TRUCKS

Heavy-duty Pollution and Action

A Centre for Science and Environment report

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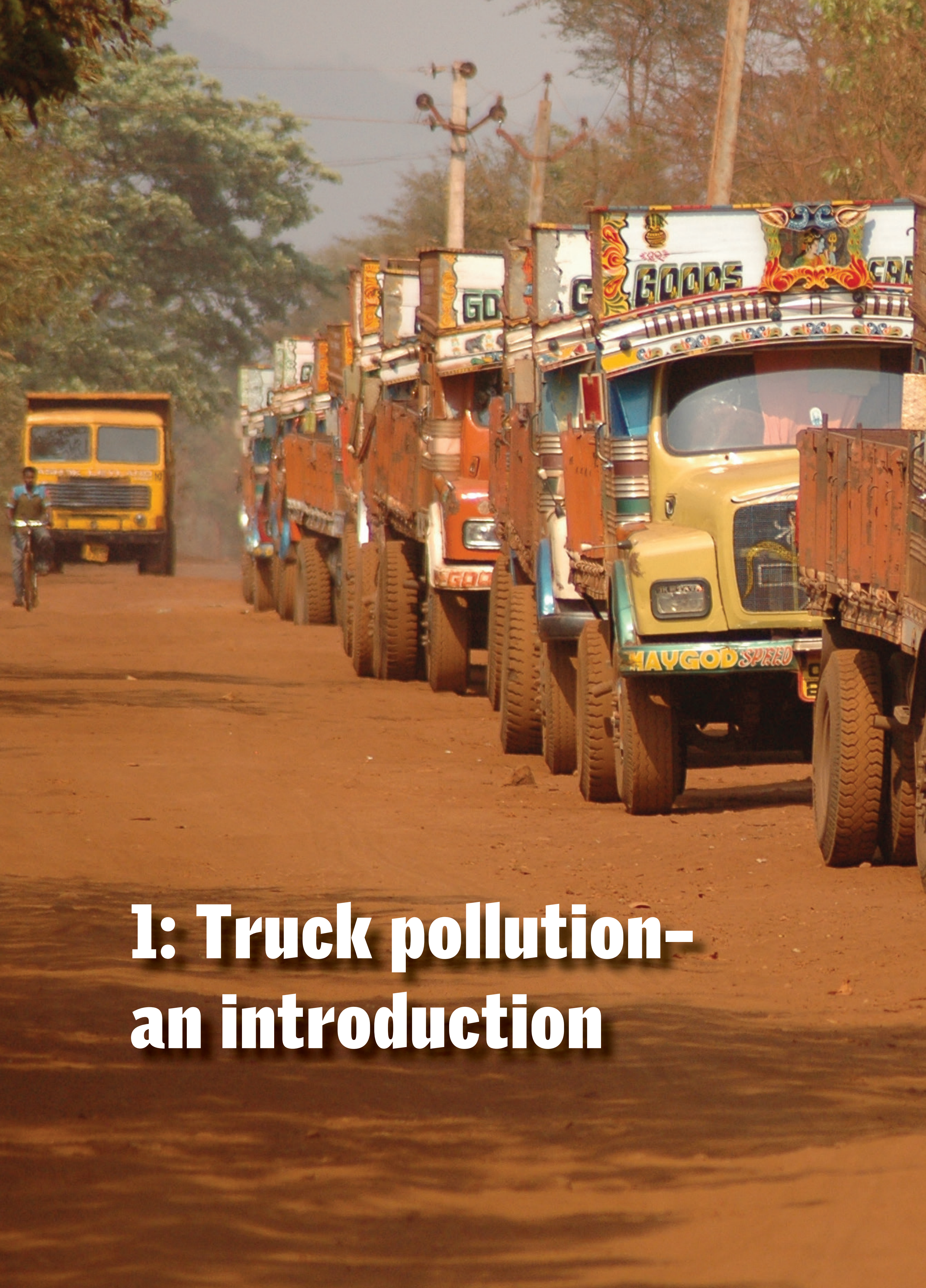


1: Truck pollution– an introduction


GOODS

Trucks are a major contributor to air pollution and fuel guzzling with serious public health and climate change consequences. Rapid growth in the economy and trade is continuously expanding road-based freight traffic, bringing more and more trucks on roads. Highways that crisscross densely populated habitations expose sizeable urban and rural populations to toxic fumes. In their quest to protect public health, cities are constantly battling truck pollution.

The heavy-duty truck segment is not an easy one to deal with. Limited pollution inventory studies in different cities of India show that the segment is the biggest contributor to air pollution and largest consumer of fossil fuels. Nationally, its contribution to the particulate matter load from on-road transport sector is as much as 66 per cent. There are also serious local impacts of this transit traffic. In Delhi, for instance, trucks that enter Delhi daily contribute as much as 30 per cent[1] of the total particulate load from the transport sector, thus negating the benefits of local pollution control.

Global evidence shows that exposure to diesel pollution causes lung cancer, heart disease and a range of other metabolic and respiratory diseases. Black carbon from diesel vehicles also traps 16 times more heat and is a more serious warming agent than carbon dioxide.

Heavy-duty trucks have been the slowest in reducing and improving their emissions as emissions standards are not uniform across the country. This is mainly because of the current practice of keeping emissions standards tighter only in a few cities and lax in the rest of the country. Thus, trucks plying on inter-city routes and highways do not have access to cleaner fuels and languish at the lower level of emissions standards. Nearly all trucks that are registered under national permit are purchased in regions that follow more lenient emissions standards. While all major cities have enforced Bharat Stage IV (BS-IV) emissions standards, trucks continue to get registered at Bharat Stage III (BS-III) level outside these cities. The vehicle industry has not ramped up the production of BS-IV trucks adequately as there is barely any demand. This problem will only be corrected only in 2017 when the BS-IV emissions standards are implemented nation-wide.

Technological solutions for the new trucks are expected to shape up quicker in the future as the government of India has taken the momentous step to skip Euro V emissions standards and leapfrog directly to Bharat Stage VI (BS-VI) emissions standards for all vehicles in 2020. These standards will make testing methods more rigorous, introduce particle number standards that will require advanced particulate traps, and will also require in-service conformity factors to control real world emissions. This is expected to reduce emission of particulate matter and nitrogen oxides from the future stock vehicle significantly—by 50–89 per cent.[2]

While technological improvements will reduce emissions per truck, additional measures are still needed at the national level to address emissions from older trucks. This will require stringent emissions regulations for the on-road older fleet, and implementation of fuel economy regulations to reduce energy impacts of road-based freight.

At a macro level, more effective time-bound action is needed to bring about infrastructural and structural changes to increase rail-based freight modal share and reduce that of road-based freight. This has remained an unfinished agenda.

As truck movement is responsible for enormous local exposure to toxic fumes, especially in densely populated cities and habitations, stringent local solutions are important as well. Several cities are trying out combination of local solutions. These include regulation of truck entry into cities, cap on age of trucks allowed to ply the roads, emissions inspection of trucks, substitution by alternative cleaner fuels and so on. The scale and intensity of these interventions vary depending on public policy awareness.

Delhi has taken the lead in this effort and has demonstrated the merit of enforcing traffic diversions, capping age of vehicles, regulating entry based on emissions standards, and levying high taxes on trucks as environment compensation charge. With these steps, Delhi has succeeded in reducing truck pollution and the results are positive. Understanding these local steps is important to scale up replication across cities.

Indian cities also need to tap into the emerging global learning curve. Other governments have implemented more evolved measures to address pollution and climate impacts of the road freight sector. Such measures need to be absorbed into policy and public awareness campaigns in India. Several short- to medium-term strategies are needed both at the Central and local level to cut toxic pollution and greenhouse gas emissions from trucks.

2: Why are trucks a problem?

Growing share of road-based freight in India

Among all modes of long-range transport, rail and road together form the dominant share of freight transport. Measured in billion tonne kilometres (btkm) by all modes, rail and road account for 86 per cent of the freight transport.[3] The other modes—shipping, inland waterways, airways etc., account for only 14 per cent (see *Table 1: Modal share of freight traffic*).

Over a period of time, the share of railway freight has declined significantly, giving way to the rapidly expanding road-based freight system. The share of railways in 1950–51 was 89 per cent, which reduced drastically to 35 per cent by 2011–12.[4] Road overtook rail in the early 1990s (see *Graph 1: Share of freight traffic by rail and road*). The share of road transport has risen from 11 per cent in 1950–51 to 65 per cent in 2011–12, which is much higher than U.S. and China, where the respective share is about 37 per cent and 22 per cent[5] (see *Graph 2: Share for freight in India, US and China*). Road freight has been encouraged by massive and rapid expansion of roads and highway infrastructure. Road transport is attractive because of its flexibility in organizing goods transfer and also providing door-to-door services.

Table 1: Modal share of freight traffic

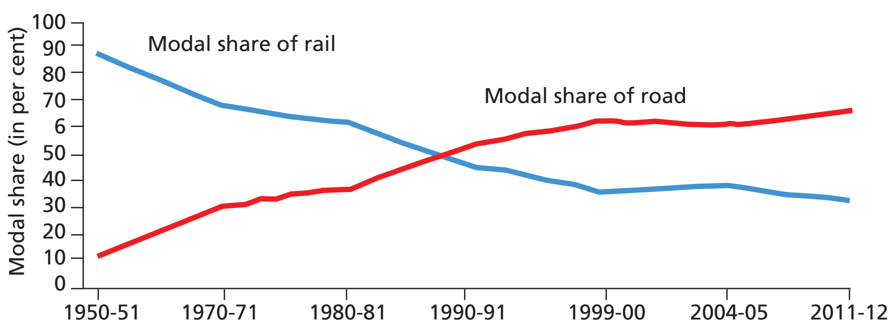
Rail and road together accounting for six-sevenths of the total freight transport

Freight mode	Share percentage
Road	50.11
Rail	36.06
Pipelines	7.45
Coastal shipping	6.10
Inland water transport	0.25
Airways	0.02
Total	100

Source: G. Raghuram 2015, An Overview of the Trucking Sector in India: Significance and Structure, Indian Institute of Management, Ahmedabad

Graph 1: Share of freight traffic by rail and road

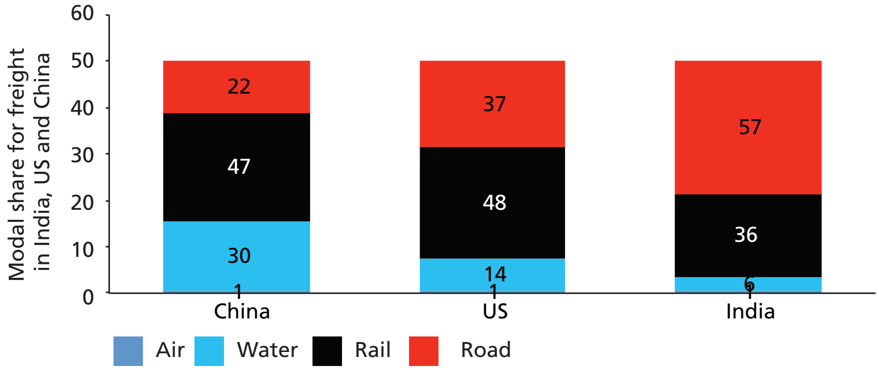
Roads overtook rail in the early 1990s



Source: The National Transport Development Policy Committee, 2014

Graph 2: Share for freight in India, US and China

The road share in India is disproportionately higher than China and US



Source: Building India—transforming the nation's logistics infrastructure, McKinsey & Company

Table 2: Projection of freight traffic and share

The share of railways is expected to rise and equal that of roadways by 2031–32

Year	GDP growth (percentage)	(btkm)	Rail: Road share
2011–12	--	2,053	--
2016–17	6.9	3,056	35:65
2021–22	8.0	4,834	39:61
2026–27	8.5	7,856	45:55
2031–32	9.0	13,118	50:50

Source: National Transport Development Policy Committee, 2014

The National Transport Development Policy Committee (NTDPC) has projected the future trend in modal share of rail and road in the total freight traffic until 2031–32. Using a growth rate of 1.2 times the GDP growth rate, the total btkm is estimated to increase more than six times and rail and road share is expected to be nearly equal by 2030–31. Even modal share of waterways (coastal shipping and inland water transport) may increase[6] (see *Table 2: Projection of freight traffic and share*). It is important for policies to be in place to ensure that the modal share of non-road freight transport expands significantly in the future to minimize the environmental impacts of road-based freight movement.

Intense road building

At 5.23 million km in 2013,[7] India's road network is the second largest in the world, after the US, with 6.5 million km of roads.[8] The road network in India has increased over 10 times in a little more than 60 years—from 0.4 million km in 1950–51 to 5.23 million km in 2013.[9] Roads in India carry 60 per cent of the freight and 85 per cent of the passengers in the country.[10]

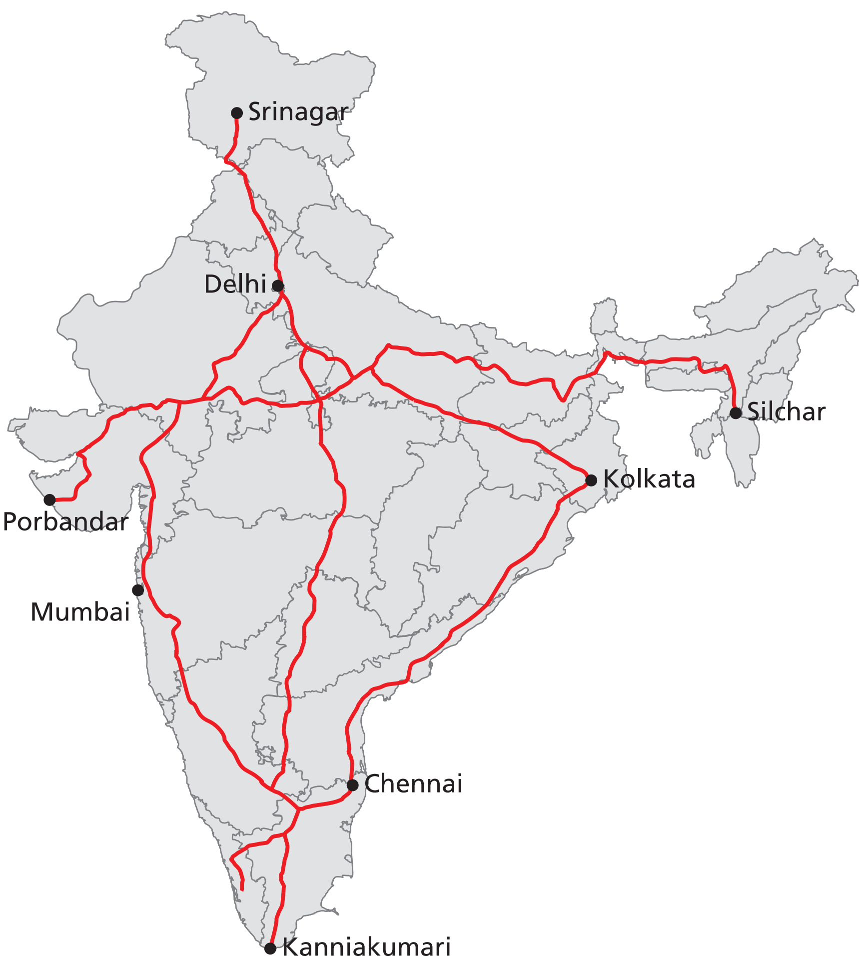
Roads under the public works department in urban areas and other roads meant for intra-city movement are about 28.92 per cent of the total road network; rural roads constitute 60.39 per cent. But national highways, that are only 2 per cent of the total road network, carry about 40 per cent of the total road traffic (see *Graph 3: Share in total road length,* 2012–13). The length of national highways has increased from 19,811 in 1950–51 to 100,088 km in 2012–13, a five-fold increase.[11] The percentage of paved roads is 57 per cent of the total.[12] State highways have grown from 56,765 km in 1970–71 to 169,227 km in 2013 (see *Map 1: National highways and the golden quadrilateral*).

Growing freight kilometers

The total kilometers travelled by vehicles decide the pollution and energy impacts of freight traffic. According to the estimate of Central Road Research Institute (CRRI), out of the total 1,437 billion vehicle kilometres tonne (VKT) in 2013, light-duty vehicles contribute about 58 per cent of VKT, whereas heavy-duty vehicles contribute about 42 per cent of VKT. The total VKT by the year 2030 would be around 4,733 billion. The kilometreage of heavy-duty vehicles is steadily increasing.

