

India Heavy-Duty Fleet Modernization Program—A Scrappage Program Combined with Accelerated Adoption of Bharat Stage VI Emission Standards

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1. Motivation and objectives of the fleet modernization program

Despite the fact that there are far fewer heavy-duty trucks and buses than motorcycles and cars plying the roads in India, heavy-duty vehicles (HDVs) contribute the majority of transportation-related emissions of black carbon (BC), fine particulate matter (PM_{2.5}), and nitrogen oxides (NO_x).¹ Older and/or poorly maintained HDVs can become high emitters, releasing levels of pollution many times higher than other vehicles in their class. These older, high-emitting vehicles are key targets for pollution reduction programs.

Any effective fleet modernization program should make provisions to get rid of the older, higher emitting vehicles in a fleet, including trucks and buses, on an accelerated schedule. Those vehicles should be scrapped and replaced, preferably with HDVs that comply with the most stringent emission standards. In India those standards are Bharat Stage (BS) VI, which will come into effect in April 2020. Implementing the fleet modernization program starting in April 2019 would provide adequate time to create the information and financial systems and infrastructure facilities necessary to scrap old vehicles in an efficient and environmentally sound way. Such a fleet modernization program would not only achieve short-term emission reductions from retiring vehicles, but also would ensure long-term emission reductions by promoting the use of the cleanest new vehicles available.

A fleet modernization program is an ambitious policy requiring major investment for it to be implemented at the

1 Bansal, G., & Bandivadekar, A. (2013) *Overview of India's vehicle emissions control program—Past successes and future prospects*. Retrieved from <http://www.theicct.org/indias-vehicle-emissions-control-program>

national level. To maximize the benefits of the program, policies ranging from periodic vehicle registration to low-emission zones (LEZ) would be needed. The program could begin with a subset of the proposed policies implemented in major urban areas, where similar vehicle emission reduction programs already are being considered, and later could be scaled up to the national level.

The objectives of a heavy-duty fleet modernization program are threefold: to rapidly reduce in-use emissions; to accelerate the transition to newer emission standards; and to closely track and monitor the in-use fleet. Table 1 illustrates these objectives in terms of the Indian fleet modernization program and outlines a number of actions necessary to ensure the program's success.

Table 1. The main objectives and key supporting actions of the Indian fleet modernization program

Objective	Key Supporting Actions
1. Rapidly reduce PM_{2.5} and NO_x emissions from India's heavy-duty vehicle fleet	Inspection and maintenance (I/M) testing
	Financial incentives for the scrappage of high-emitting vehicles
2. Accelerate the transition to BS VI standards and encourage early adoption of vehicles certified to meet these standards	Vehicle excise tax reduction for purchase of BS VI vehicles
	Indirect incentives, such as access to low emission zones and a 5-year I/M test waiver for BS VI certified vehicles
3. Track and monitor the in-use fleet closely and promote local policy efforts	Periodic vehicle registration system
	Labeling system to distinguish cleaner vehicles from dirtier vehicles
	Low-emission zones
	Indirect incentives such as parking privileges

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One possible decision tree for this Indian HDV fleet modernization program is shown in Figure 1. All vehicles would have to be registered in a national database and undergo periodic I/M testing. Each vehicle would be labeled green, yellow, or red depending on the age of the vehicle, the emission standard to which the vehicle was manufactured, and its current emission performance based on I/M testing. Such labeling would facilitate the implementation of LEZs, collection of local environmental compensation charges (ECC), and help fleet owners identify which of their vehicles are eligible for scrappage subsidies.

Vehicles certified to BS VI emission standards would get a 5-year waiver from I/M testing and automatically receive a green label when first registered. Vehicles receiving yellow and red labels would become eligible for a voluntary scrappage program. Owners of yellow- and red-labeled vehicles electing to retire them would receive financial incentives. Red-labeled vehicles that fail the I/M tests twice in succession would be subject to a mandatory scrappage program, but owners would receive financial compensation consistent with the incentives provided in

the voluntary scrappage program. An additional subsidy would be available if the scrapped vehicle were replaced with a new BS VI vehicle.

An estimated 1.4-2.8 million HDVs currently on the road in India would qualify for this type of fleet modernization program. The technology improvement from BS IV to BS VI entails an approximate cost increase of \$1,000-\$1,500 (66,000-100,000 rupees) in India's market.² Thus, full-scale implementation of the program—replacing all HDVs over 10 years of age with vehicles equipped with the cleanest technology and subsidizing the full price difference—will cost \$1.4-\$4.2 billion (9,448 - 27,838 crore rupees). Multiple approaches can support funding of this program, including providing some of the subsidy as a rollback on vehicle excise tax, allocating corporate social responsibility (CSR) funds for clean vehicle subsidies, and seeking funds from multilateral financial institutions.

