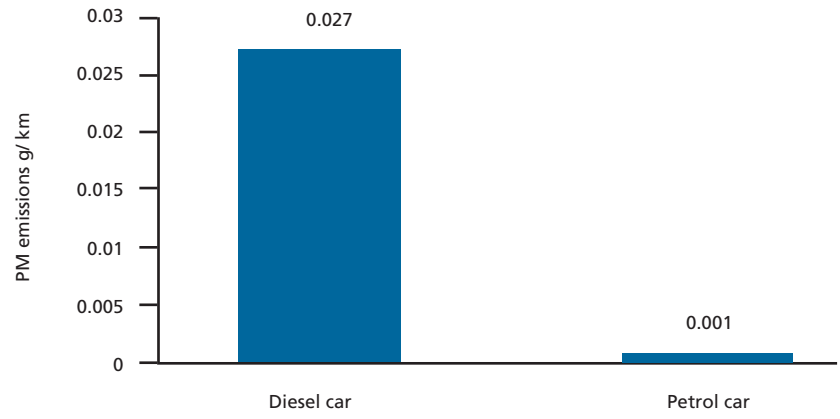
Diesel cars emit much more than petrol cars across emissions standards




Source: Environment Committee, 2016

**Graph 19: Real world emissions from Euro-IV cars in Europe**

India will move to Euro-IV by April 2017




Source: Environment Committee 2015

Environment, found that $NO_x$ emissions level from diesel cars were two to 16 times higher than the type approval emissions limit value (see *Graph 17: Real world $NO_x$ emissions vs norms in diesel and petrol cars in UK* and *Graph 18: Real world $NO_x$ emissions—evidence from UK*).

A 2014 study by the International Council on Clean Transportation in Europe found new diesel passenger cars meeting Euro-VI standards and US equivalent (Tier-2 Bin-5), emitted six to seven times higher than the certified level.

The European Commission performed road test on emissions from seven diesel cars starting 2007 and released the data in 2011 and 2013. Joint Research Centre of the European Commission, in a scientific paper in 2013, stated that the on-road $NO_X$ emissions of the tested Euro III–VI diesel vehicles reach 350 ± 125 per cent of their emissions standards, whereas the on-road $NO_X$ emissions of the tested Euro III–V petrol vehicles remain at only 44 ± 22 per cent of the respective emissions standard. There is no appreciable reduction in on-road $NO_X$ emissions from Euro-IV to Euro-V diesel vehicles. Based on the assessment, the European Commission and the Member States concluded that the test procedure should contain portable emissions monitoring for on-road testing as a complementary to regulatory test procedure.

Evidence from Europe shows how bad the performance of Euro-IV compliant cars can be. Delhi is currently at Euro-IV level.

Emission results from London show on-road diesel cars are emitting 27 times higher PM compared to petrol cars. In India, such detailed emissions testing of on-road vehicles has not been carried out. Indian industry has also not disclosed either actual certification data or real world on-road emissions data for different car models. There is no surveillance of real world emissions from Indian cars. There is an urgent need for voluntary disclosure of actual emissions levels of all car models and makes from the automobile industry (see *Graph 19: Real world emissions from Euro-IV cars in Europe*).

## Diesel cars have not delivered on their mandate to emit less heat trapping gases

Europe had initially encouraged diesel cars hoping that they are fuel efficient and may help to reduce heat trapping $CO_2$ emissions. But even after massive dieselization Europe has not been able to meet its $CO_2$ emissions standards for transport. On the contrary, black carbon emissions from diesel vehicles that are part of PM emissions are several times more heat trapping than $CO_2$.

Moreover, $CO_2$ emissions from the upstream diesel refining process have also increased. European Commission has found that lifetime pollution costs of Euro-IV compliant diesel cars are much higher than petrol cars. There is also a rebound effect. Diesel fuel has higher carbon content than petrol. If more diesel is burnt due to more driving encouraged by cheaper fuel prices more heat-trapping $CO_2$ will escape and negate the fuel efficiency advantage of cars.