Map 1: National highways and the golden quadrilateral

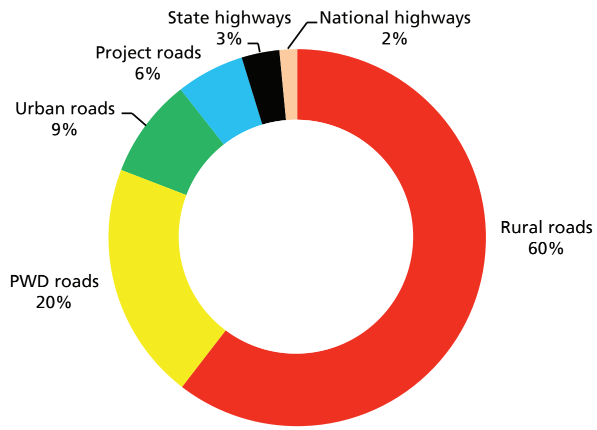
India has the second largest road network in the world, and it is growing



Source: National Highways Development Project

Graph 3: Share in total road length, 2012-13

National highways constitute only 2 per cent of roads, but carry 40 per cent traffic



Source: Basic Road Statistics, 2015, Ministry Of Road Transport and Highways, Government of India

Table 3: Operation of Indian and global freight

India lags behind, but catching up would increase the pollution headache

Indicators in road transportation	India	Global
Average truck speed (in km/h)	20–40	60–80 (developed countries)
Average truck distance covered in a year (km)	60,000–100,000	400,000–600,000
Average truck distance per day (km)	250–400	500 (BRICS) 700–800 (US and Europe)

Source: Movement of goods in India, Report by Ernst & Young and Retailers Association of India, December 2013

The scale and efficiency of operations of heavy-duty traffic in India falls short of global benchmarks. Indicators such as average truck speed, average truck distance and total length of expressways are lower compared to advanced and rapidly developing countries (see *Table 3: Operation of Indian and global freight*). Average truck distance covered in India is about 60,000 to 100,000 km a year, the global average is 400,000 to 600,000 km a year. Average truck distance per day is 250–400 km as opposed to 500 km in other BRICS countries and 800 km in the US. Pollution and energy impacts are expected to be massive if India rises up to these global benchmarks.

Origin and destination of freight traffic

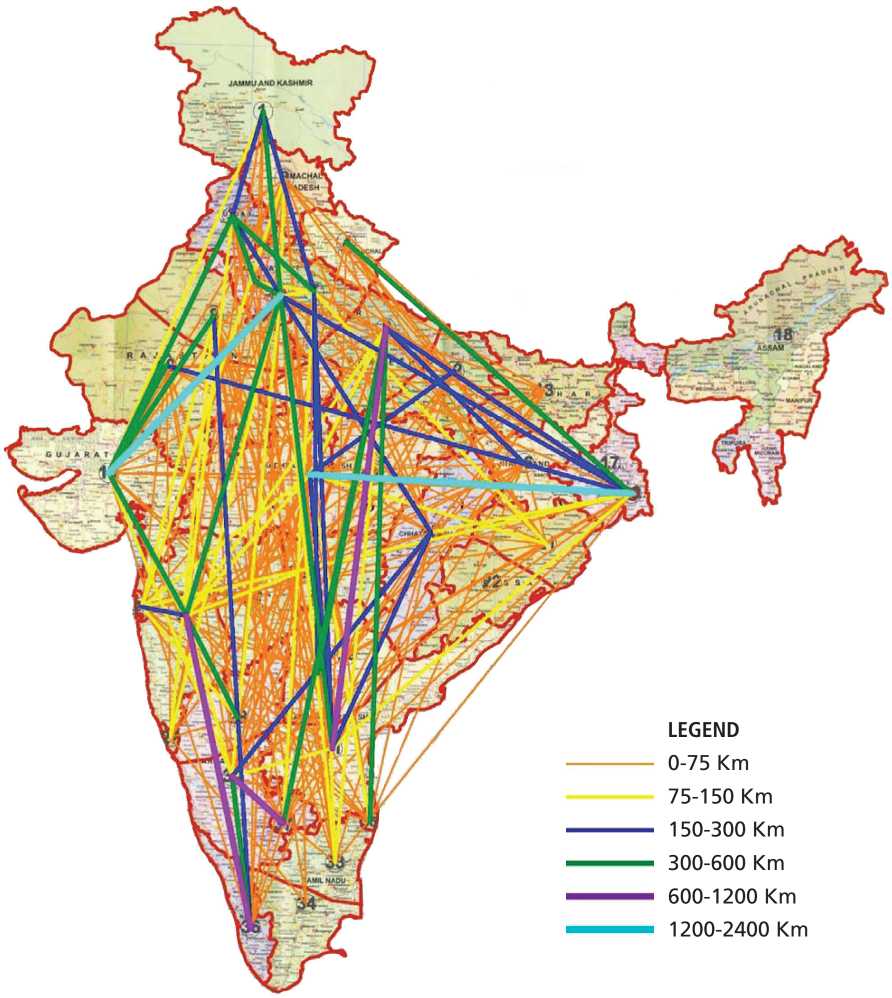
The origin–destination survey of freight traffic carried out by the Union Ministry of Road Transport and Highways (MoRTH) in 2009 identified major routes of truck traffic in the country.[13] The survey provided information on the origin, destination, length and purpose of trips, mode of travel, journey time etc. The survey was conducted at seven locations: i) Bellur Cross (NH-48), ii) Sindhudurg (NH-17), iii) Baleshwar (NH-5), iv) Nagpur (Madhya Pradesh/ Maharashtra Border, NH-7), v) Kurukshetra (NH-1), vi) Kanpur (NH-2), vii) Udaipur (NH-8).

The survey data revealed that 48 per cent of journeys have long distance trip length of more than 1,200 km. Trips with length between 600–1,200 km constitute about 25 per cent of the total. Freight journeys with short trip length, i.e. less than 300 km, are about 18 per cent of the total.

The major share of freight traffic originates in 10 states, namely Maharashtra, Gujarat, Andhra Pradesh, Odisha, Madhya Pradesh, Karnataka, Jharkhand, Uttar Pradesh, Punjab and Rajasthan, together constituting 82 per cent of the total freight traffic.[14] Maharashtra tops the list with an 11 per cent share. The same 10 states account for about 70 per cent of the total terminating traffic.[15] About 12 per cent of the total freight of the country is destined for Maharashtra which also has several ports. On the basis of the origin–destination survey and secondary data, a list of 36 important freight routes has been prepared[16] (see *Map 2: Direction of goods traffic* and *Table 4: Major origin and destination points*).

Map 2: Direction of goods traffic

Maharashtra has the highest density because it has important ports



Source: Report of Ministry Of Road Transport and Highways, 2009 and 2015, Government of India

Table 4: Major origin and destination points

Cities in 10 states have 82 per cent of originating and 70 per cent of terminating goods traffic

S. no.	Pair	S. no.	Pair
1	Kolkata–Delhi	19	Kolkata–Bhopal
2	Delhi–Guntur	20	Kolkata–Dehradun
3	Ahmedabad–Dharwad	21	Ranchi–Kanpur
4	Pune–Kochi	22	Agra–Guntur
5	Amritsar–Jammu	23	Bengaluru–Kanpur
6	Amritsar–Rohtak	24	Hyderabad–Kanpur
7	Amritsar–Agra	25	Mysuru–Raipur
8	Amritsar–Ahmedabad	26	Kanpur–Guntur
9	Delhi–Ahmedabad	27	Bengaluru–Mysuru
10	Ahmedabad–Jodhpur	28	Delhi–Jammu
11	Ahmedabad–Dharwad	29	Kolkata–Ranchi
12	Pune–Mumbai	30	Bengaluru–Chennai
13	Amritsar–Raipur	31	Chennai–Kolkata
14	Guntur–Raipur	32	Mumbai–Hyderabad
15	Mysuru–Raipur	33	Mumbai–Delhi
16	Kolkata–Kanpur	34	Mumbai–Ahmedabad
17	Mysuru–Kochi	35	Mumbai–Nagpur
18	Kanpur–Chennai	36	Chennai–Hyderabad

Source: Report of Ministry Of Road Transport and Highways, 2009 and 2015, Government of India

Trend in number of goods vehicles in India

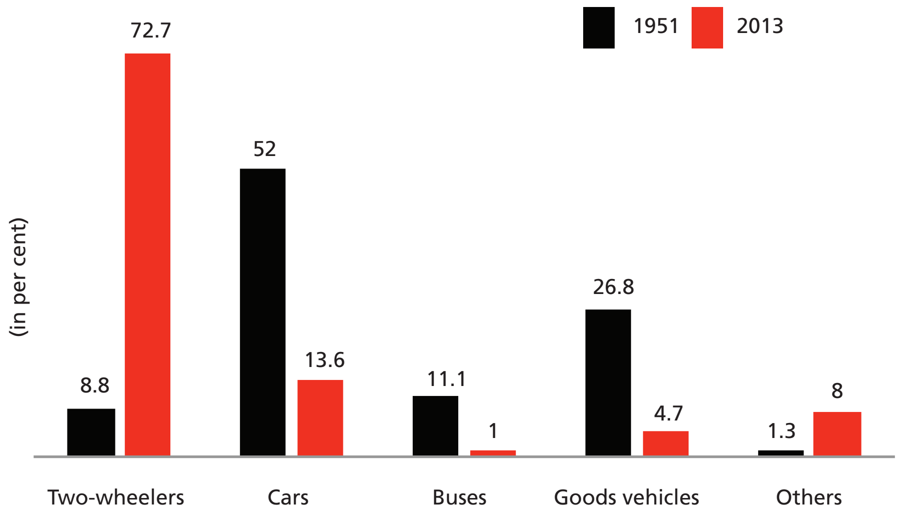
As trade in goods expands it creates more demand for goods vehicles. As on 31 March 2013, the total numbers of registered goods vehicles in India was 8.6 million. These are cumulative numbers and it is not possible to assess exactly how many of these are on road. These include multi-axle/articulated trucks and lorries, and light motor vehicles. The compound annual growth rate (CAGR) during the period 2003–2013 for goods vehicles was 9.4 per cent, when the total vehicle population grew at a CAGR of 10.5 per cent in relation to the CAGR of 4 per cent in the total road length.[17]

However, with the explosive increase in the number of other passenger vehicles the relative share of goods vehicles in total vehicle registrations has reduced sharply, from a share of 26.8 per cent of the total vehicles in 1951 to 4.7 per cent in 2013[18] (see *Graph 4: Vehicle population composition)*. Out of the 21.4 million vehicles produced in 2013–14, two wheelers are 78 per cent and cars are 12 per cent of the total vehicle production.[19] The commercial vehicles (light-, medium- and heavy-duty) are 3 per cent of all vehicle production (see *Graph 5: Production in India per category, 2013–14)*.

Production of commercial vehicles that had been increasing till 2011–12, started to decline after that because of the economic slowdown and other reasons (see *Graph 6: Trend in commercial vehicles production*). Maharashtra has the highest number of registered heavy-duty vehicles in India (1.14 million), followed by Tamil Nadu (0.89 million) and Gujarat (0.81 million).[20]

Graph 4: Vehicle population composition

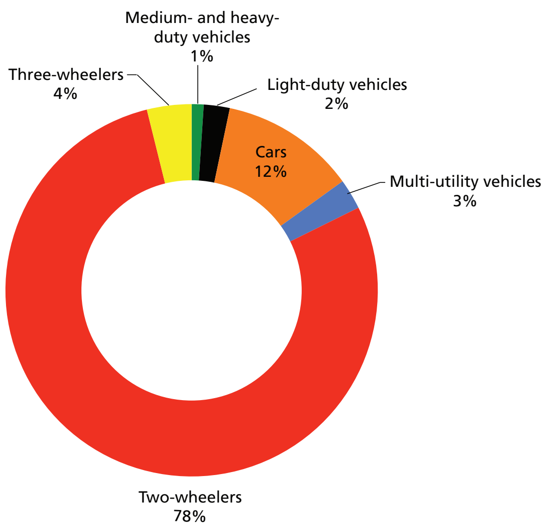
The growth in the two-wheeler segment has reduced the share of goods vehicles, but absolute numbers have grown exponentially



Source: Road Transport Yearbook 2012-13 and 2015, Ministry Of Road Transport and Highways

Graph 5: Production in India per category, 2013–14

Medium- and heavy-duty vehicles are small in numbers, but big on pollution



Source: Road Transport Yearbook 2012–13 and 2015, Ministry Of Road Transport and Highways

Trend in the sales of commercial vehicles in India

The sale of trucks shows a trend similar to their production. The sales of commercial increased until 2011–12. After that there is a consistent reduction (see *Graph 7: Trend in sale of commercial vehicles*).

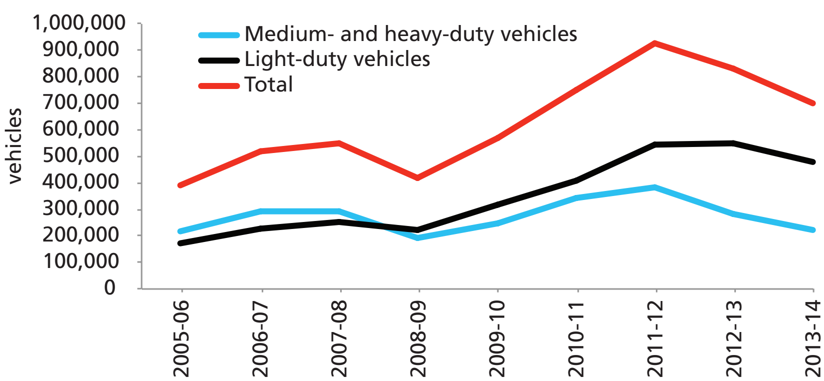
According to an assessment by the US-based International Council on Clean Transportation, heavy-duty vehicle sales have increased by a factor of 2.7 since 2000. However, this is a highly diverse segment in terms of size and capacity.

Around 75 per cent of the trucks are two-axle trucks with a capacity of nine tonnes each. Two- and three-axle rigid trucks constitute the bulk of trucks in India. The share of three-axle trucks and light commercial vehicles is on the rise. About 40 per cent of Indian trucks are less than six years old, while 34 per cent are older than 10 years.

Over half of the heavy duty market (vehicles with a carrying capacity of more than 3.5 tonnes) is produced by Tata Motors with a share of 53 per cent in new heavy-duty vehicle sales in 2013–14. The second major player in this segment is Ashok Leyland with a share of 19 per cent. VE Commercial Vehicles (VECV), a joint venture of the Volvo Group and Eicher Motors, is at 14 per cent. The rest is covered by six manufacturers, namely Daimler, SML Isuzu, Mahindra & Mahindra, AMW Motors, Volkswagen Commercial Vehicles, and the Volvo Group[21] (see *Graph 8: Manufacturer-wise share of new sales)*.

Graph 6: Trend in commercial vehicle production

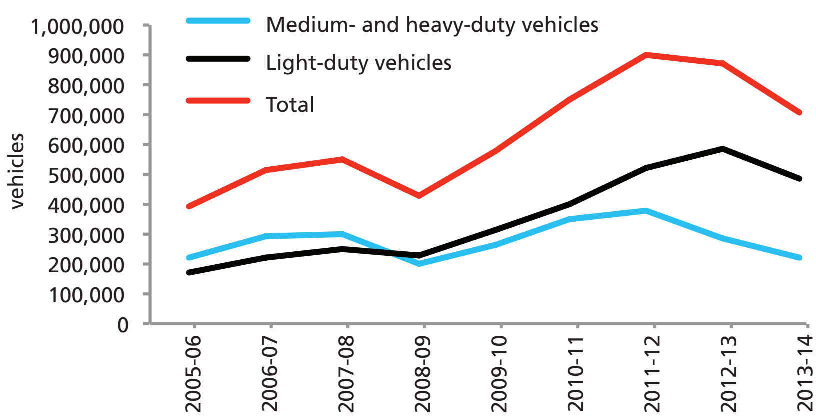
Economic slowdown and other factors contributed to decline in the production of commercial vehicles post-2011–12



Source: Road Transport Yearbook 2012-13 and 2015, Ministry Of Road Transport and Highways

Graph 7: Trend in sale of commercial vehicles

The sale of goods transport vehicles has also gone down since 2011–12



Source: Road Transport Yearbook 2012-13, 2015, Ministry Of Road Transport and Highways

Ownership pattern of trucks in India

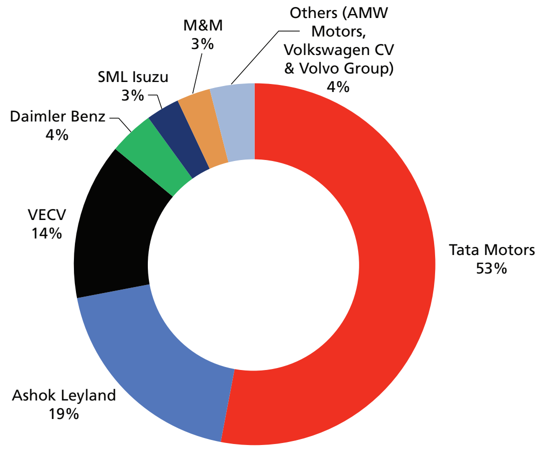
The ownership pattern of vehicles determines the management and operational efficiency of the trucking industry. This is a highly decentralized system with numerous small operators. Small operators, those who own five or less trucks, constitute 75 per cent of the trucking industry[22] (see *Graph 9: Ownership pattern by transporters*). Thus, the role of the organized sector and the policies designed for it, are limited. More inventive models are needed for the segment of small operators.