Various elements of the proposed program as shown in Figure 1 are discussed in detail below.

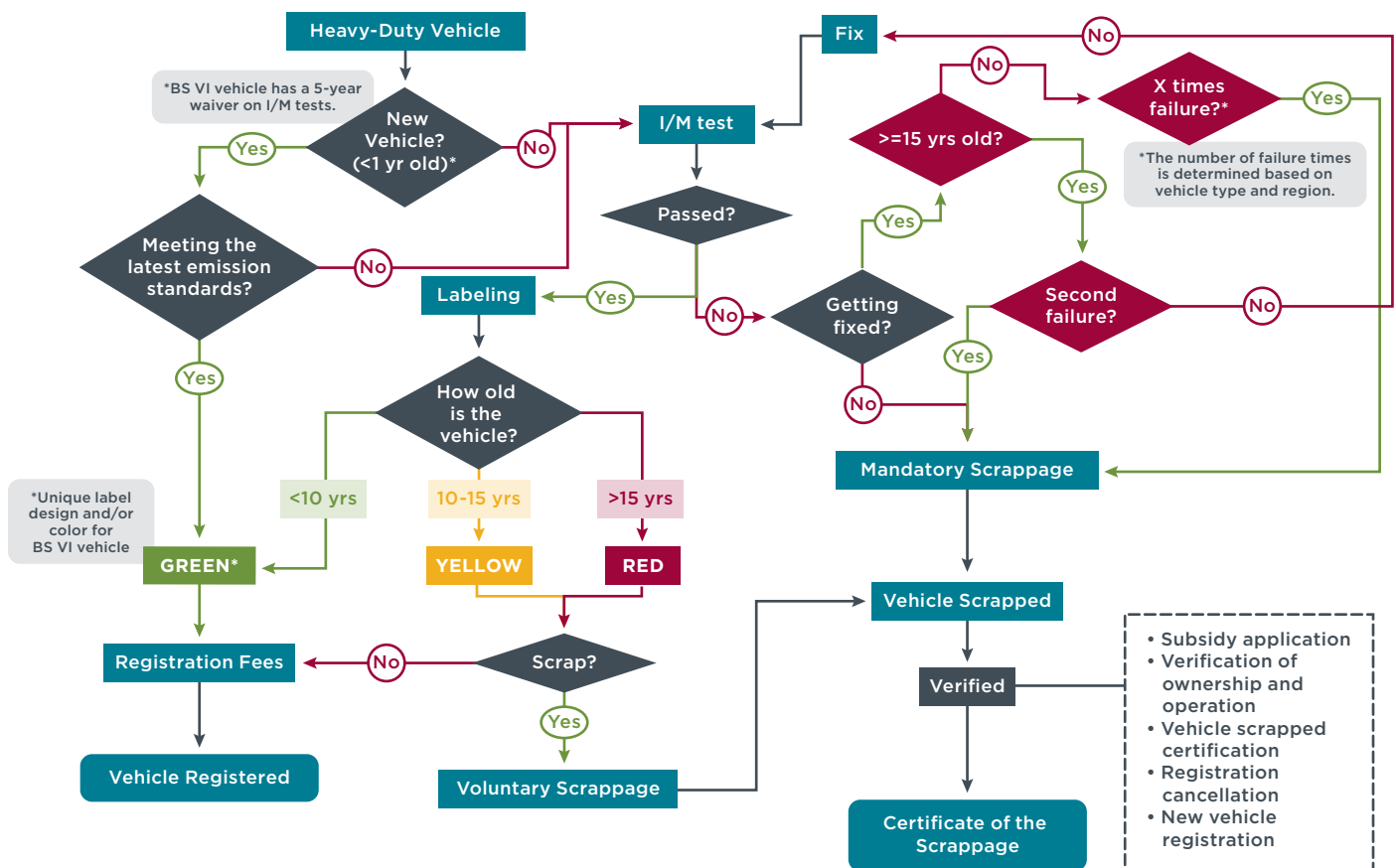


Figure 1. Conceptual chart of the vehicle registration, labeling, and scrappage programs.
 Note: Additional incentives for the purchase of BS VI vehicles are not shown.

2 Posada, F., Chambliss, S., & Blumberg, K. (2016). *Costs of emission reduction technologies for heavy-duty diesel vehicles*. Retrieved from <http://www.theicct.org/costs-emission-reduction-tech-hdvs>

2. Key supporting strategies

2.1 PERIODIC VEHICLE REGISTRATION

Periodic vehicle registration is an essential element of a successful multiyear fleet modernization program. Registration data, including the annual distance traveled by a vehicle, the vehicle's age, and emissions certification level, all support the long-term effort to monitor and control the in-use vehicle fleet and its emissions. The overall success of such a program depends on an effective, centralized system that tracks vehicles in operation, as well as their ownership and location.