The 2013 report of Environmental Sciences Europe has assessed the European diesel car boom; it shows that with higher calorific value, diesel fuel contains about 14 per cent more carbon per litre. This reduces the $CO_2$ reduction advantage. If more diesel fuel is burnt, more carbon will be emitted. The report assessed 250 German cars between 2000 and 2008. At the latter date, petrol cars recorded an average surplus fuel consumption of 16.9 per cent while diesel cars consumed 23.8 per cent more. All these have nullified marginal greenhouse gas reduction benefits of diesel cars. They found diesel cars have given little advantage in terms of $CO_2$ savings. Moreover, black carbon, the core of diesel PM emissions, has 16 times higher warming potential than $CO_2$. Studies in the UK have also found that diesel vehicles emit more $CO_2$ in slow start and stop–driving conditions on the road. This further negates the climate benefits of dieselization.

## Impact of high heat trapping black carbon emissions

The latest IPCC report shows that the warming potential of black carbon, which is part of PM, can be as much as 16 times that of $CO_2$ emissions. The transport sector is one of the key sources of black carbon and is responsible for about 25 per cent of global black carbon emissions. Of the total black carbon emissions, 20 per cent is expected to be from diesel black carbon. Although petrol vehicles are numerous, diesel black carbon is much higher in quantum.

# 5. World-wide backlash against diesel cars

In 2014, the UK-based group Client Earth sued the government for not meeting the 2010 targets of ambient $NO_x$ standards. Even European Commission initiated a formal infringement proceeding against UK for not meeting the $NO_x$ standards. On behalf of secretary of state of UK, it was submitted that the main reason for this was that real world emissions of vehicles was quite different from the original official limit—that real world $NO_x$ emissions from Euro-V diesel cars were even more than Euro-I compliant cars. Thus, expected reduction from the introduction of stricter Euro emissions standards had not materialized.

The Environment Committee of the London Assembly, in its 2015 report *Driving away from diesel: Reducing air pollution from diesel vehicles* states that, follwing the Supreme Court order, it had become even more imperative that diesel be disallowed. The report recommended further strengthening of the measures proposed by the mayor of London. These include creating an ultra-low emissions zone in central London from 2020, a diesel scrappage scheme, widespread road pricing and linking of vehicle excise duty with $NO_x$, PM and $CO_2$ emissions. It also asked for testing and monitoring of real word emissions of diesel vehicles. For heavy-duty vehicles, Euro-VI and hybrids are being promoted as there are limited alternatives.

A group of healthcare professionals campaigning as the group Doctors Against Diesel, have called for diesel engines to be outlawed in London. The organization says that the mayor of London, Sadiq Khan, should commit the capital to a growing list of cities to ban diesel engines. According to this campaign group, every year 9,400 deaths in London are caused by toxic fumes from diesel engines.

Recently, the administrative court of Dusseldorf in Germany has upheld the action of the Environmental Action Germany (DUH) against the Federal State of North Rhine–Westphalia for exceeding air quality values in the state capital of Dusseldorf in its entirety. The court concluded that bans on diesel-driven vehicles should be issued as soon as possible. In the court's view, the legal instruments to do so already exist. There is an entrance prohibition sign with an additional sign forbidding entrance to diesel vehicles.

The DUH has filed 15 lawsuits against federal states and summoned cities for violations of the limit values for $NO_2$, the noxious diesel exhaust gas, and has won all cases to date. On 17 November 2015, the DUH filed a lawsuit with the Administrative Court Dusseldorf against the state of North Rhine–Westphalia. The reason for doing so was the fact that the air in Dusseldorf was still contaminated with high levels of the pollutant $NO_2$. The limit value of 40 µg/$m^3$ $NO_2$ annual average, which has been in force since 2010, was significantly exceeded in the state capital at measuring stations close to traffic. The aim of the action is to ensure that the district authorities see to it as soon as possible that harmful air pollution is reduced in Dusseldorf and that the EU-wide limit values for $NO_2$ are respected in urban area.