Pollution and public health impacts of heavy-duty emissions

There are special air pollution and health concerns around heavy-duty trucks that weigh between 3.5 and 25 tonnes. The emissions factors developed by Automotive Research Association of India (ARAI) for post-2005 models

Graph 8: Manufacturer-wise share of new sales

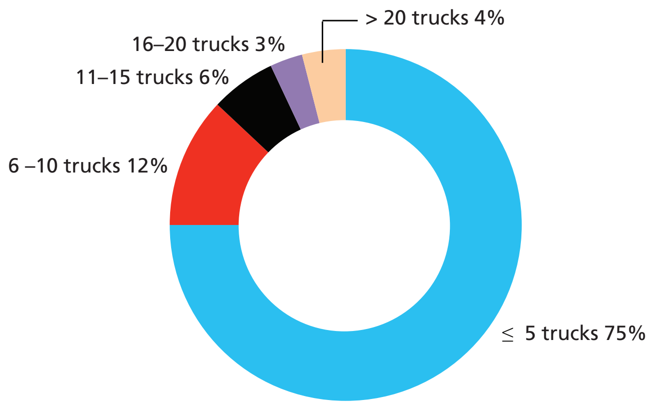
The heavy-duty vehicle market is dominated by three players



Source: Ben Sharpe 2015, Market analysis of heavy-duty vehicles in India, The International Council on Clean Transportation (ICCT), Washington, DC

Graph 9: Ownership pattern by transporters

Small operators are a bulk of the industry, so inventive models targeting them are needed



Source: Ernst & Young 2013

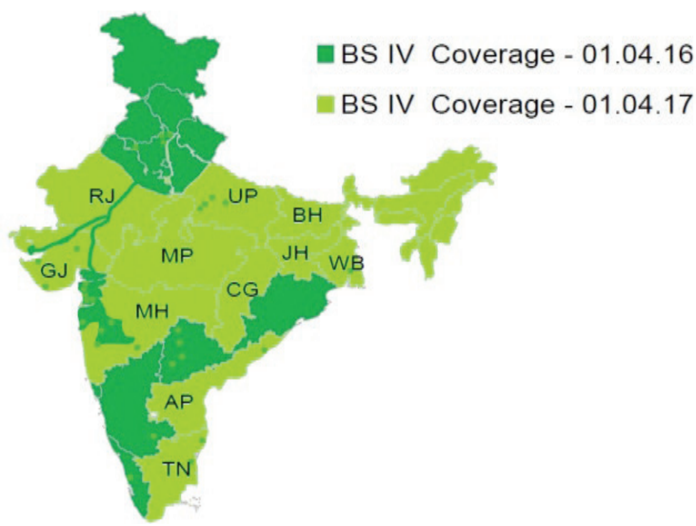
shows that particulate matter emission from bigger engines is higher than smaller engines. Emissions from vehicles with engines upto 3,000 cc class are six times higher than diesel car engines with less than 1,600 cc diesel engines; that of nitrogen oxides (NO_x) is two times higher. A petrol car with a 1,400 cc engine emits 48 times lower particulate and seven times less NO_x compared to diesel multi-utility vehicles.

The situation is made worse by an ill-maintained and ageing fleet of trucks that barely meet outdated emissions standards. Even though BS-IV emissions standards were introduced in major cities way back in 2010, the share of BS-IV petrol- and diesel-compliant vehicles in metropolitan cities in 2014 was only 24 per cent and 16 per cent respectively. The Auto Fuel Vision and Policy 2025 explains that unavailability of compatible fuel across the country, and the option of registering cheaper BS-III vehicles outside the metropolitan regions, have blocked adequate expansion of the BS-IV heavy duty fleet.[23] Availability of BS-IV fuels and vehicles in 2016 is still limited (See *Map 3: Status of Bharat Stage IV fuel in India*).

The 2016 estimates of Centre for Science and Environment (CSE) show that diesel commercial vehicles or goods carriers contribute maximum pollution from vehicular sources. Nationally, goods carriers contribute about 66 per cent of the particulate matter emission load and 62 per cent of the NO_x emission load from all vehicles.

Map 3: Status of Bharat Stage IV fuel in India

The proposal is to cover whole of India by 2017



Current percentage volume of fuel (On 1 April 2016)

BS-IV Petrol	BS-IV Diesel
54%	51%

Source: Ministry of Petroleum and Natural Gas, 2016

The pollution impact of the total VKT performed by trucks—which is 42 per cent of the total VKT, is expected to be enormous as heavy-duty vehicles emit several times more than light-duty vehicles or a two-wheelers. Specific impact of trucks on air pollution in different cities of India has not been assessed. But there is some local evidence of the magnitude of the impact.

Delhi, fighting a losing battle against air pollution, exemplifies this challenge. Analysis of real time air quality of Delhi Pollution Control Committee (DPCC) carried out by CSE has shown a trend towards a third peaking of pollution during night when overall weather is cooler and calmer but coincides with rush entry of enormous truck traffic into the city. Similar evidence available from CRRI has shown skewing of night-time pollution along the Ring Road and Outer Ring Road in Delhi. Several recent studies show very high pollution at night in Delhi. This does not allow the city to get a chance to clean up. While overall night-time pollution remains elevated, arterial roads like the Ring Road turn into pollution corridors (see *Graph 10: Night-time pollution in Delhi due to trucks* and Graph 11: *High night-time pollution in selected neighbourhoods in Delhi due to truck traffic*).

Heavy-duty trucks are responsible for very high exposure to toxic fumes when they pass through human habitations. A study conducted by the Health Effects Institute, Boston, has found that the maximum effect of vehicular pollution is upto 500 metres from the road. More than 55 per cent to 60 per cent of Delhi's 17 million people live in that highly exposed zone.[24] The study found that particles from coal and diesel are more harmful than wind-blown dust.

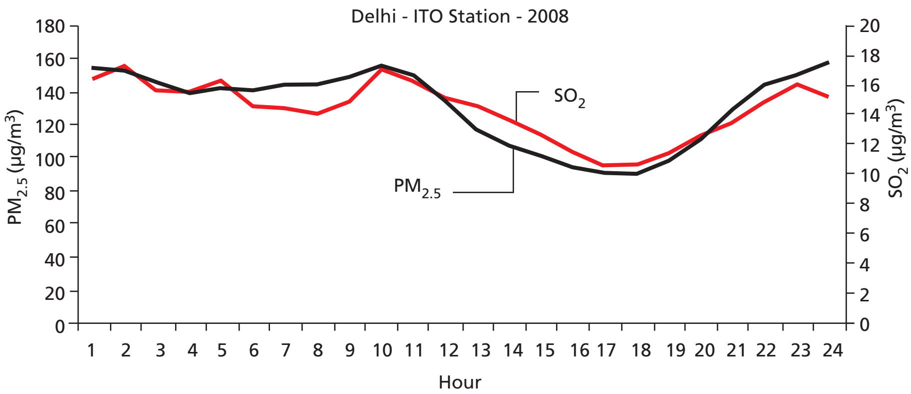
Diesel vehicles emit high level of tiny particles and NO_x that also contribute to the formation of ground ozone. Diesel exhaust is also laced with some of the worst known toxins that can have severe metabolic effects and cause cancer.

Globally, several studies have been carried out demonstrating the high impact of highway traffic on respiratory conditions, heart ailments and size of brains of children in close vicinity of highways. Special studies have been carried out among children in school buses running on diesel. WHO and International Agency for Research on Cancer have classified diesel exhaust as Class 1 carcinogen in June 2012 for its definite link with lung cancer, putting it in the same class as tobacco smoking, asbestos and arsenic.[25] According to the California Air Resources Board, the number of excess cancer cases per million people due to lifetime exposure to diesel fumes is 300 compared to 29 for benzene (that comes from petrol).[26]

A March 2016 report of Health Canada of Canadian government has provided evidence of both cancer and non-cancer effects of diesel emissions including on the respiratory, heart and immune system. The Global Burden of Diseases for India attributes half of air pollution-related deaths to heart disease. It states that if people spend 6 per cent of their time in micro-environments with high traffic and high pollutant concentration, it can result in daily exposure of as much as 21 per cent of the black carbon. California Multiple Air Toxics Exposure Study of 2015 has found that diesel sources constitute 68 per cent of air toxics risk in Los Angeles.

Graph 10: Night-time pollution in Delhi due to trucks

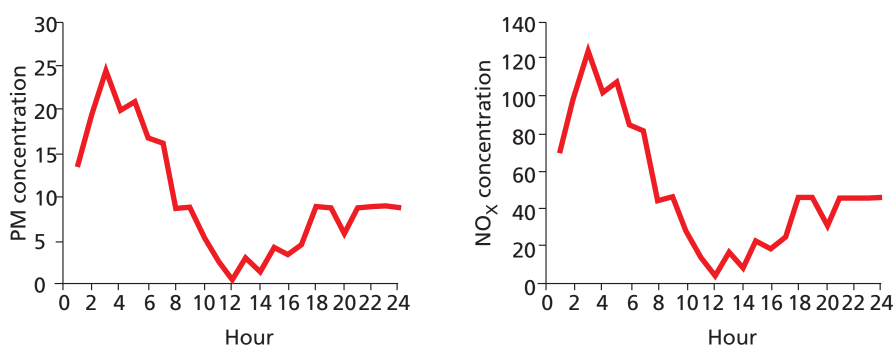
Rush entry of trucks increases vehicular contribution to air pollution drastically



Source: Sarath Guttikunda 2009, Simple Interactive Models for Better Air Quality

Graph 11: High night-time pollution in selected neighbourhoods in Delhi due to truck traffic

Hourly variation of PM and NO_x concentration due to diesel commercial vehicles at Moti Bagh on Ring Road during winter in Delhi



Source: IIT Delhi, 2007

A report by London Assembly Environment Committee in 2015, titled 'Driving away from diesel, reducing air pollution from diesel vehicles' states that particulate emissions from diesel vehicles can be more harmful than other particulates.[27] For example, $PM_{2.5}$ emissions from diesel exhaust contains high levels of black carbon, which has been found to be four–nine times more deadly than other types of $PM_{2.5}$.

Trucks and fuel guzzling

Besides toxic fumes, trucks also spew heat-trapping emissions that warm the climate. Globally, the heavy-duty sector represents just 11 per cent of motor vehicles, but is responsible for 46 per cent of heat-trapping CO_2 from vehicular sources, and 71 per cent of vehicle particulate emissions. This particulate matter also contains black carbon that is 16 times more heat-trapping than CO_2.

Table 5: Contribution to on-road climate pollutants

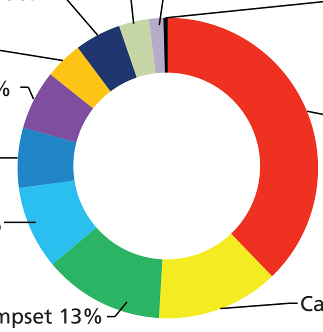
Heavy-duty vehicles are the biggest contributors to on-road pollution

Countries	Number of heavy-duty vehicles	Share of heavy-duty vehicles in CO_2 emissions	Share of heavy-duty vehicles in particulate emissions
China	10%	65%	83%
United States	5%	30%	36%
European Union	11%	37%	47%
Japan	19%	43%	59%
Brazil	4%	61%	85%
India	5%	71%	74%
Russia	14%	54%	81%
Canada	15%	42%	52%
Global	11%	46%	71%

Source: Drew Kodjak 2015, International Council on Clean Transportation, Washington DC

Graph 12: Diesel consumption by different sectors

Heavy-duty vehicles are the biggest consumers of diesel in the country



Source: Ministry of Petroleum and Natural Gas, 2013

Table 6: Active or emerging regulatory programmes

Globally, heavy-duty vehicles regulations are being adopted and implemented

Regulatory development	Reduction in new fleet fuel consumption	CO_2 reduced in 2030 ($MtCO_2$)	Status
Canada's Phase 1 standards, similar to US rules, applied starting with model year 2014 vehicles	14%	12	Implemented
Japan's Phase 1 standards, established in 2005, became fully enforceable in 2015	12%	12	Implemented
US Phase 1 standards began 2014 vehicles; they require CO_2 emission reduction of 6-23 per cent and will be fully phased in by 2018	14%	76	Implemented
China adopted Phase 2 fuel consumption standards in February 2014. New type approvals followed in July 2014. The standard is expected to reduce new fleet average fuel consumption 11 per cent by 2015.	11%	110	Implemented
US proposed Phase 2 standards will apply to model year 2018–27 vehicles. Together with Phase 1, the standards will reduce fuel consumption by 20-45 per cent compared with model year 2010 technology	10-24%	77	Adopted
Total		287	

Source: Fuel Economy State of the World 2016, Global Fuel Economy Initiative

The 2015 estimates of the US-based International Council on Clean Transportation (ICCT) shows that the contribution to emissions of heavy-duty vehicles is disproportionately high across major economies. In India, the share of heavy-duty vehicles is only 5 per cent of the total vehicles but they are responsible for 71 per cent of the CO_2 and 74 per cent of the particulate load in the country[28] (see *Table 5: Contribution to on-road climate pollutants*)

The transport sector consumes as much as 40 per cent of the total petroleum fuel in India. Within that, the heavy-duty sector consumes the most. According to the Ministry of Petroleum and Natural Gas, the share of heavy-duty vehicles in the consumption of diesel was the highest in 2013 when they consumed 38 per cent of the total diesel sales in the country (see *Graph 12: Diesel consumption by different sectors*).

India has just about started the discussions on framing of fuel economy standards for heavy-duty vehicles. This process will have to be accelerated. Parallel to this, there are several operational issues that worsen fuel economy of the fleet and that need to be addressed through eco-driving practices as well as operational reforms (see *Table 6: Active or emerging regulatory programmes*).

3: Reducing emissions from trucks


USE
PLEASE
OBEY THE
TRAFFIC
RULES
2516
STOP

India needs both national and local level strategies to reduce pollution and energy impacts of truck traffic. Globally, several strategies are being worked out to control emissions from trucks. These include continuous tightening of emissions standards, in-use emissions inspection and management, age regulations and scrap policy, fuel economy regulations, retrofitment and re-powering of older vehicles based on clean diesel fuel, and eco-driving approaches.

Several of these actions have already started in India, but the current approaches are very limited in scope and effectiveness. Action is also not equally stringent across cities and regions. While at the national level emissions standards are improving incrementally, at local level only a few city governments have taken very rudimentary steps. It is important to understand what has and has not worked so far and what needs to be done to cut emissions from trucks substantially.

Stringent emissions standards roadmap

After a considerable delay in tightening the emissions standards in India, there are encouraging signs to fast forward the action. The BS-IV emissions standards are now scheduled to be introduced nation-wide in April 2017.

However, the most significant development has been the final notification of BS-VI emissions standards that will be advanced and implemented nationwide in 2020. Thus, India will skip Euro-V altogether and leapfrog to Euro-VI. This is expected to have significant impact on emissions from new trucks. MoRTH has issued the final notification on BS-VI emissions standards for all vehicle categories in September 2016. The BS-VI standards will go into effect for all vehicles manufactured on or after 1 April 2020. This is a unique step in the developing world. With introduction of the BS-VI standards, emission of particulate matter and NO_x from trucks will drop by 50 to 89 per cent (see *Graph 13: Effect of successive Bharat Stage standards*).