The implementation of a national vehicle registration program requires coordination and cooperation across local, state, and national government agencies. Registration data from the Regional Transport Offices (RTOs) must align with the state or national database used to create a transparent, streamlined system. The backbone of such a comprehensive national system already exists in the form of the VAHAN database (<https://vahan.nic.in/>).

The implementation and continuity of the registration program requires significant financial resources, but by implementing owner-paid registration fees, the program could be self-sustaining. Requiring older vehicles to pay higher registration fees also can provide an additional incentive to purchase newer vehicles.³

2.2 INSPECTION AND MAINTENANCE TESTING

In addition to a national registration program, private sector capacity for regular I/M testing (either annual or biennial) for the entire in-use heavy-duty fleet also must be developed. The purpose of the I/M testing component of the fleet modernization program is to identify high-emitting vehicles in the in-use fleet and to ensure that those vehicles are either repaired or retired. In many cases, high-emitting vehicles make up a small share of the fleet but account for a disproportionately large share of total NO_x and PM emissions. In Brazil, for example, it is estimated that 3% of HDV account for 46% of HDV NO_x emissions and 45% of PM emissions.⁴ In Hong Kong it is estimated that 19% of HDVs are high emitters, producing

70% of NO_x emissions and 91% of PM emissions.⁵ A well-designed I/M program allows for targeted repair and replacement of high-emitting vehicles. Vehicles failing an I/M test must be repaired to continue operating, and multiple test failures for old vehicles should result in forced non-operation.

The initial phases of an I/M program should focus on identifying the highest emitting older vehicles, but the program also should be adjusted over time to account for the retirement of the oldest vehicles and the influx of more vehicles meeting BS IV standards and beyond. Adjustments likely would include a change in test procedures,⁶ and perhaps a reduction in the frequency of testing for BS VI vehicles, as well as an increase in the test frequency for older vehicles.

To ensure standardization and to avoid any appearance of impropriety, I/M testing should be conducted by privately owned, specialized test-only facilities.⁷ All employees authorized to conduct tests should be required to undergo a training program developed in collaboration with the vehicle industry, and certified by the National Skill Development Corporation (NSDC). A separate training and certification program should be developed for facility inspectors who are employees of the state pollution control boards and/or the RTOs, and who conduct periodic unannounced inspections of the testing facilities.

To avoid repairs that simply create a temporary fix, rather than providing robust maintenance, maintenance services should not be performed at the same facility that administers the test. Failure to repair and retest the vehicle within one month (as indicated by an absence of a color coded label—see below) should result in instant expiration of the current registration, and the vehicle should not be

3 This is consistent with the cut-off age proposed by the automotive industry on end-of-life vehicle (ELV) draft standard, which suggests "Motor Vehicle Insurance could be increased progressively with the age of the vehicle." (Automotive Research Association of India (ARAI). (2014, September). *Draft: Automotive Industry Standard, End of Life Vehicles*. Retrieved from https://araiindia.com/hmr/Control/AIS/811201443718PM3_Draft_AIS-129_F4_Aug_2014_ELV.pdf)

4 Ministry of the Environment (Brazil). (2011). *Primeiro inventário nacional de emissões atmosféricas por veículos automotores rodoviários. Executive summary (in Portuguese)*. Retrieved from http://www.mma.gov.br/estruturas/163/_arquivos/inventario_veicular2010_163.pdf

5 Hong Kong Environmental Protection Department (HKEPD). (2013). *Hong Kong air pollutant emission inventory (in English)*. Retrieved from http://www.epd.gov.hk/epd/english/environmentinhk/air/data/emission_inve.html

6 Currently, the most common testing procedure worldwide is the Society of Automotive Engineers (SAE) J1667 Recommended Practice, "Snap Acceleration Smoke Test Procedure for Heavy-Duty Diesel Powered Vehicles," which is similar to the free acceleration test used in India. This test measures smoke opacity during engine acceleration. It is a roadside test and thus does not need a chassis dynamometer, but it has several major shortcomings, for example, it does not measure NO_x, and it measures smoke opacity rather than particulate matter. Opacity itself is not well correlated with PM, so PM emission levels are predicted from CO and total hydrocarbon measurements. This test can identify gross emitters among diesel vehicles equipped with older technology, however it is not an effective test for newer (BS IV and better) diesel vehicles. It may be appropriate as an interim test procedure while the infrastructure for more sophisticated testing, such as that using remote sensing, and/or on-board diagnostics, is being developed.

7 U.S. Agency for International Development USAID (2004). *Vehicle inspection and maintenance programs: International experience and best practices—a report for the Office of Energy and Information Technology, prepared by PA Government Services*. Washington DC: PA Government Services.

allowed to operate until it has been reregistered. If the vehicle has not been reregistered within the grace period, the owner should face additional fees for late registration, or a planned non-operation of the vehicle.