Elsewhere in Germany, the administrative court of Wiesbaden has issued warning to the Hesse Ministry of Environment, Climate Protection, Agriculture and Consumer protection that it would be ordered to pay a fine of €10,000 if the ministry fails to draw up air quality plans to meet $NO_x$ standards. The 2016 judgment has also asked for a flat rate for public transport, a city toll, and a drive-through ban on diesel cars based on the last digit of the number plate.

A loophole in diesel cars' pollution limits, despite the Volkswagen emissions scandal, provoked strong political reaction from the mayors of 20 European cities in 2015, who signed a petition addressed to the European Union denouncing it. The mayors are from Paris, Brussels, Madrid, Copenhagen, Oslo, Lisbon, Stockholm, Vienna, Warsaw, Athens, Amsterdam, Rome and London, among others. They have expressed deep concern that despite making efforts to control pollution in their cities, they are still not able to meet $NO_2$ standards and there has been a steady increase in deaths and illness. The policy in European Union to incentivize diesel cars for emitting less $CO_2$ has now come under a scathing attack.

In December 2015, a group of 24 scientists from leading scientific institutions in Europe, and supported by scientists from the US, issued an open letter to European policy makers expressing strong concern over the impact of diesel cars on air quality of Europe. They stated that "with the help of weaker standards, diesel cars have been granted pollution privileges by EU law. As a result, poor air quality continues to have grave consequences for public health and European policy makers must act to correct this as a matter of urgency."

No surprise then that the French government has not included Euro-VI diesel cars in category 1 in the new colour coding scheme that classifies vehicles according to their pollution level. Excise tax on diesel cars has been increased and all incentives have been taken away. The mayor of Paris plans to phase out pre-2011 diesel cars by the end of the decade.

The Green-Dot programme would be voluntary and place cars in different classes according to tailpipe emissions—electric cars are placed in separate class, and the rest of the vehicles are categorized into six classes as follows:

Class 1: Euro-V and –VI gasoline cars first registered in 2011.

Class 2: Euro-V and –VI diesel cars first registered in 2011, and Euro-IV gasoline cars sold between 2006 and 2010.

Class 3: Euro-IV diesel cars registered between 2006 and 2010, and Euro-II and -III gasoline cars first sold from 1997 to 2005.

Class 4: Euro-III diesel cars first registered between 2001 and 2005.

Class 5: Euro-II vehicles sold between 1997 and 2000.

Class 6: Euro-I gasoline and diesel cars registered before 31 December 1996.

The French government has pledged to 'progressively' ban diesel vehicles. In an announcement made in November 2015, the Prime Minister Manuel Valls admitted that the promotion of diesel cars had been a 'mistake'. This was followed by a promise by the Paris mayor Anne Hidalgo to ban all such vehicles from the city by 2020.

The mayor of Madrid has proposed to ban polluting diesel cars from the city centre from 2020.

In 1998, the Third National Environment Policy targeted to reduce diesel car share to only 5 per cent in 2010. Dutch registration and circulation taxes for diesel cars are close to prohibitive—almost double that imposed on petrol cars. This has kept share of diesel cars in Netherland lower than the EU average.

In Brazil, sale of diesel passenger cars and commercial vehicles with capacity inferior to 1,000 kg has been banned since the 1970s. Their place has been taken by vehicles that run on ethanol or a mixture of ethanol and gasoline (FlexFuel). Because of import restrictions and taxes, vehicles are very expensive in Brazil. Cars are a luxury. This is reflected in the low level of car ownership at around 200 vehicles per 1,000 inhabitants.

In China, taxes do not differentiate between petrol and diesel fuel. Beijing has banned diesel cars as a pollution control measure. China has the lowest diesel car penetration at less than 1 per cent.

Sri Lanka has imposed several times higher duties for diesel cars compared to petrol cars and have reduced diesel car sales.

Even in India, several official committees have asked for special and additional taxes on diesel cars to neutralize the incentive of cheaper diesel fuel.