Robust technology roadmap

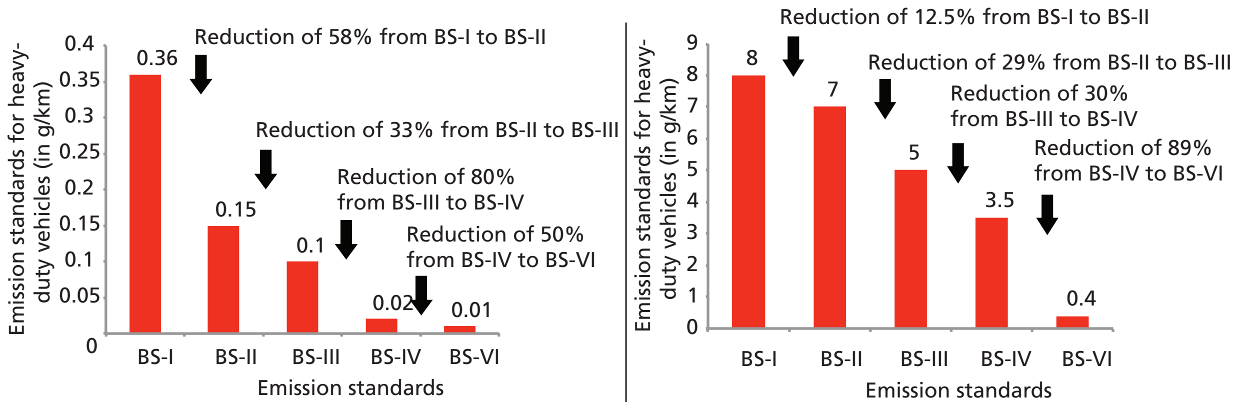
Emissions standards are shaping the technology roadmap for the truck segment. A review of the options and evolution of emissions control systems in trucks through successive stages of emissions standards carried out by ICCT shows that there will be a paradigm shift while moving from BS-IV to BS-VI emissions standards (see *Table 7: Heavy-duty diesel engine emissions control technology developments*).

The Euro-VI lowers both NO_x and mass PM limits significantly, and imposes limits on particulate number for the first time. To ensure compliance, use of advanced diesel particulate filter (DPF) for heavy-duty diesel vehicles is required. Selective catalytic reduction (SCR) is adopted for NO_x control. The Euro-VI standards also revamp testing procedures to better represent real world driving conditions, broaden the set of pollutants considered, and strengthens durability and on-board diagnostic (OBD) requirements. The Euro-IV and Euro-V emissions standards-compliant heavy-duty vehicles frequently do not achieve real world NO_x emissions expected under those standards. Evidence indicates that a Euro-VI emissions standard-compliant heavy-duty vehicle

Graph 13: Effect of successive Bharat Stage standards

Emission of particulate matter and NO_x is going to reduce for heavy-duty vehicles

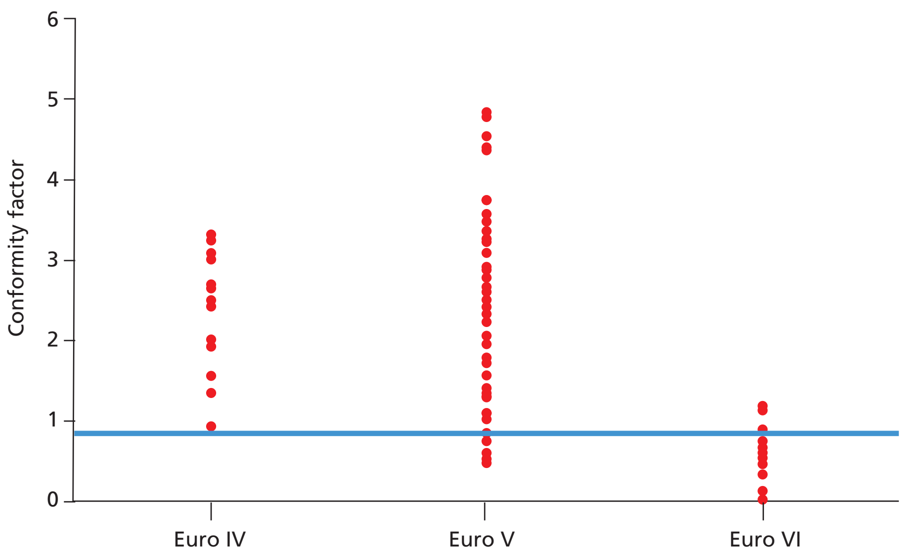
Trend in particulate matter norms | Trend in NO_x norms



Source: CSE computation based on data provided by transportpolicy.net

Graph 14: NO_X emissions for all tests plotted vs Euro emissions standards

Euro VI will bring about a drastic reduction in NO_x emissions from heavy-duty vehicles



Source: Comparison of real-world off-cycle NO_X emissions control in Euro IV, V, and VI, ICCT

indeed meets the benchmark, even in the most difficult operating conditions. Euro-VI standards will allow a much greater reduction in NO_X emissions than Euro-IV or V levels.[29]

According to ICCT, Euro-VI standards are expected to provide greater real-world benefits. Going directly from Euro-IV to Euro-VI will achieve a larger

NO_x reduction than the 88 per cent reduction in certification level would indicate. In practice, this number is likely to be as much as 98 per cent, and could be even higher due to the fact that real world Euro-IV or V emissions are much higher than the limits would indicate. Euro VI standards can also give confidence that off-cycle NO_X emissions should no longer be an issue, even for low-speed urban vehicles.

Euro-VI standards, along with adoption of DPFs to meet particulate matter mass standards and particulate number standards, would lead to 90 per cent or greater reduction of $PM_{2.5}$ emissions. Moreover, the new test cycles for certification along with the in-service conformity requirements can lead to real world reduction in NO_x emissions by 95 per cent or greater even in urban driving conditions, that has been a concern at the Euro-V level.[30]

Table 7: Heavy-duty diesel engine emissions control technology developments

Paradigm shift from Euro III to VI, better on-road reduction due to improved technology

	Euro III to Euro IV	Euro IV to Euro V	Euro V to Euro VI
Euro III technology	• High pressure fuel injection • Electronic fuel timing and metering, including timing retard for low NO_x	-	-
Combustion and air fuel controls	• Improvement in engine combustion and calibration for PM control • Turbo-charging with intercooling • NO_x control through EGR (exhaust gas recirculation) or SCR (selective catalytic reduction): EGR cooled	Previous technology plus: • Improvement in engine combustion and calibration • Multiple injection fuel system (pilot-main-post) • VGT (variable geometry turbo-charger) • NO_x control through EGR or SCR: EGR cooled • Higher EGR rates	Previous technology plus: • VGT improvements • Combustion system improvements
After treatment system	• NO_x control through EGR or SCR; SCR system (open loop) • PM control for EGR; DOC (diesel oxidation catalyst) + PFF (partial flow filter)	• NO_x control through EGR or SCR; SCR system (closed loop) • Ammonia slip catalyst • PM control for EGR pathway: DOC + PFF	PM control: DOC + diesel particulate filter
On-board diagnostic (OBD) requirements	OBD Stage I must monitor thresholds: • Complete removal of the catalyst when fitted in separate housing from DPF (diesel particulate filter) or de-NO_x system • Efficiency reduction of the PFF or de-NO_x system	OBD Stage II adds the following: • Monitoring of the interface between the ECU (electronic control unit) and other power-train and vehicle electrical or electronic systems for continuity • Adoption of standardized OBD systems across manufacturers and also access to repair information	• More stringent OBD threshold values and type approval based on the World Harmonized Test Cycle • Adoption of in-use performance ratios • Additional monitoring requirements for EGR flow, EGR cooling system, boost (turbo- and superchargers) and fuel injection systems

Source: Ben Sharpe, Oscar Delgado 2016, Engine technology pathways for heavy-duty vehicles in India, ICCT

Expanding natural gas vehicle programme

The expanding network of natural gas pipelines in the country opens up opportunities to create natural gas highways. This is already happening in Gujarat. It can enable natural gas-based goods vehicles to serve long distance. In fact, such natural gas pipelines are also being planned in Uttar Pradesh, linking Delhi with Haridwar and Agra etc. Natural gas industry, suppliers included, is looking at promoting Liquefied Natural Gas (LNG) supply networks to introduce LNG trucks. These steps will go a long way in reducing pollution impact of road-based freight traffic.

Vehicle inspection programme for on-road trucks

There is a rudimentary emissions inspection programme called pollution under control (PUC) certification programme for all on-road vehicles. Under this programme, only smoke density tests are carried out as part of the annual vehicle fitness and roadworthiness check for all diesel commercial vehicles. This is a very weak programme with serious enforcement challenges.

CSE reviewed the average emissions performance of this PUC programme by analyzing the smoke density results of commercial vehicles in Delhi. It showed a suspiciously low (6 per cent) failure rate. This looked incongruous, given that trucks are a very visible source of serious pollution. Moreover, the smoke density norms of 65 Hartridge Smoke Units (HSU) is very lenient for the post-Bharat Stage II vehicles. The norm has been tightened to 50 HSU for BS-IV vehicles. But hardly any BS-IV vehicles ply the roads at present. In Singapore and Pakistan, this norm is 40 HSU; in Indonesia, Thailand, Hong Kong and Malaysia it is 50 HSU for all genres of vehicles.

As emissions inspection is carried out in large number of small decentralized testing centres located in refueling stations, it is very difficult to carry out quality control of these centres across the country. These tests are highly vulnerable to cheating. There are serious concerns over quality and credibility of PUC tests across cities. In fact, a detailed audit of 76 PUC centres carried out by the Central Pollution Control Board in 2013 exposed serious anomalies. Code of practice was not followed, calibration certificates for testing instruments was not available in several centres, the laboratories were in a poor condition, several failed the leak test, and analyzers were not functioning properly.

China has already taken steps to tighten tests and standards for on-road diesel vehicles. The new systems now allows testing on-road diesel vehicles on chassis dynamometer in inspection and maintenance centres (I&M) that can simulate driving conditions on roads. This makes the emissions test more rigorous. China is further developing a nationwide I&M system for evaluating NO_X emissions from in-use heavy-duty vehicles.

Inspection system for new genres of technology

On-road emissions testing for newer vehicles must be overhauled. India has already introduced OBD systems in post-2013 vehicles. But this has not been leveraged to improve vehicle inspection programme for improved emissions control systems. If a problem or malfunction is detected, the OBD-II system illuminates a warning light on the vehicle instrument panel to alert the driver.

This warning light will typically display the phrase 'check engine' or 'service engine soon' and will often include an engine symbol. The OBD system stores important information about any detected malfunction so that a repair technician can accurately find and fix the problem. Smog check inspections in US for post-2000 model vehicles are now primarily based on an inspection of the OBD-II system. Tail-pipe testing is no longer required. It identifies emission-related components covered under warranty. This eliminates unnecessary repairs, providing accurate information about areas of malfunction, thus reducing costs of warranty repairs and improving customer satisfaction, and allowing early detection of malfunctions.

India needs strong compliance regulations to make manufactures responsible for on-road emissions performance**.** Consistent with the global best practices, India needs an independent authority to check emissions against standards and conformity factors to be set for real world performance of vehicles, issue recall of vehicles by companies if they are found non-compliant, levy fines on defaulting companies, and withdraw approval of sale if vehicles do not conform to the stated emissions targets. An independent authority should monitor this process. Only such a system will make non-compliance with regulations more expensive and ensure implementation. The automobile fuel policy committee has recommended emissions warranty and recall programme and in-use compliance regulations. But it is yet to be implemented.

CSE's review shows that currently, Indian certification agencies do not select vehicle samples for certification tests randomly and independently. In fact, certification agencies give prior notice to manufacturers about the approximate time during which samples will be collected from a given lot. This compromises independent and impartial testing. Legal procedures for the MoRTH to issue mandatory recalls or levy fines have not been established yet.

In comparison, China has recently revised its programmes to allow the selection of vehicles at random without any prior notice. Furthermore, conformity of production testing in China is now corroborated through inter-laboratory round-robin testing, which adds an additional level of scrutiny.

Age of commercial vehicles

Yet another approach that has been adopted in a few cities is reducing the age of the on-road commercial fleet. In Delhi, the Supreme Court has intervened to cap the age of commercial vehicles at 15 years. The National Green Tribunal has proposed to reduce this age cap for diesel vehicles to 10 years.

This approach is not without its detractors, who claim that banning vehicles on the basis of age is not workable and is inconsistent with legal provisions that state any vehicle meeting the on-road norms should be allowed to ply.

It may be noted that age caps are often the easier option in developing countries where overall administrative capacity to implement more refined strategies based on emission levels and zoning is weak. Also, claiming that PUC norms should be the benchmark to allow older and polluting vehicles to ply is a fallacy. The bigger concern in India is that trucks that are more than eight or 10 years

CHEAT DEVICES

India must nip the evil in the bud and stop their proliferation before they spread

There are widespread reports from other major vehicle markets of the world that shows operators disable the emission control systems like SCR or remove DPFs to reduce their operational costs. This is dangerous as it will lead to massive uncontrolled emission from vehicles negating the investments in advance emission control systems. There are now reports on how a product called 'Adblue OBD-II Emulator for Trucks Plug Drive Ready Device by OBD-II' is being sold openly through internet retail agencies like Amazon etc. These are defeat devices that disable the emission control system for NO_x in diesel vehicles. Adblue is a urea-based solution that is regularly filled in the selective catalytic reducing (SCR) system attached to the exhaust of the modern diesel vehicles to control NO_x emission. As regular refill is a recurring cost for the consumer, these dubious and illegal devices that are flooding the global market tempt the customers to disable the SCR system. If this practice is not stopped immediately, it will only result in uncontrolled NO_x emission, leading to serious ground ozone build up and damaging health consequences.

SCR is the most dominant approach to controlling NO_x from diesel vehicles meeting emission standards of Euro-IV, V and VI. If these systems are disabled NO_x emission will be uncontrolled. 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 emission regulations. Indian vehicle manufacturers have already started installing SCR systems in Euro-IV diesel buses to control NO_x and its application will expand quickly to other diesel segments when Euro-IV emission standards become uniform across the country in 2017 and Euro-VI is implemented in 2020. India, in grip of severe pollution, cannot afford widespread compromises of emissions performance. The evidence from other countries is scary—46 per cent of diesel vehicles in Brazil fitted with SCR systems have had them disabled. India needs a strong regulatory and monitoring system against this.

old are often withdrawn from the highways to operate within the city. This further aggravates local pollution problems, especially in densely populated cities and regions.

Globally, several programmes have evolved to reduce emissions from trucks effectively (see *Box: Global good practices*).

Scrap policy for heavy-duty vehicles

In May 2016, MoRTH presented a concept note on a new scrap programme called 'Voluntary Vehicle Fleet Modernisation Programme', proposing modernization of all heavy-duty vehicles bought before 31 march 2005.[31]

MoRTH estimated that if this programme comes into force, about 28 million vehicles will be replaced. The owners of old vehicle will get monetary incentives to buy a new vehicle in three forms: (a) scrap value from the old vehicle, (b) automobile manufacturers' special discount, and (c) partial excise duty exemption.[32]

MoRTH estimates that the programme will lead to a 17 per cent reduction in carbon monoxide emission, 18 per cent reduction in hydrocarbon + NO_x emission, and 24 per cent reduction in particulate matter emission from the heavy-duty vehicle sector in India (see *Graph 15: Emissions reduction due to scrap programme*).

The automobile industry has a strong interest in pushing for scrap policies with incentives as this is designed to accelerate fleet renewal that stimulates market for the industry. CSE is not in support of utilizing public money for providing fiscal incentive for personal vehicles like cars and two-wheelers. But there can be strategic, limited and targeted application of the scrap approach for polluting trucks and buses. These are high mileage vehicles with very slow fleet turnover. They are also saddled with very old diesel technologies. They guzzle fuel, and this has both climate and energy impacts. Targeted replacement of old trucks can be worked out in consultation with fleet operators. Modernization programme for this segment should be linked with targeted fuel economy regulations and Euro-VI emissions standards.

GLOBAL GOOD PRACTICES

Controlling emissions from on-road trucks requires knowledge of local conditions

Advance in-use vehicle inspection

Inspection method and test procedures for in-use emission tests for trucks have improved in other countries. Other governments are increasingly relying on OBD to identify gross emitters. They are looking at new test methods and equipment to measure on-road particulate and NO_x emission.

Hong Kong has one of the most developed spotter programmes in the world for the visibly smoky vehicles. Begun in 1988, the programme currently has more than 5,000 trained citizen volunteer spotters who identify visibly polluting trucks that are then taken for rigorous lug down smoke density tests on chassis dynamometers.

Beijing has now introduced nine remote sensing systems for inspection of vehicles. These identify high-emitting vehicles among passing traffic. Beijing Environment Protection Bureau sends notices to owners of high-emitting vehicles.

Germany has created a national vehicle labelling programme based on emission levels. In Berlin, this has resulted in over 60,000 vehicles being retrofitted with a diesel particulate filter and reduction of diesel particulate emissions.