## Europe is changing emissions monitoring to address real world emissions

Regulatory authorities in Europe now acknowledge that test cycles used for emissions certification of vehicles will not solve the issue of high real world emissions from vehicles. According to the communiqué and the fact sheet of the European Commission on 'EU legislation on passenger car type approval and emissions standards of December 2016', the Commission is now changing the rules to introduce Real Driving Emissions (RDE) legislation which prescribes emissions testing with portable emissions measurements during normal on-road driving. Only this can reduce the type approval and real world values. The RDE legislation developed by the European Commission will become mandatory for new passenger vehicles by 1 September 2017 and two years later in 2019 for all passenger vehicles. It is important to note that the BS-VI emissions standards have also adopted these testing requirements.

The European Commission has also proposed a new regulatory act (RDE-3), which will further tighten and fine-tune testing provisions. This will also be extended to cover particle number emissions and will be fine-tuned to address high emissions in short city driving cycles when the engine gets cold. Manufacturers will be mandated to state clearly the real world emissions performance of the car. European Commission is also looking at ways of making emissions testing more effective.

## Fiscal solutions

Dieselization is not a major concern in those countries which do not maintain any difference in retail price of petrol and diesel (China, USA), or those who impose higher tax (e.g., Sri Lanka has 300 per cent import tax on diesel cars),

or those who have outrightly banned them in cities.

In 2015, Chilean Congress introduced environmental tax on cars. This has been imposed based on $NO_x$ emissions from cars. $NO_x$ tax has been levied on cars—with higher burden on diesel cars (see *Graph 20: $NO_x$ tax on diesel and petrol cars in Chile*).

The formula of $NO_x$ tax on cars in Chile

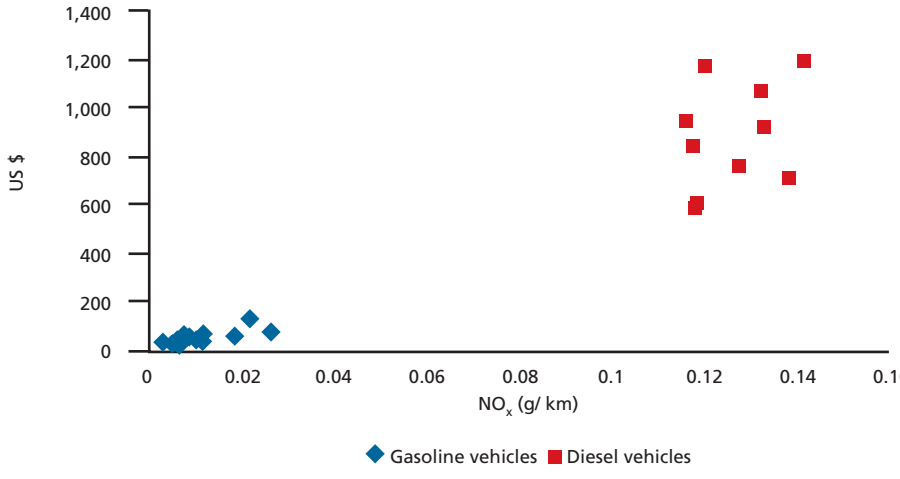
Tax for LDV *Unidad Tributaria Mensual* (UTM or Monthly Tax Unit) = Tax for $NO_x$ emission] x Vehicle price factor

Where:
Tax for $NO_x$ emission= 120 x $NO_x$ emission in NEDC [g/ km] vehicle
Price factor= Vehicle price [Chilean $] x 0.00000006 UTM = 84 [US $]

The tax has made immediate impacts on diesel vehicles sales, with a 45 per cent drop in January 2015, in comparison with the same month in 2014, affecting the demand of diesel SUVs and light-duty trucks. Another effect of the tax is the increase of the price all over the vehicle market, with the exception of electric vehicles, on which the Ministry of Transport is actually defining how the fuel economy will be assigned to this type of vehicles.

**Graph 20: $NO_x$ tax on diesel and petrol cars in Chile**

Higher taxes on diesel cars have resulted in a drop in sales




Source: Mario Molina Research Centre, Chile

# 6. Need for fiscal measures in India

India will have to either equalize fuel taxes or impose extra pollution taxes on diesel cars to prevent misuse of fuel tax policy. This matter came to head in 2015 when the SC observed that big luxury diesel cars were misusing the low tax on diesel fuel. The Chief Justice bench put a temporary ban on diesel cars with engine capacity equal to or more than 2,000 cc.

Based on the current fuel taxe regime, it has been estimated that an average of at least 20 per cent of car value on diesel cars in needed to equalize the extra tax petrol cars pay over a lifetime of use.

A 2013 World Bank study on the environmental costs in India found that outdoor air pollution is 29 per cent of the total environmental damages. The health cost of $PM_{10}$ is already 3 per cent of the GDP. But it also states that $PM_{10}$ mitigation will cost less than 1 per cent of the GDP. In that case, annual

## Proposal for environment compensation charge for diesel cars in the Supreme Court

The Supreme Court, in an ongoing public interest litigation on air pollution in Delhi and the national capital region, has directed the Environment Pollution (Prevention and Control) Authority (EPCA) to recommend the Environment Compensation Charge (ECC) for diesel cars to disincentivize and stop misuse of fuel taxation policy. Based on the recommendations of EPCA in April 2016 and further modification by the Amicus Curiae, the following proposal was placed in the court in July 2016. This proposal is still pending in the court for decision.

The proposal states that diesel car users cannot pay less tax per litre of fuel compared to petrol car and two-wheeler users. This needs to be equalized to control growing use of low tax diesel fuel (meant for farmers and freight) in cars that have cleaner substitutes. This is needed to reduce public health risks. Only cleaner fuels like CNG, LPG, electric and hybrid can incentivize the protection of public health.

Under the current fuel taxation regime, as of 1 July 2016, the total excise and VAT difference between the two fuels is Rs 9.94 per litre. The retail price difference is Rs 10.46 per litre. This encourages use of low tax and polluting diesel fuel in cars.

This calculation has estimated the lifetime difference in taxes paid by a petrol car user and a diesel car user. The ECC should recover this difference. The annual value of ECC over the lifetime of a vehicle has been taken forgoing the effect of inflation and retaining the nominal value. If an inflation rate of 5.47 per cent (CPI Inflation Index-2016) is taken into account then ECC will be much higher—estimated at an average of 45 per cent for the small car segment and 48 per cent for the bigger car segment. For the purpose of calculating, ECC the official definition of small and big cars, which is used for tax purpose, was considered. These are
i) Engine size less than 1,500 cc engines, and
ii) engine size equal to or more than 1,500 cc.

ECC of 10 per cent is proposed for vehicles upto 1,200 cc. ECC of 25 per cent is proposed for vehicles above 2,000 cc engines as they are the largest and most polluting segment of the market. For vehicles with engine sizes between 1,200 cc and 2,000 cc, ECC of 20 per cent has been proposed.

**Health cost of diesel vehicles**

The health cost of on-road PM and $NO_x$ emissions is one of the tools used by regulatory bodies to determine the appropriate opportunity costs.

The European Commission's Directive on the Promotion of Clean and Energy Efficient Road Transport Vehicles requires that energy and environmental impacts of vehicles over their lifetime are taken into account in purchase decisions by authorities. According to this directive, the cost for pollutants in road transport (at 2007 prices) for PM is €0.087/g, for $NO_x$ it is €0.0044/g, and for non-methane hydrocarbons it is €0.001/g. Thus, diesel cars with higher emissions have higher health costs.

Further, this directive suggests that a Euro-IV diesel car in Europe has lifetime external cost upto five times higher than a

savings from health benefits can be more than US $100 billion. This demands an aggressive mitigation strategy.

## Need regulation to stop emissions cheating in India

India will have to wake up right now to put in place regulations to prevent use of defeat devices by people and manufacturers to cheat emissions regulations. Indian vehicle manufacturers have started installing selective catalytic reducing (SCR) systems in BS-IV diesel buses to control $NO_x$. This application will expand quickly to other diesel segments when BS-VI is introduced. India cannot afford deliberate compromises of on-road emissions performance of vehicles. Already, there is scary evidence from Latin America—countries like Brazil show only 46 per cent of the diesel vehicles that are fitted with SCR systems have working SCRs and the rest have been disabled.