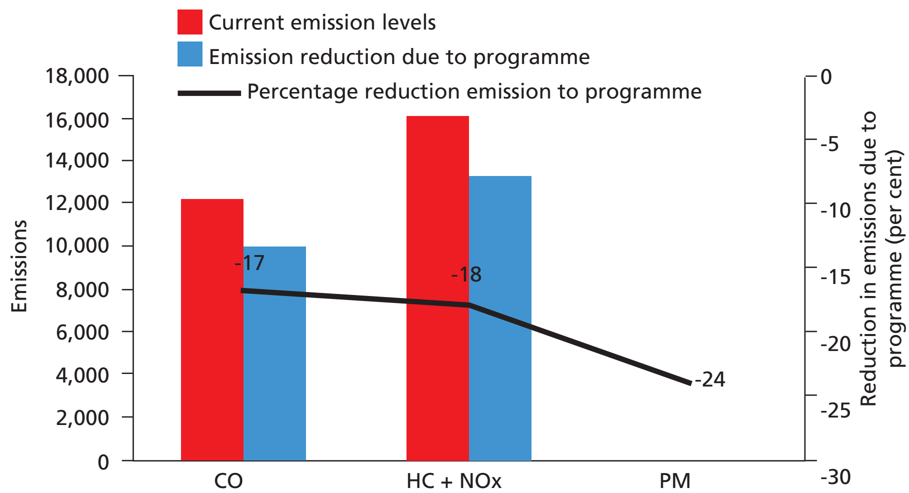
Introduction of clean diesel fuels with 10 ppm sulphur levels opens up option of retrofitting advance emission control systems and repowering with new engines in in-use trucks. California has adopted both retrofitment and repowering approaches for older trucks. More advanced programmes are carrying out in-use particulate and NO_x emission tests.

Low emission zone

Several cities in Europe and China have demarcated city centres as low emission zones where older and polluting vehicles are not allowed to enter. Vehicles are labelled based on their emission levels and cannot enter the city or the zones if they are not compliant. Beijing, for instance, has established low emission zones where yellow-label vehicles, indicating older emission standards, are prohibited. This complements the city's scrap programme for high-polluting vehicles. The government has reported that over 500,000 vehicles have been taken out of the city during 2011 and 2012 while subsidies were issued to only 254,000 vehicle owners.

Graph 15: Emissions reduction due to scrap programme

Abatement of a fifth of carbon monoxide, hydrocarbons, NO_x and particulate matter



Source: Voluntary Vehicle Fleet Modernization Programme, MoRTH

Globally, several governments are implementing these programmes. In 2008, the Beijing government offered subsidies ranging from US $131 to $4,086 to replace yellow-label vehicles that meet older emissions standards, making it clear that the subsidy would be reduced in later years, to encourage early action. In 2009 and 2010, over 150,000 yellow-label vehicles were taken out of the city, with an average subsidy of US $1,225 per vehicle.

Retrofitting advanced emissions control systems in old vehicles

In retrofitment schemes, emissions control devices are retrofitted in the exhaust system of in-use diesel vehicles to help reduce emissions on road. Retrofitment programmes have been implemented in advanced markets of US, Europe, and Japan; as well as in Asian markets of Beijing and Hong Kong, where clean diesel fuel is available. California has launched a retrofitment programme for buses and trucks as part of a diesel risk reduction programme.

Availability of clean diesel (10 ppm sulphur) allows retrofitment of advanced emissions control systems in used vehicles that are otherwise fitted in new vehicles meeting Euro-V and Euro-VI standards.

But retrofitment is not a panacea. The devices which can be retrofitted are limited, as are the vehicles on which these devices can be retrofitted. Particulate filters can be used for retrofitment, but not basic devices like diesel oxidation catalysts, that are not at all effective in cleaning up particulate emission. Old vehicles with high fuel and oil consumption do not often qualify for retrofitment. The life of emissions control systems can be shortened considerably if engines are poorly maintained, fuel injector leaks, there is excessive fuel consumption or lubricating oil in the exhaust system. Retrofitted emissions control devices are sulphur sensitive and can get irreversibly damaged if the fuel is not clean.

This is the reason that many countries have set up stringent rules regarding retrofitment. The US retrofitment programme evaluates the emissions reduction performance of retrofitment including durability of the system. Regulators identify engine operating conditions that are needed to reduce emissions. In Hong Kong, manufacturers have to get the performance of the retrofitment certified in a lab based on proper certification tests. Regulations have also laid down manufacturers' responsibility. In use performance of the retrofitment device is required to be verified. The durability of the entire system for the warranty period has to be demonstrated. In Europe, several procedures have been laid down for periodic testing. This requires component inspection, their setting and function.

MoRTH should frame a national retrofitment policy for diesel trucks and diesel buses and certification system for targeted models. This should include a strong durability requirement. Monitoring, testing and verification systems to assess on-road performance should be set up. Periodic testing is critical. On-board monitoring should be enabled.

Taxation to discourage older and polluting vehicles

To complement command and control approaches, cities can also use fiscal disincentives for older and polluting vehicles. Though, as a principle, some states including Maharashtra and Gujarat have adopted a strategy of green tax where road tax increases with age of vehicles, it is not effectively designed to make a difference.

But state governments can be encouraged to design taxation measures linked to emission levels or vintage of the vehicles.

Fuel economy regulations

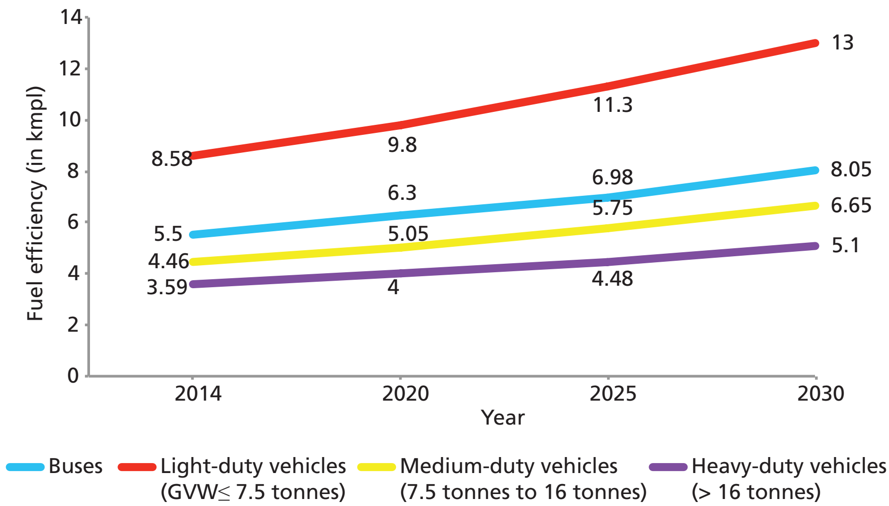
India has already adopted fuel economy norms for passenger cars that will be implemented in 2017. In 2014, the Ministry of Petroleum and Natural Gas formed a steering committee for monitoring the progress of fuel economy standards for heavy-duty vehicles in India. Commercial vehicles are responsible for highest consumption of diesel at 26.75 per cent, followed by buses at 10.75 per cent.[33]

Petroleum Conservation Research Association and Bureau of Energy Efficiency are jointly responsible for formulating a time-bound action plan for the development of fuel economy standards for heavy-duty vehicles. CRRI was commissioned to carry out a technical study to make recommendations in this regard. Its 2014 report, *Fuel Efficiency For Heavy-duty Vehicles in India*, recommended weight- and CO_2 emissions-based fuel economy labelling to be made mandatory by the year 2016. This has not happened yet.

CRRI has computed the average fuel economy of different heavy-duty vehicles based on available secondary data.[34] The calculations are based on the distance travelled (in km) on one litre of fuel. After setting a base year fuel economy, CRRI has projected improved fuel economy ratio for the years 2020, 2025 and 2030 (see *Graph 16: Proposed fuel efficiency in India*).

Graph 16: Proposed fuel efficiency in India

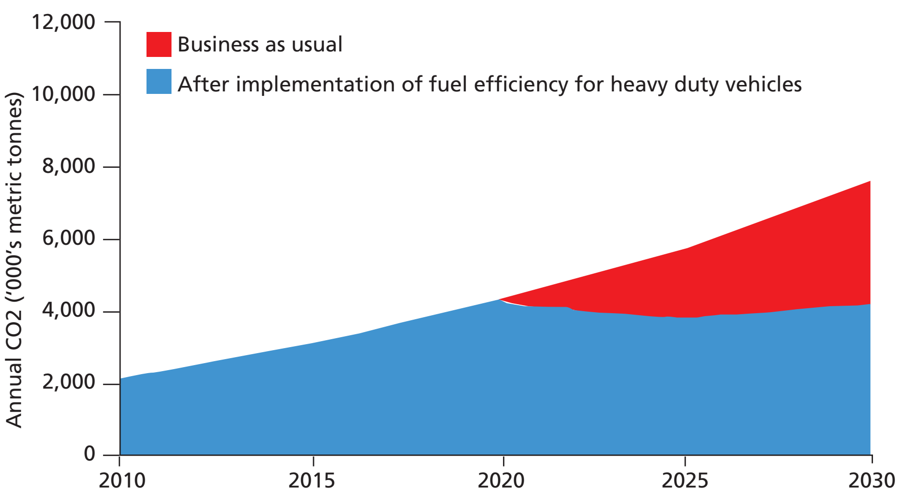
Heavy-duty vehicles are expected to achieve significant improvements by 2030)



Source: Fuel Efficiency Standards of Heavy Duty Vehicles in India, CRRI

Graph 17: Impact of proposed fuel economy targets

CO_2 emission from heavy-duty vehicles are expected to stabilize from a business-as-usual scenario



Source: Anon 2014, Fuel Efficiency Standards of Heavy Duty Vehicles in India, Central Road Research Institute, New Delhi

With these targets and timeline in mind, CRRI has estimated the potential reduction in CO_2 emission from heavy-duty vehicles (see Graph 17: *Impact of proposed fuel economy targets*). The reduction in 2025 is estimated to be 192 thousand metric tonnes which will further increase to 343 thousand metric tonnes by 2030 from a business-as-usual scenario. About 147 billion litres in the year 2025 and 262 billion litres in the year 2030 of fuel is expected to be saved.

Mandatory fuel economy standards provide regulatory certainty to manufacturers and ensures uptake of new technology. This can be supported by fiscal measures.

CRRI, in its 2014 report, proposed that for Indian conditions, the implementing agency or government should establish the fuel consumption standards based on engine improvements by considering extensive test of producers based on i) on-road testing, ii) engine testing iii) chassis + engine testing, and iv) computer simulation based on adoption of standard driving test cycles. This was to establish fuel efficiency standards, and help develop and maintain a level playing field among manufacturers, as all are required to meet fuel economy targets. It has also been suggested that vehicle segmentation for commercial freight vehicles and trucks should be restricted to three categories: i) light-duty vehicles (gross vehicle weight upto 7.5 tonnes), ii) medium-duty vehicles (gross vehicle weight ranging from 7.5 tonnes to 16 tonnes), and iii) heavy-duty vehicles (gross vehicle weight of more than 16 tonnes). There is still no regulatory action on these recommendations.

Fuel economy labelling for heavy-duty vehicles

The labelling of fuel economy of new light-duty vehicles has already been introduced in other countries to encourage the public to value fuel efficiency and to provide easy comparisons between different types and brands of vehicles. But there are very few examples of fuel economy labelling for heavy-duty vehicles, except Japan and United States (see *Box: Fuel economy standards in Japan*). In United States, the voluntary 'Smart Way' technology programme awards the 'Smart Way' labels to heavy-duty vehicles meeting the programme specifications.

Green freight programmes

There is now a growing world-wide focus on improving freight operations to reduce pollution and climate impacts of heavy-duty vehicles. This can be achieved by focusing on eco-driving, optimizing trips to reduce trip numbers and empty-container trips, etc. The high percentage of empty hauls combined with systemic overloading of trucks is common and results in economic losses, higher fuel use and emissions and safety concerns.

An Asia-wide assessment carried out by Manila based Clean Air Asia (CAI Asia) has shown that the road freight sector is highly fragmented, with a majority of driver-owned trucks, making it difficult for government agencies to reach out to them with information and policies or new technologies.

Freight is seldom included in the planning of urban transport systems. This results in ad hoc policies and operations. The wide range of agencies involved with freight industry makes coordination for policy development difficult.

Driver training and technologies can allow significant fuel savings as the fuel costs are the largest component of truck operational costs. In the US, anti-idling regulations and eco-driving have been adopted to improve local air quality and to reduce fuel consumption. Heavy-duty vehicle operators participate in periodic training programmes that train on environment-friendly driving. Challenges

FUEL ECONOMY STANDARDS IN JAPAN

Fuel efficiency improved across categories after the measures were implemented

Japan was the first country to introduce mandatory fuel economy standards for heavy duty vehicles in 2005–06. Heavy-duty vehicles were responsible for approximately 25 per cent of all CO_2 emissions from motor vehicles in 2002. The government set 2015 as the deadline for compliance with the fuel economy targets.

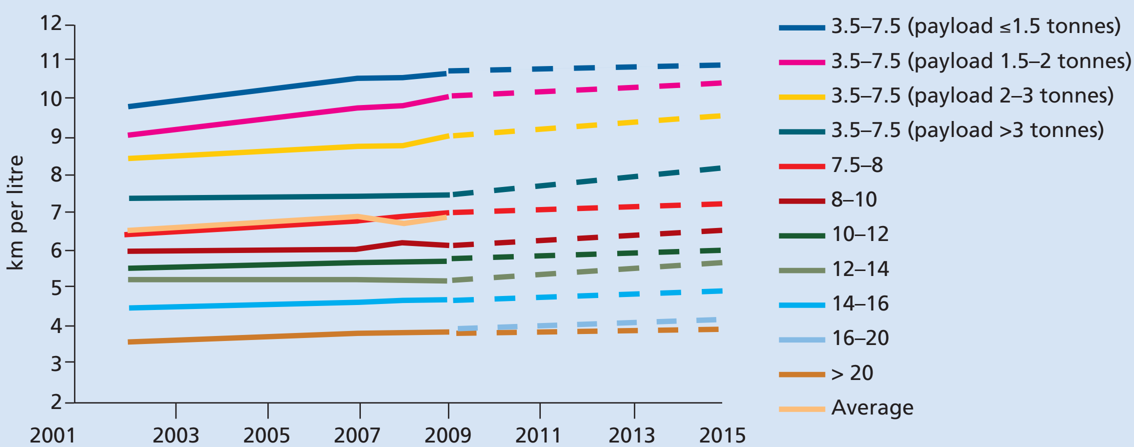
The target for each vehicle category was set at the level of most efficient vehicle model or the top runner model in 2002. The test procedure combines engine testing with a vehicle simulation model. Heavy-duty vehicles are divided into trucks, tractors, city and other buses. These are further subdivided by gross vehicle weight, because fuel efficiency of heavy-duty vehicles strongly depends on gross vehicle weight or payload. As the result of this categorization, the number of vehicle types in a few categories can be small, which can reduce manufacturer flexibility in achieving target values. To address this concern, Japan introduced a credit trade system among vehicle categories.

The government gathered real world data of fuel efficiency of vehicles on highways and urban roads and developed two driving cycles; highways and urban. A simulation method was adopted to convert a vehicle-based driving cycle to an engine-based operation cycle that defines engine torque and rotation speed for each second to calculate fuel efficiency. The exhaust gas emissions control (the new long-term control), effective since 2005, requires vehicles having a gross vehicle weight of greater than 3.5 tonnes to be tested in JE05 mode (a transient driving mode defined on the basis of urban driving statistics).

After the regulation was developed in 2006, the Japanese government started collecting data. Sufficient data became available from 2007. Compared to fuel efficiency in 2002, base year for deciding target values, fuel efficiency in 2009 had improved in all categories. Although average fuel efficiency in some categories continuously improved from 2007 to 2009, almost no improvement occurred in other categories during the same years.

The fuel efficiency improvement rate has been smaller than the improvement rate in other categories. The sales volume in this category was less than 1,000 vehicles annually from 2007 to 2009, while in some other categories, the annual sales volume was more than 10,000 vehicles. With very low volume sales, manufacturers may face difficulty in improving corporate average fuel efficiency levels for each categories. As a result, the Japanese credit trade system plays an important role in allowing manufacturers to cost-effectively meet target values. In addition, average fuel efficiency decreased in 2008 compared to 2007, while fuel efficiency in each category increased. This trend was caused by the shift of the sales mix. In Japan, the credit trade system is likely to be an important feature for meeting targets in 2015.

Graph 18: Fuel efficiency improvements



Source: Central Road Research Institute, 2014 for wide-spread technology adoption are limited availability and fragmented suppliers' network. The CAI Asia review shows that certain technologies that can improve fuel savings and lower emissions face unique challenges in congested cities. For example, aerodynamics technologies, an important strategy to improve air resistance to make vehicles more fuel efficient, work only at higher speeds. They lose their relevance in congested, low-speed conditions. Similarly, financing of clean vehicles is also a barrier as banks and financiers are reluctant to lend to trucks drivers and companies with small trucking fleets wanting to invest in fleet renewal.

A variety of urban planning approaches are also evolving to reduce travel distances for road-based freight by promoting local production and consumption, co-location of facilities within the same supply chain and with ports for goods that are to be shipped abroad, improved logistics that involves shippers, carriers, logistics centres and manufacturers or end-users, and load management. Similarly, efforts are needed ensure a shift to more energy-efficient environmentally-friendly modes. Optimization of railways and inland waterways is a way forward. Also, improvement in energy efficiency through operations and technologies, fuel economy standards, stricter implementation of anti-overloading laws, and tools such as radio frequency identification tags (RFID), global positioning systems (GPS) and vehicle routing software is needed.

The government needs to play an important role in establishing policies and providing the right incentives that favour more sustainable freight practices. This can be done through partnerships and market mechanisms. Green freight programmes are designed to help freight carriers save fuel, reduce costs, as well as negative externalities such as greenhouse gases, particulate matter and short-lived climate pollutants such as black carbon. These results are driven by efficiency improvements brought about by enabling technological and operational enhancement actions, and through the sharing of best practices.

It is important to influence the entire supply chain. A trainer guide by the United States Environment Protection Agency called Smart Way was developed for establishing green freight programmes in 2016.[35] It can be a good model to emulate and improve on. Developing clear performance goals and metrics is also crucial. Securing funding is one of the most critical factors in ensuring a sustainable programme.

One of the several improvement is the drop and hook system in which **a** 'drop' refers to delivering a trailer at the customer site and 'hook' refers to immediately hooking up a loaded trailer and moving it to the destination. This effectively de-couples the vehicle loading and unloading operations from the transport operation allowing each to be separately optimized, thus saving time. It should be promoted as a healthy practice.

MoRTH is in the process of setting up 15 multi-modal logistics parks**.** These are venues where goods from different suppliers with same origin and destination are combined into single shipments of smaller sizes for movement into the cities, thereby improving efficiency and reducing vehicles on the road. The locations identified for these parks include Delhi-NCR, Mumbai, North Gujarat, Hyderabad, Gujarat, Punjab, Jaipur, Kandla, Bengaluru, Pune, Vijayawada, Cochin, Chennai and Nagpur.

Logistics parks provide modern mechanized warehousing space, satisfying the special requirements of different commodity groups. For example, cold storage for perishables, racked warehousing space for storing pelletizable cargo (eg. parcels, apparel, etc.). With higher proportion of mechanized material handling, warehousing in logistics parks will reduce storing and handling losses. These parks will also provide value added services such as customs clearance with bonded storage yards, warehousing management services etc.

4: Case study–Delhi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Delhi has witnessed a prolonged battle against truck pollution and has evolved a more complex set of control measures at the local level compared to other cities of India, with good results. Understanding this experience is important to find replicable solutions for other cities.

Delhi has become a major corridor for crisscrossing transit traffic in the northern region. Action on trucks started in 2005 when the Supreme Court, in response to a public interest litigation on air pollution, directed creation of two peripheral expressways to divert transit traffic away from Delhi. The eastern and western peripheral expressways are within the jurisdiction of the neighbouring states of Uttar Pradesh and Haryana respectively. Lack of coordination, rigid investments and lack of timely action delayed these projects considerably.

On the western peripheral expressway (WPE), or the Kundli–Manesar–Palwal (KMP) expressway (135.6 km) in Haryana, only the Palwal (NH-2) to Manesar (NH-8) stretch, which is 52 km, is complete and operating since 5 April 2016. According to Haryana government officials, the remaining stretch (Kundli to Manesar—83.32 km) will be completed within a year. The eastern peripheral expressway (EPE) (134.99 km) in Uttar Pradesh is expected to be commissioned by July 2018. The National Highways Authority of India (NHAI) is executing the project on an engineering, procurement and construction basis. This expressway has been delayed inordinately, as after the initial land acquisition, no further action was taken for a considerable length of time. As a result of these delays, transit traffic through Delhi has continued to rise, fouling up the air. This has made other measures necessary.

With an intention of helping in breaking this stalemate, CSE carried out a field investigation on the actual truck numbers and their pollution impact to inform the policy deliberation at the level of the Supreme Court and its advisory body—Environment Pollution (Prevention and Control) Authority (EPCA).

There is lack of clarity on the number of commercial vehicles, including trucks that enter or leave Delhi each day. There are 127 entry points around Delhi, of which nine are major, representing 70–80 per cent of the incoming truck traffic. The Municipal Corporation of Delhi (MCD) has tendered out the operation of collecting toll at these entry points to a private concessionaire. The reserve price was announced as Rs 541 crore annually for a tender for three years.

CSE commissioned a study done by M/s V.R. Techniche Consultants Pvt Ltd to accurately estimate the number of commercial vehicles entering and leaving Delhi at all key toll points. The survey was conducted using round-the-clock video recording method at fixed spots near selected entry points between 29 June and 18 July 2015. It has counted all categories of trucks and other commercial vehicles that feature in the MCD database. These include mini-light goods vehicles, light goods vehicles, and two- three- four- five- and six-axle trucks.

The selected entry points include: Kundli border on NH-1 (KGT Main), Tikri border on NH-10, Rajokari border on NH-8, Badarpur border on NH-2, Kalindi Kunj and Ghazipur Main on NH-24, Ghazipur Old and Shahdara Ist border on NH-19, Shahdara flyover (see *Map 4: Survey locations in Delhi*). The survey showed that the number of commercial vehicles entering and leaving Delhi and, therefore, criss-crossing the length of the city is massive. Some 38,588 commercial vehicles (excluding taxis) enter Delhi daily. Extrapolated to all the 127 entry points, this comes to 52,146.

The survey measured vehicles travelling in both directions. While it is difficult to know if the same vehicle has entered and left Delhi on the same day, it is clear that the total number has an imprint on Delhi's air, as these vehicles will traverse through the city and add to emissions. The daily average number of light and heavy goods vehicles that enter and exit from the nine points is 85,799. The total commercial light- and heavy-duty trucks entering and leaving the city number 115,945 a day. Thus, the official estimate of the number of trucks that cross Delhi borders is grossly underestimated and unreliable in calculating the pollution load.

Data provided to EPCA by MCD on the total number of commercial vehicles, including trucks, that have entered Delhi during the period of 16 May 2015 to 31 July 2015 overlaps with the data collected in the survey. CSE matched MCD categories of vehicles (Category 2 to Category 5) with its survey to arrive at an assessment of the numbers.[36]

According to MCD data, on an average, only 22,648 commercial vehicles, excluding taxis, enter Delhi each day, as against the 38,588 commercial vehicles counted by CSE survey—a difference of almost 16,000 vehicles. This is an underestimation of about 40 per cent in the number of trucks entering from the nine entry points (see *Table 8: Comparison between CSE and MCD data*). According to the MCD, the total number of light and heavy trucks entering Delhi every day is 30,373. This is even lower than what CSE survey counted at the selected nine entry points.

Map 4: Survey locations in Delhi

The busiest entry and exit points were chosen, to get a fair view of the traffic

Selected entry points

1- Kundli border on NH1 (KGT main)
2- Tikri border on NH10
3- Rajokari border on NH8
4- Badarpur border on NH2
5- Kalindi Kunj
6- Ghazipur Main on NH24
7- Ghazipur Old
8- Shahdara 1st border on NH91
9- Shahdara Flyover

Source: Body Burden 2015, CSE

Table 8: Comparison between CSE and MCD data

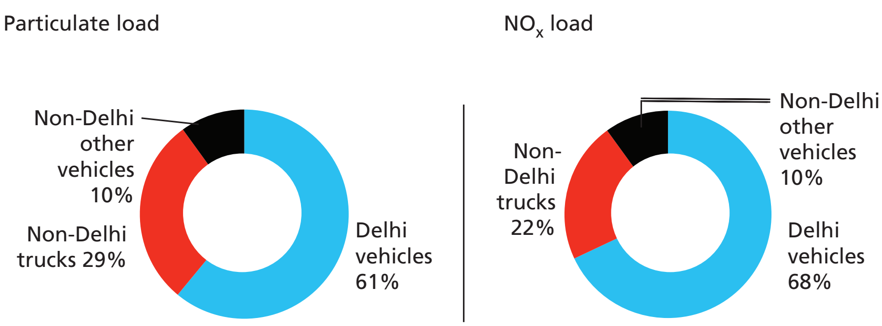
There is a big difference in the estimates of daily average trucks entering Delhi from the selected nine entry points, MCD estimates are suspiciously lower

Location	Entry point(s)	Comparison between CSE and MCD data (Daily average) from 16 May 2015 to 31 July 2015		
		CSE	MCD	Difference (%)
Kundli border on NH-1	KGT Main	8,369	4,554	46
Tikri border on NH-10	Tikri	3,700	1,890	49
Rajokari border on NH-8	Rajokari	9,919	6,335	36
Badarpur	BFTL (Badarpur toll)	4,460	3,001	33
Kalindi Kunj	Kalindi Kunj	4,271	2,275	47
Ghazipur	Ghazipur Main b) Old Ghazipur	3,914	2,372	39
Shahdara	a) Shahdara Ist b) Shahdara flyover	3,955	2,201	44
Total from nine entry points		38,588	22,628	41
Total from all 127 entry points		52,146	30,373	42

Source: CSE Traffic Count Survey and MCD Data for toll entry between 16 May 2015 to 31 July 2015

Graph 19: Percentage contribution to pollution

Non-Delhi vehicles contribute nearly one-third of the particulate matter and NO_x load within Delhi



Source: Centre for Science and Environment, 2015

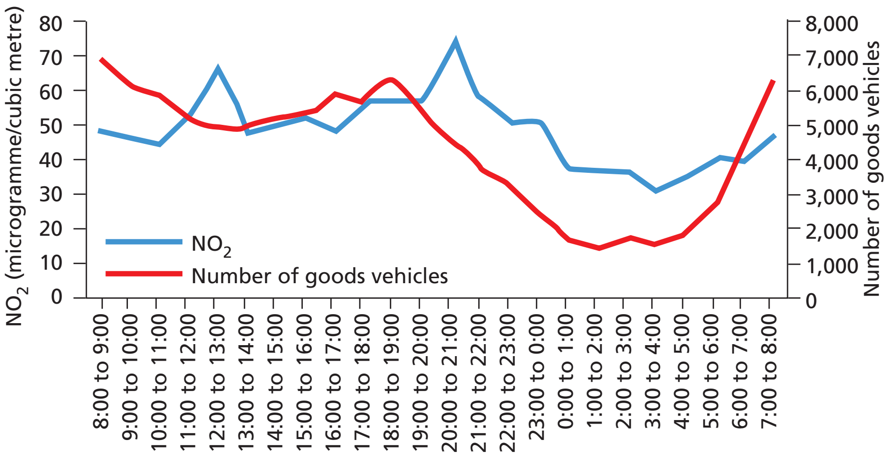
Enormous pollution from trucks in Delhi

As per CSE estimates, Delhi's own vehicles are responsible for 62 per cent of the particulate load from the transport sector and 68 per cent of the NO_x load. The total number of light and heavy trucks that enter Delhi spew close to 30 per cent of the total particulate load and 22 per cent of the total NO_x load from the transport sector (see Graph 19: *Percentage contribution to pollution*).

This has huge impact on Delhi's air quality. CSE survey includes information on the time of entry of all commercial vehicles. When this movement of vehicles is correlated with pollution data, a clear trend emerges. Pollution in the city is highest during the time when there is movement of heavy trucks (see *Graph 20: Correlation between truck entry* and NO_2 and *Graph 21: Correlation between truck entry and* $PM_{2.5}$).

Graph 20: Correlation between truck entry and NO_2

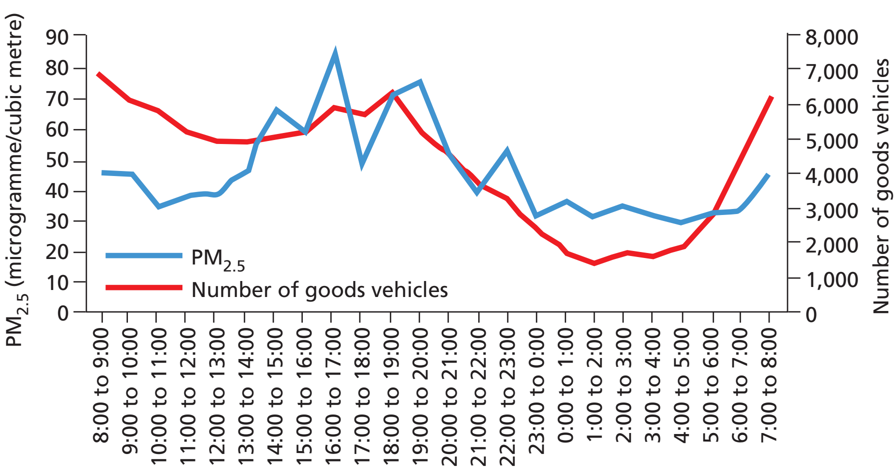
NO_2 levels and the entry of vehicles in Delhi show a clear and direct correlation



Source: CSE, based on real-time monitoring by DPCC

Graph 21: Correlation between truck entry and $PM_{2.5}$

$PM_{2.5}$ levels and the entry of trucks into Delhi more or less mirror each other



Source: CSE, based on real-time monitoring by DPCC

Enormous pollution impacts

Light goods vehicles constitute 65 per cent of the total commercial vehicles entering Delhi, they contribute 39 per cent of the particulate matter load and 42 per cent of the NO_x load from commercial vehicles entering Delhi. Heavy-duty trucks are a quarter of the commercial vehicles entering Delhi, but they emit 61 per cent of particulate and 58 per cent of the NO_x load from the commercial fleet entering Delhi. Among the heavy-duty trucks, the three-axle trucks, which constitute 16 per cent of the commercial vehicle segment, are among the highest emitters entering Delhi (see *Graph 22: Number of vehicles entering Delhi* and *Graph 23: Share of different truck segments in pollution*).

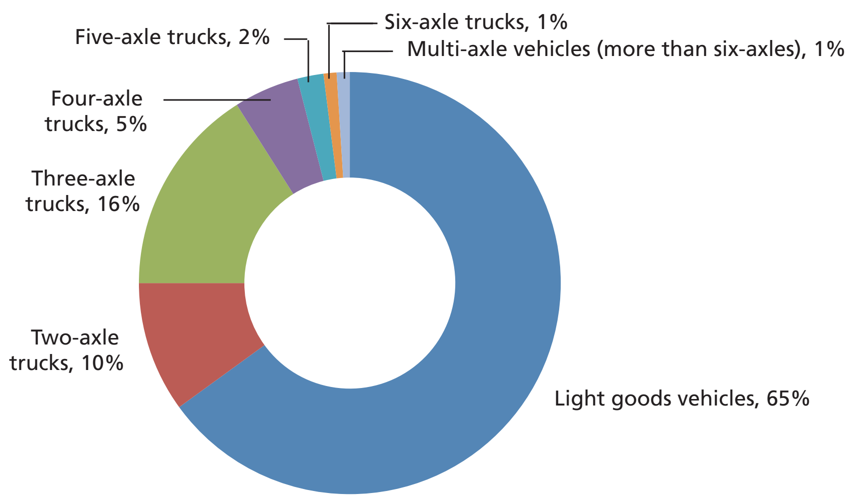
Assessment of traffic not destined for Delhi

There is no reliable data on commercial traffic passing through but not destined for Delhi. MCD data shows that the trucks that turned back, in compliance with the order of the Supreme Court, are a mere 0.3 per cent of the total traffic. In other words, if we consider MCD estimates, just 90 vehicles were not destined for Delhi and the rest 29,000 needed to do business in the city!