There is now open sale even through retail platforms like Amazon of "Adblue OBD2 Emulator for Trucks Plug Drive Ready Device by OBD2". This is a defeat device that disables the SCR. Adblue is a urea-based solution that is

Euro-IV petrol car. Thus, the pollution cost based on lifetime PM emissions, costs of a diesel car and petrol car are €435 and €87, respectively. For $NO_x$, it is €220 and €70, respectively. For non-methane hydrocarbon it is €10 and €20, respectively.

In US and Australia, damage function estimates are applied to pollutants based on health outcomes from chronic exposure to annual average concentrations of $PM_{2.5}$ and emissions. These include premature mortality from adult cardiopulmonary diseases and lung cancer, and child respiratory infections; and morbidity from non-fatal heart attacks, chronic bronchitis reduction, chronic asthma reduction, hospital admission, worker productivity etc. The damage function values for PM have been reported by the US EPA and Australian Department of Infrastructure and Regional Development (DIRD) based on the value of statistical life which in the US is US $7.3 million and Australia AU $4.2 million respectively. This can be used as unit health cost per tonne of pollutant. Based on this, the excess health damages from a diesel car compared with a petrol car can be calculated by multiplying the excess diesel emissions over lifetime with the damage function cost adjusted for India.

In India, the total lifetime PM emissions of a BS-IV diesel car are significantly higher than petrol cars. Studies have shown that the damage function values reported by the US EPA and Australia DIRD are based on the value of statistical life (VSL) used in US (US $7.3 million) and Australia (AU $4.2 million), respectively. In order to use these values in India, they have to be scaled down to reflect the value of statistical life (VSL) used in India—Rs 7.75 crore in year 2006, which is equivalent to Rs 24.59 crore in 2016, when adjusted for the changes in gross national income per capita. The excess health damages from a BS-IV diesel compared with a petrol vehicle is calculated by multiplying the excess diesel emissions with the damage function adjusted for India. The estimated health damage from the sale of a single diesel car when compared with a petrol car is estimated to range from Rs 56,301 per vehicle at the low end to Rs 1,27,329 at the high end.

Over and above the tax differences that should be recovered by ECC, there are higher health costs associated with diesel, including strong cancer risk. The added cancer risk assessment of diesel vehicles comes from the toxic nature of these emissions. Based on studies, it is estimated that the combined cancer risk of diesel exhausts in Delhi would be several times that of petrol engines. If the entire population is taken into account, more than 280,000 individuals are at additional risk of cancer in Delhi-NCR from lifetime exposure to diesel exhaust.

However, due to unavailability of comprehensive quantifiable cost of health damage specific to the Indian context, at present the same is not being factored into the ECC. This, therefore, underestimates the ECC.

Removing the fuel price differential, through the imposition of ECC, will be a step in removing the incentive for diesel vehicles. This is needed to reduce public health risk as diesel emissions are among the more harmful pollutants.

regularly filled in the SCR system attached to the exhaust of the modern diesel vehicles to control $NO_x$ emissions. As regular refill is a recurring cost for the consumer, these dubious and illegal devices that are flooding the global market tempt customers to disable the SCR system. If this practice is not stopped immediately, it will only result in uncontrolled $NO_x$ emissions leading to serious ozone build-up and damaging health consequences.

The bigger concern, as the Latin American experience shows, is that these devices are gaining more popularity in regions that have tighter standards and have introduced SCR systems in diesel vehicles. While vehicle users are disabling SCR systems to avoid the extra cost of refilling urea solution, vehicle manufacturers are increasingly finding it difficult to meet real world $NO_x$ limits or, as Volkswagen has done—cheating to escape regulations. The Volkswagen scandal shows how defeat devices reduce the severity of the SCR systems and the urea dosage for $NO_x$ control. Diesel vehicles meeting Euro-VI emissions standards in Europe are emitting six to 12 times higher $NO_x$ on road than their certification levels.

Already, major vehicle-producing regions like the US and Europe, scalded by the diesel-gate, are framing laws to prevent and penalize the use of defeat devices in diesel vehicles. The US regulation (40 CFR §86.1803-01) defines a defeat device as "an auxiliary emission control device that reduces the effectiveness of the emission control system". Any element of design which senses temperature, vehicle speed, transmission gear, or any other parameter for the purpose of activating, delaying, or deactivating the operation of any part of the emission control system is liable for severe penal action. This provision was included in the US Clean Air Act, 1975.

US laws have instituted civil penalties as well. The US Environmental Protection Agency can levy civil penalties of up to $37,500 per vehicle and $3,750 per sale of defeat device.

The EU framework regulation empowers the European Commission to adopt "requirements for the implementation". It is evident from the review carried out by the International Council on Clean Transportation that the EU vehicle emissions regulation (EC 715/ 2007, Article 13) directs Member States to "lay down the provisions on penalties applicable for infringement by manufacturers of the provisions of this Regulation and [to] take all measures necessary to ensure that they are implemented." In January 2016, the Commission has received reports on penalties from only 18 of the 28 member states. These range from fines to withdrawal of type approval, recall and repair obligations, as well as prison.

India urgently needs two sets of regulations—one to prevent diesel vehicle manufacturers from cheating emissions regulations and, second, to stop people from using defeat devices to disable emissions control systems when vehicles are on the road. Emission standard regulations must prohibit disablement of emission controls.

# 7. The way forward

**Implement Euro-VI emissions standards in 2020. Do not backtrack.** Government of India has already notified implementation of Euro-VI emissions standards in 2020. India will skip Euro-VI and move directly to Euro-VI. This is a significant step forward.

**Ensure vehicles remain low emitting and compliant in real world.** New vehicles will come fitted with advanced emissions control systems that are extremely sensitive to maintenance and quality of fuels. Their lifetime performance is critical to keep the the emissions from the vehicles low over a lifetime. Moreover, as the Volkswagen fraud has demonstrated, there is considerable scope for the use of defeat devices to reduce the severity of emissions control in cars to lower the cost of meeting stringent emissions standards. To prevent this, in-use compliance regulations will have to be enforced quickly.

For the first time ever, monitoring of real world emissions with portable monitoring system along with in-service compliance regulations will be implemented to keep an eye on real world emissions. Real driving emissions testing will be included as an additional requirement for vehicle certification. Emissions measurements will be carried out with the help of Portable Emission Measurement System and an onwards in-service conformity factor will be applied to ensure that emissions from vehicles remain within the stated margin. This can prevent emissions cheating and use of sub-standards emissions control or defeat devices, as was done by Volkswagen. However, adoption of more advanced on-board diagnostic systems has been delayed until 2023.

Moreover, higher durability requirements in BS-VI can ensure that emissions stay low throughout the useful life of a vehicle. The test procedures are to become more rigorous. World Harmonized Light-duty Vehicle Test Cycle will replace the New European Drive Cycle, and a variety of test parameters will be adjusted to close loopholes and address shortcomings of the current procedures. Thus, ensuring that the emissions control equipment is functioning through the most productive lifetime is especially critical for long-lived and intensively-used diesel vehicles.

**Impose environmental tax on diesel cars to recover the extra fuel tax that petrol car users pay over the life time of the car.** This is the equity principle that the SC has established while banning and subsequently imposing the 1 per cent cess on luxury diesel cars and SUVs with engines equal to or more than 2,000 cc. Even the union budget of 2016–17 imposed differentiated infrastructure tax based on this principle—1 per cent on petrol cars and 2.5 per cent on diesel cars. But environment tax will have to be effective to recover the extra fuel tax that the petrol car users pay.

**Mandate automobile industry to voluntarily disclose certification as well as real world emissions levels of each model and make of cars.**

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**Centre for Science and Environment**
41, Tughlakabad Institutional Area, New Delhi 110 062, India,
**Ph:** +91-11-40616000 **Fax:** +91-11-29955879
**E-mail:** polash@cseindia.org **Website:** www.cseindia.org