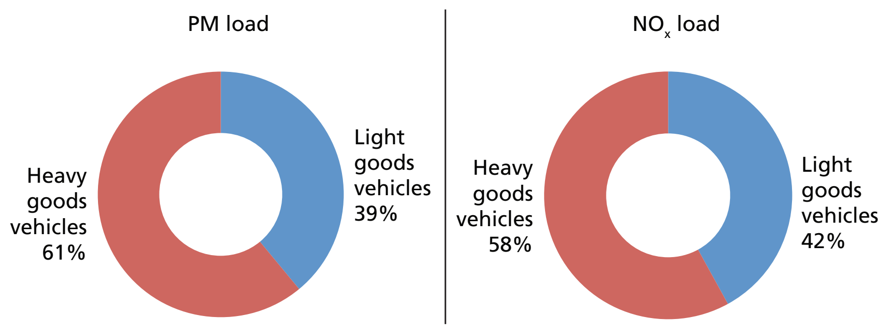
Graph 22: Number of vehicles entering Delhi

Light goods vehicles constitute 65 per cent of the traffic entering Delhi, but contribute only about a third of the pollution

A. Share of different truck segments entering Delhi



B. Share of pollution indicators

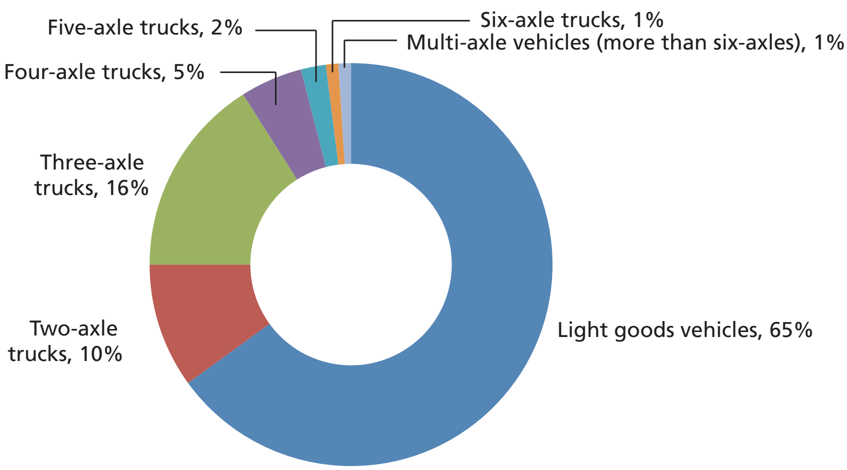


Source: Centre for Science and Environment, 2015

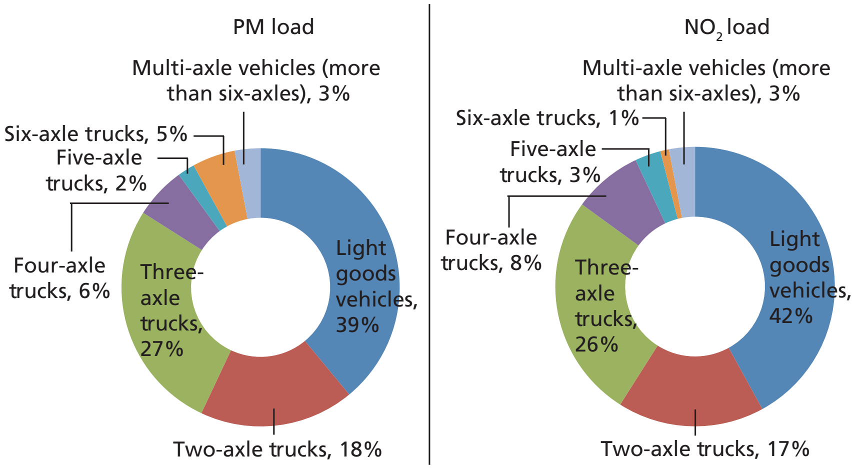
Graph 23: Share of different truck segments in pollution

Five-axle trucks are the biggest culprits, contributing 39 and 42 per cent of PM and NO_2 respectively

A. Share of different truck segments entering Delhi



B. Particulate load from different segments of trucks



Source: Centre for Science and Environment, 2015

Conducting a travel destination study is challenging as drivers do not provide accurate or correct information. A rapid diagnostic survey was done in 2014 on the roads approaching NH-1 and NH-10 entry to Delhi. Truck drivers were randomly surveyed and asked about their origin and destination, about the trip and commodity carried. This rapid and limited survey found that some 23 per cent of all commercial vehicles travelling on NH-1 were not destined for Delhi. The same survey found that over 40–60 per cent of heavy trucks (three-axle and above) were not destined for Delhi. But it is also clear that it is not possible to distinguish between such vehicles and a strategy must be designed so that it becomes easier to discover the destination of all light- and heavy-duty trucks.

Cheap short-cuts?

The study has also revealed that while there are some viable options available to bypass commercial traffic, these roads are not favoured by transporters. There are alternative highways that exist on the western side of the city, to transport goods between north, west and south India. But trucks prefer to traverse through Delhi instead of taking these alternative highways, even though there is no difference in length. The key reason is that it is cheaper to travel through Delhi. The alternative roads are toll roads and charge on the basis of rates decided by the NHAI. The roads that cut through Delhi have a lower charge based on rates decided by MCD.

For instance, NH-71 and NH-71A are toll roads that connect Rewari via Jhajjar and Rohtak to Panipat. This means that commercial traffic, which is travelling from north India to west via Jaipur and then to south India, could take this route. It would not need to travel through Delhi. But the toll rate for three-axle trucks to travel on this road is Rs 1,420. If the same truck travels through Delhi, it is only required to pay Rs 450 (see *Table 9: Tolls along alternative routes around Delhi*). The length of the trip does not change much, while travelling via NH-71 and NH-71A it is 172 km, travelling through Delhi is marginally shorter at 163 km (see *Map 5: Alternative routes around Delhi*).

It is also clear that travelling from north to east via Agra, there are fewer completed highways that can obviate the need to traverse through Delhi. Even then, travel through Delhi needs to be charged so that there is a clear disincentive for the use of these roads, the cost of pollution is paid for, and there is an incentive for viable options to be built that do not require going through the already congested and polluted airshed of Delhi. The delay in building the two expressways has cost the city dearly in terms of pollution. Given the coming winter and the expected increase in pollution, the city needs to find solutions urgently.

Trucks to pay ECC

EPCA took note of all the new findings from the study and survey and submitted new data to the Supreme Court. The Court, in its 9 October 2015 order, imposed a green tax or environment compensation charge (ECC) on commercial goods vehicle entering Delhi from124 entry points which come under South Delhi Municipal Corporation (SDMC)—of the other three entry points, two are under Badarpur–Faridabad Tollway Limited and one falls under Delhi–Noida Direct (DND). Different amount of ECC was levied on different types of trucks; Rs 700 and Rs 1,300 on light-duty and trucks having two or more axles respectively. Trucks carrying essential commodities like food and petroleum tankers were exempted. These charges were later doubled by the court in December 2015. This made passing through Delhi more expensive than the alternative routes while also helping generate revenue for pollution control in the city, augmenting public transport and improving road infrastructure for vulnerable users like pedestrians and cyclists, as required by the Supreme Court order. Subsequently, another order passed in December 2015 barred entry of pre-2006, or more than 10 year old trucks, into Delhi. The VAHAN vehicle database of MoRTH is going to be connected to toll collection booths at the entry points to identify pre-2006 vehicles and deny them entry.

Table 9: Tolls along alternative routes around Delhi

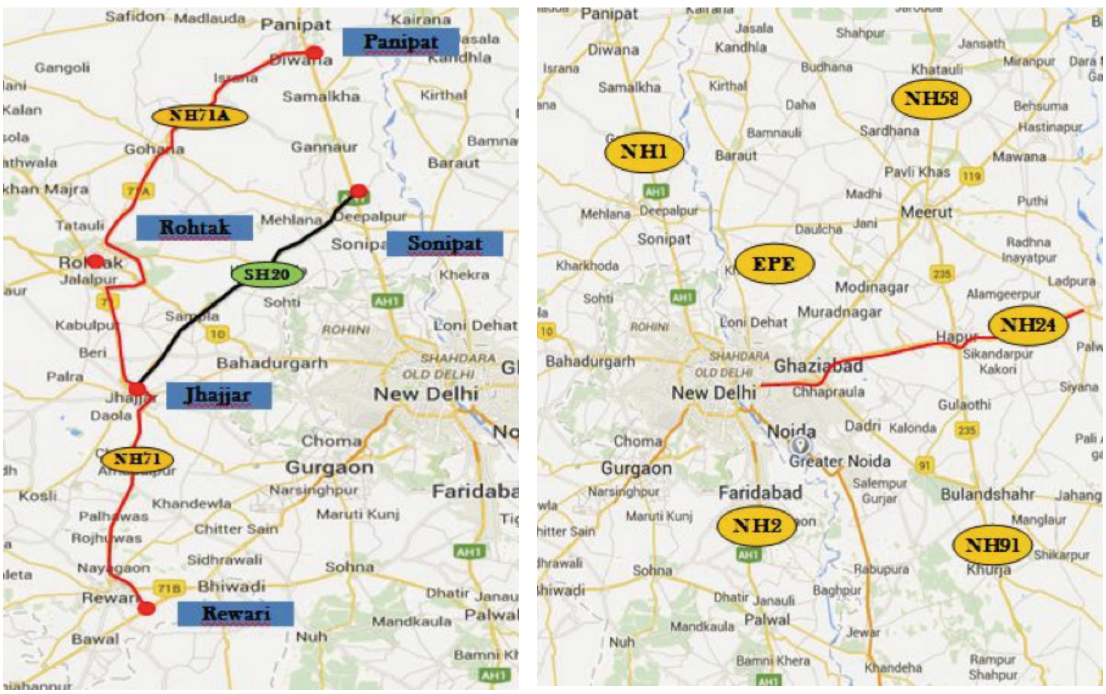
Lower toll rates make passing through Delhi lucrative

Route (From Panipat to Rewari)		Length, in km	Toll rate for			
			Light goods vehicles	Two-axle trucks	Three-axle trucks	Four-axle and above
Alternative 1	NH-71A–NH-71 (through Rohtak)	172	450	930	1,420	1,550
Alternative 2	Through Delhi	163	120	225	450	1,120

Source: Department of toll tax, SDMC, 2015

Map 5: Alternative routes around Delhi

The alternate routes around Delhi do not increase the distance by much, yet trucks prefer to pass through Delhi



Source: Environment Pollution (Prevention and Control) Authority, 2015, Delhi

Goods and services tax co-existent with ECC

The Constitutional Amendment to facilitate the goods and services tax (GST) has brought lot of cheer to the market. GST will subsume all indirect taxes of the Centre and the states, remove cascading impact of multiple taxes to reduce tax burden and make way for a common market. What about effective fiscal signals to discourage polluting goods and services? Or tax the bad to fund the good?

The GST is expected to work on the principle of harmonized tax and market. Technically, a majority of goods and services will be taxed at a standard, revenue neutral rate. Some goods and services can be taxed at a rate lower than the standard or have zero tax for reasons of equity, while a few can attract higher rates. How will the approach of ECC work in the context of GST?

In the GST reforms, barrier free truck movement is a priority as trucks provide freight services and add to the input cost of goods. The Arvind Subramanian Committee Report on the Revenue Neutral Rate and Structure of Rates for the Goods and Services Tax, has justified this, based on studies that show trucks in India drive only one third of the distance of trucks in the US. Only 40 per cent of the total travel time of the trucks is spent driving whereas checkpoints and other stoppages are one quarter of the total travel time. If checkpoint delays can be eliminated, trucks can travel for six more hours (or 164 km) a day on an average. Such delays increase inter-state trade costs by a factor of 7–16 hours. GST wants to cut this down.

But there is a bigger public health question involved here. Air pollution management will require entry restrictions—both physical and fiscal—on polluting trucks in cities battling pollution. Delhi has seen significant reduction in truck pollution after the introduction of ECC on entry of each truck. With road-based freight transport becoming cheaper and easier—and more so after GST, no commensurate investments in railways, and awfully outdated emissions standards for trucks, highway pollution will continue to choke cities and kill people.

While fast tracking reforms, the government cannot ignore fiscal measures that can be more cost-effective than command and control strategies to induce change and sway consumer choices towards cleaner options. Globally, it has been proven that health and social benefits of tougher green regulations are several times higher in economic terms than the costs of complying with the rules. Fiscal correction and reforms have to allow bolder roadmap to reduce pollution and energy impacts of new growth. The markets must work for the cleaning up job too.

What matters most from the standpoint of environmentally responsible fiscal regime is the high sin/demerit tax and the rates worked out in public interest. The recommendations of Arvind Subramanian Committee Report give hope that fiscal restraints on polluting goods and services are a possibility within the GST framework. This report recognizes that 'there is a growing international practice to levy sin/demerit rates in the form of excise outside the scope of GST on goods and services that create negative externality for the economy. These include carbon taxes, taxes on cars that create environmental pollution, taxes to address health concerns etc.' But this principle is not explicitly articulated in the Amendment bill.

The Subramanian report has clearly stated that 'such demerit rates—other than for alcohol, petroleum and tobacco, will have to be provided for within the structure of GST.' The proposal of the committee to have a single demerit rate of 40 per cent for luxury cars, aerated beverages, tobacco products etc., is narrow in scope and is being widely read as tax on luxuries. There needs to be a dynamic strategy for a much broader mix of polluting goods and services.

The GST reform process has to take cognizance of this principle so that tax measures are framed to effectively offset pollution and health impacts of growth. The new Constitution Amendment confers powers on the government of India to exempt goods and services from taxes wherever it thinks it is necessary 'in the public interest'. The GST Council can decide 'any other matter related to GST'. Therefore, the principle of incentive and disincentive has to be on the table. The environment and development discourse has already exposed severe market distortions that make India vulnerable to high pollution and energy guzzling.

Impact of ECC on air quality of Delhi

If truck numbers have declined by close to half by the early months of 2016, as reported by SDMC, pollution load from this segment is expected to lessen.

Based on the initial estimates of reduction of 25 per cent, CSE has estimated the possible reduction in pollution load from this segment. The estimates show that lowering of truck traffic has led to reduction of as much as 30–35 per cent in particulate matter and NO_x emissions from this category (see *Graph 24: Particulate matter and NO_x emissions in Delhi*).

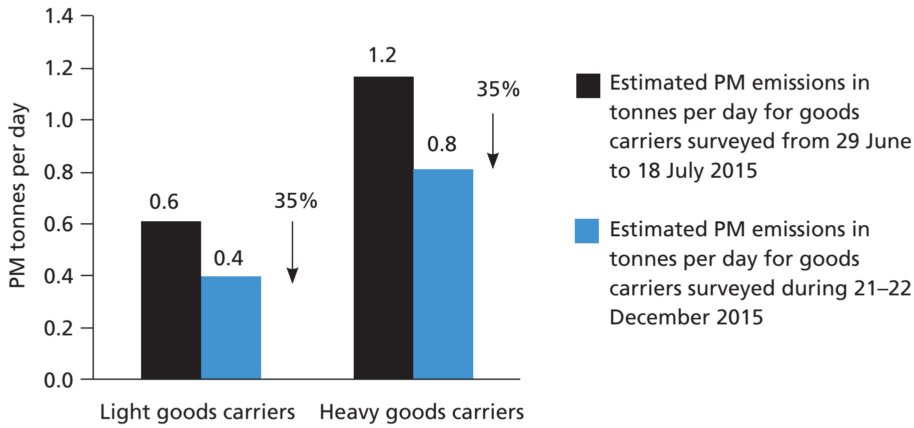
These measures were implemented during harsh winter conditions when cold temperature, calm wind, and inversion kept pollution level highly and consistently elevated. It is challenging to isolate the impact of this one measure on the overall quality of air in the city as air quality is influenced by many factors, including weather. However, as trucks traverse through Delhi during night time, an indicative comparison of night time pollution during the winter of 2015–16 with night time pollution of previous winter of 2014–15 shows lower peaking of pollution during the former winter. The average pollution trend during night dropped during the winter of 2015–16 compared to the previous winter (see *Graph 25: Average night peak pollution during winters, 2014–15 and 2015-16*).

Yet another visible impact is the slower peaking of pollution during the winter of 2015-16. Even though pollution levels remained several times higher than the permissible levels, the peaking of pollution was slower and lower as the winter progressed. A few critical steps were initiated during this winter that include imposition of ECC on trucks, odd and even formula for cars for a fortnight, a ban on diesel cars with engines larger than 2,000 cc, and also more effective diversion of truck traffic. To this was added stronger enforcement on construction dust and open burning.

Together these measures had an impact on the overall pollution. The analysis of DPCC's real time ambient air quality data shows that in contrast to the previous year, when winter pollution levels were erratic and largely influenced by weather events, this winter, despite adverse weather conditions, the pollution peaks showed a steady decline (see *Graph 26: Sustained pollution control measures during the winter helped lower the pollution in a systematic fashion*).

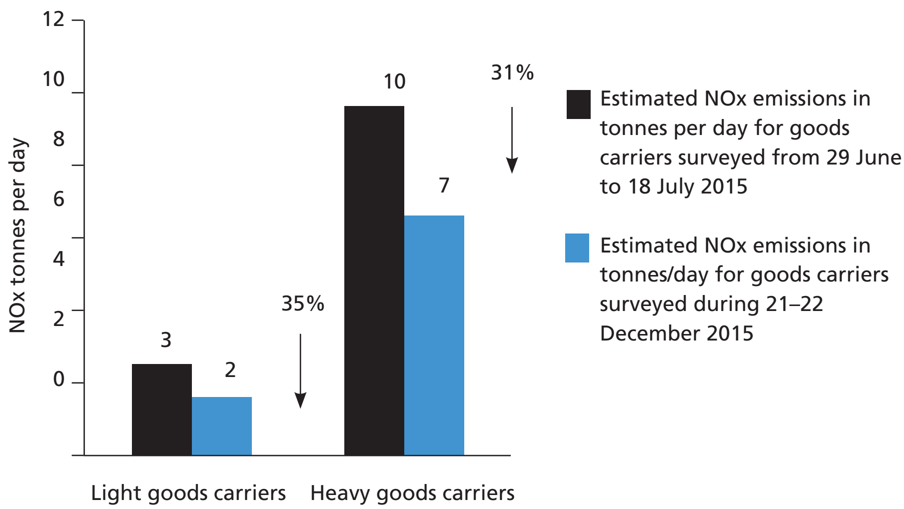
Graph 24: Particulate matter and NO_x emissions in Delhi

a. Particulate matter emissions load from goods carriers



Source: CSE estimates based on vehicle data real time traffic survey by V R TECHNICHE Consultants Pvt Ltd

b. NO_x emissions load from goods carriers



Source: CSE estimates based on vehicle data real time traffic survey by V R TECHNICHE Consultants Pvt Ltd

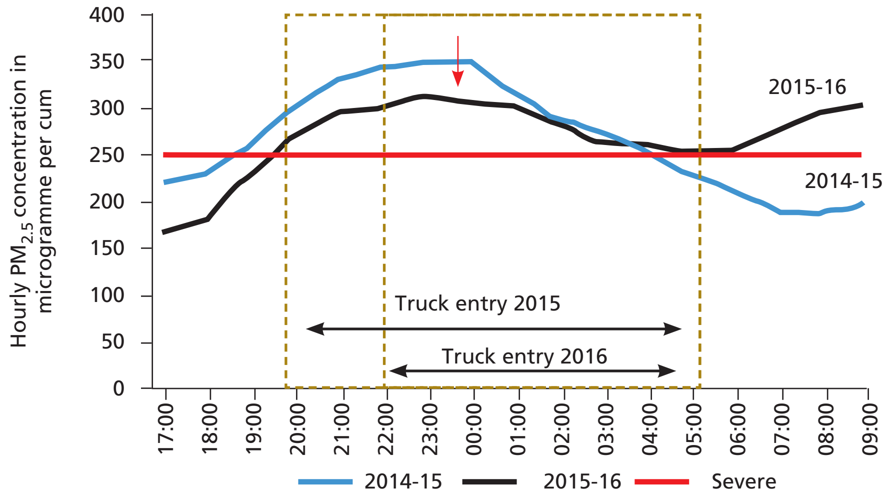
Truck diversion and effective implementation of ECC with RFID

Even though ECC collection from trucks has been introduced in Delhi, there are concerns that manual collection will compromise the effectiveness of the measures and will lead to long queues and evasion of payment.

To address this, the Supreme Court modified its 9 October 2015 order and directed that the collected ECC should be used for installing the Radio frequency identification (RFID) infrastructure in Delhi. RFID is an electronic system that

Graph 25: Average night peak pollution during winters, 2014–15 and 2015–16

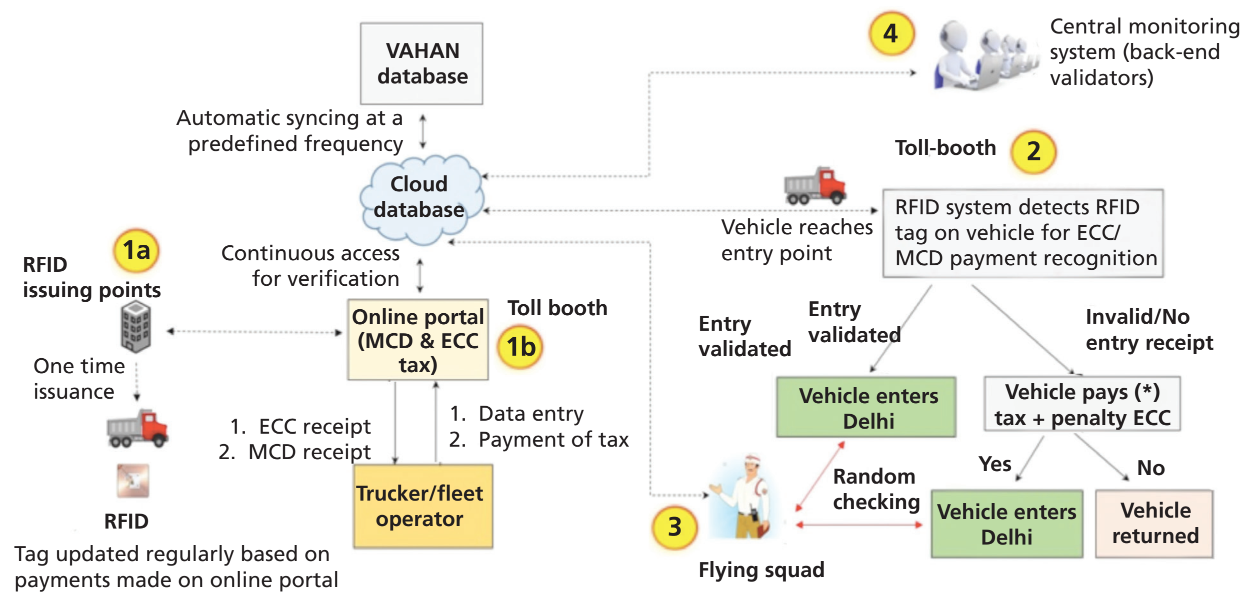
The drop happened earlier in 2015–16, because entry of trucks was delayed, showing a clear correlation



Source: CSE based on real time monitoring data of Delhi Pollution Control Committee

Figure 1: Proposed system flow, automatic ECC collection

ECC will go a long way in reducing the attraction of Delhi as a cheap throughfare for trucks

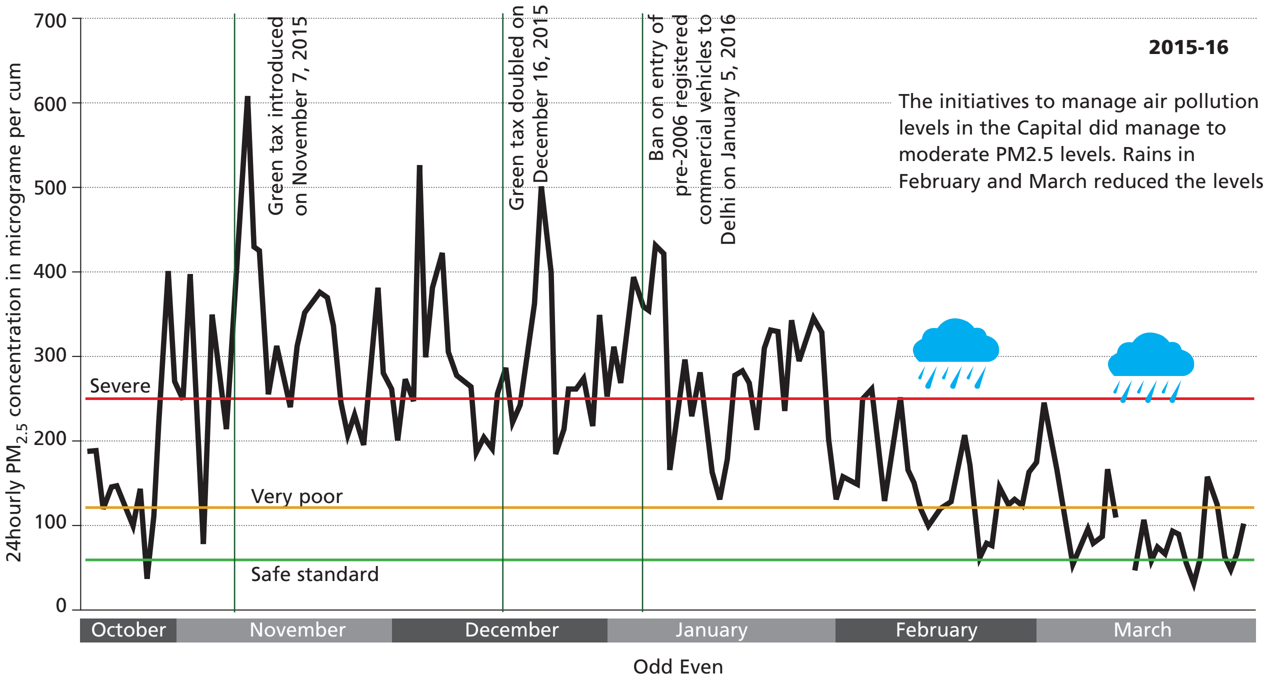


*Note: Vehicle with an invalid/no-entry receipt will be issued an entry receipt at toll booth only if it meets specified pre requisites, otherwise it will be turned back.

allows automatic toll collection when vehicles pass through the entry gates. The ECC will be transferred to separate accounts of the SDMC and transport department. The manual system currently in place is based on collection in cash and involves human discretion, which is open to misuse (see *Figure 1: Proposed system flow, automatic ECC collection*).

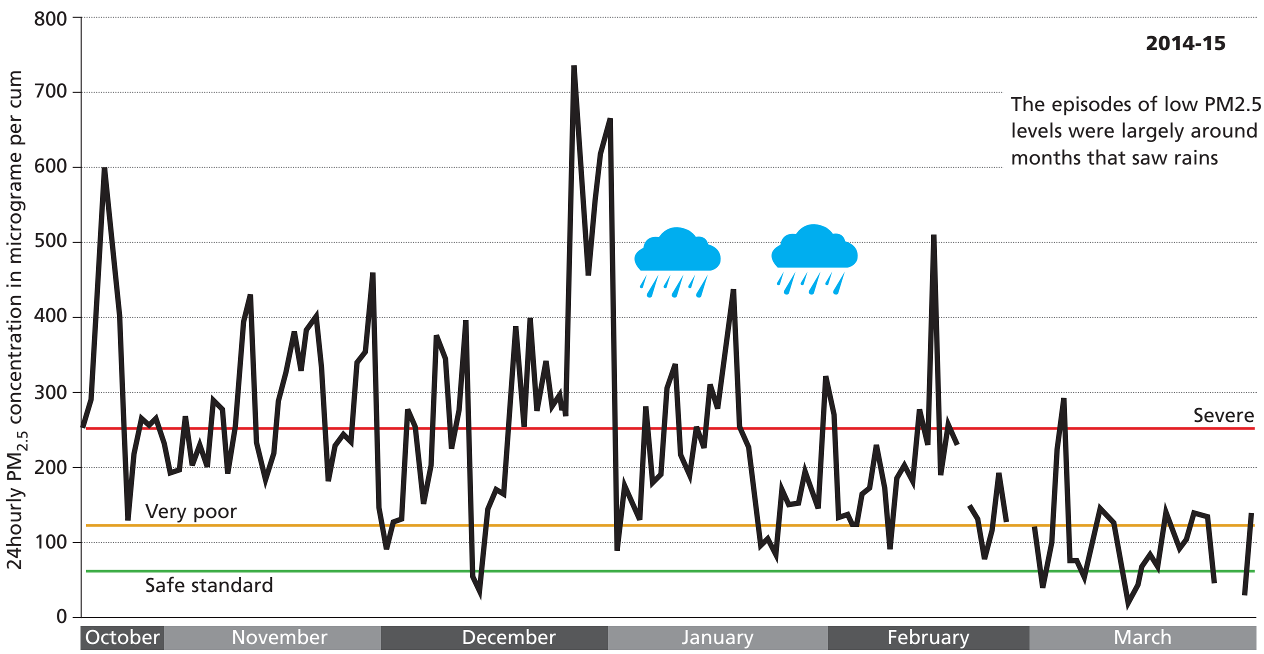
Graph 26: Sustained pollution control measures during the winter helped lower pollution in a systematic fashion

a) ECC and $PM_{2.5}$, 2015–16



Source: CSE based on real-time monitoring data of Delhi Pollution Control Committee

b) Pollution indicators 2014-15



Source: CSE based on real time monitoring data of Delhi Pollution Control Committee

Table 10: Proposed entry points for RFID installation

The new measures will be strengthened by making use of proper technology

No.	Entry point	Highway	Bordering state
1	Kundli	NH–1	Haryana
2	Tikri	NH–10	Haryana
3	Kapasehra	Old NH–8	Haryana
4	Rajokri	NH–8	Haryana
5	Aya Nagar	Mehrauli–Gurgaon road	Haryana
6	Badarpur–Faridabad	NH–2	Haryana
7	Badarpur–Faridabad (Main)	NH–2	Haryana
8	Kalindi Kunj	Noida link road	UP
9	DND	DND	UP
10	Gazipur (Main)	NH–24	UP
11	Gazipur (Old)	NH–24	UP
12	Shahdara (Main)	SH–57	UP
13	Shahdara (flyover)	SH–57	UP

Source: Environment Pollution (Prevention and Control) Authority, 2015, Delhi

Delhi's transport department and MCD will share funds created out of the ECC to fund the implementation of RFID. The Supreme Court, in its 22 August 2016 order, has asked the Delhi government to release Rs 120 crore from the ECC account to SDMC, appointed as the executing agency for the installation of RFID. About 13 key entry points have been identified where RFID installation will be piloted. These entry points bring in as much as 80 per cent of the incoming truck traffic (see *Table 10: Proposed entry points for RFID installation*). The Court has also asked the transport department to give Rs 93 lakh to RITES Ltd to vet the RFID project for implementation.

RFID will not only allow efficient collection of toll but also open up enormous possibility of tracking vehicle operations and performance. This can be further broadened to include all vehicle segments and advance operational aspects of traffic and pollution control in the future.

Controlling overloading of trucks

A major concern in India is overloading of trucks. Even though MoRTH has issued advisories to the state governments from time to time to take action and even considered imposing penalties, there has been no change on the ground situation. Monitoring and enforcement are serious challenges.

Recently, 60 weigh-in-motion bridges have been installed at six entry toll plazas of Delhi, with provisions of penalty and unloading if trucks are found overladen. It is yet to be seen how well these new measures will work because past experience has shown that there is usually a huge implementation gap.

The way forward

Policy and public awareness related to truck pollution will have to be enhanced significantly to accelerate action and protect public health. Trucks are the deadliest source of toxic emissions and fuel guzzling. Several short- to medium-term strategies are needed both at the Central and local level to cut toxic pollution and greenhouse gas emissions from trucks. This will require emissions standards and technology roadmaps to clean up the fleet, urban and regional strategizing of truck movement for spatial planning of commercial hubs, and eco-driving approaches. Overall, structural measures are needed to reduce the modal share of trucks and increase that of railways and waterways. All these strategies—national as well as local—will require time-bound action that is monitored for effectiveness. These measures will require well-defined strategies by the Central government and all state governments.

Action at the Central government level

- Expedite the policy decision to introduce Bharat Stage IV emissions standards nation-wide in April 2017, as already notified by the government.
- Expedite implementation of the Bharat Stage VI emissions standards for vehicles and fuels nation-wide for all vehicles in 2020.
- Ensure that the regulatory provisions and compliance factors for real world emissions performance are implemented as scheduled.
- Implement fuel economy standards for heavy-duty vehicles in 2017.
- Leverage natural gas highways that are being set up to introduce CNG or LNG trucks, as has already been done in Gujarat.
- Develop retrofitment, re-powering strategies and fleet renewal for a targeted on-road fleet of trucks after 10 ppm sulphur diesel is introduced. But this strategy will require regulations and a robust certification and continuous monitoring strategies to ensure these vehicles are delivering on the intended emissions performance.
- Develop time-bound infrastructure and freight pricing policy plan to expand the modal share of railway freight within a targeted a timeframe.

Action at the city level

- Adopt urban planning strategies for spatial reorganization of warehouses, and commercial and business hubs.
- Develop transport strategies to reduce the load of truck traffic inside cities.
- Plan road networks and alignment to divert and bypass transit traffic away from densely populated cities or habitation.
- Adopt fiscal measures to support restrictive truck entry into cities and also to accelerate quicker fleet renewal by taxing the older trucks more.
- Age cap can become necessary if other measures are not in place and the fleet is dominated by very old and polluting trucks.
- Introduce such measures as weigh-in-motion bridges, covered containers etc. to control overloading of trucks. Introduce stringent penalty and unloading facilities in case of non-compliance.
- Adopt green freight programmes and eco-driving requirements.

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