2.3 LABELING SYSTEM

Color coded labels can provide a simple signal to vehicle owners, inspectors, and other members of the public of how high a vehicle's emissions are, and whether the vehicle is eligible for scrappage subsidies and/or liable for an environmental compensation charge (ECC). The labels can also be used to enforce driving restrictions at the city or regional levels, and to check compliance with the I/M requirements. Such labels must be clearly displayed in a vehicle's windshield to show that the vehicle's registration is current and to provide a clear visual sign of the vehicle's age and emission standard. In general, vehicles less than 10 years old should be given green labels, vehicles between 10 and 15 years old should be given yellow labels, and vehicles over 15 years old, as well as any vehicles that have failed an I/M test but have been issued a waiver, should be given red labels.

Additional signs and designs can be added to provide detailed vehicle status. For example, Beijing, China, uses different shades to show each level of emission standard that a green-labeled vehicle meets,⁸ and uses blue coloring to identify those vehicles that meet China 5/V emission standards (equivalent to Euro 5/V in the European Union).⁹ At the national level, China has implemented a similar labeling system to streamline the process of identifying and removing high emitters from its in-use fleet. Yellow labels distinguish all gasoline vehicles not meeting China 1/I standards (equivalent to Euro 1/I in Europe), and diesel vehicles not meeting China 3/III standards (equivalent to Euro 3/III in Europe). The Chinese government has set a goal to retire all yellow-labeled vehicles by the end of 2017.¹⁰ If this system were to be adopted in India, a BS VI vehicle would be assigned an additional symbol, such as a star (★) or a blue label, to distinguish it. Vehicles that fail I/M tests, but are granted by waivers would be assigned with a red label with bold cross (X) for potential driving restrictions. This system, or one of similar designs, would conveniently allow for local governments to implement an incentive program that allows or restricts

8 The green label is issued for LDVs qualified between China 1 and China 4 emission standards, and HDVs qualified for China III and China IV emission standards.

9 Yang, Z., Wang, H., Shao, Z., & Muncrief, R. (2015). *Review of Beijing's comprehensive motor vehicle emission control programs*. Retrieved from <http://www.theicct.org/review-beijing-motor-vehicle-emission-control>

10 State Council, China. (2013, June 14). *Ten measurements of atmospheric pollution prevention. Action Plan (in Chinese)*. Retrieved from http://www.gov.cn/dhd/2013-06/14/content_2426237.htm

access to certain city streets and areas, special parking privileges, as well as a highway toll reduction for vehicles meeting the most stringent vehicle standards.

2.4 SCRAPPAGE PROGRAM WITH ACCELERATED BS VI IMPLEMENTATION

The objective of the fleet modernization program is to simultaneously take gross emitters and other targeted vehicles off the road and to accelerate introduction of vehicles complying with BS VI emission standards. Although HDVs account for less than 3% of the vehicle market in India, they contribute more than 55% of the BC, 60% of the PM, and 70% of the NO_x emissions, with most of that coming from vehicles more than 10 years old (see footnote 1). Older vehicles have much higher emission rates than newer vehicles, as they are equipped with limited emission control technology, if any, and may be poorly maintained.

Details of an HDV scrappage program, a strategy for accelerating fleet turnover, and a description of additional supporting mechanisms are included in the following sections.

2.4.1 Program structure

The proposed scrappage program has both mandatory and voluntary components. Red-labeled HDVs (more than 15 years old) that fail the I/M tests twice in a row (i.e., even after repairs) would not be eligible for registration and would have to be scrapped.¹¹ Yellow-labeled HDVs (10-15 years old), other red-labeled vehicles that pass the I/M tests, and any vehicles that fail the I/M tests with no intention of repairs would be eligible for a voluntary early retirement program.

The greatest emission reductions from scrapping old HDVs will result from encouraging their replacement with vehicles equipped with the cleanest technology available, in this case BS VI compliant vehicles. However, the cost of a BS VI vehicle exceeds that of a BS IV vehicle due to the use of a diesel particulate filter (DPF) to meet BS VI standards. While the BS VI HDVs are also likely to have newer engine technology, and as a result to have a more competitive fuel consumption performance, the cost increment due to the addition of a DPF may deter consumers from purchasing BS VI vehicles ahead of the implementation of mandatory BS VI standards. This resistance could be overcome with additional economic incentives.

Due to high per-vehicle activity, buses are key targets for urban fleet modernization programs. Unlike freight

11 ARAI's ELV draft standard suggests the fleet modernization program should encompass all vehicles registered before 2000 (see footnote 3)

vehicles, buses are used in cities primarily during the daytime, precisely where and when the general public is most present. Due to the potential impact on public health, it should therefore be a priority to have the bus fleet move toward BS VI emission control technology as early as possible. At the same time, because buses are a major source of public transportation, the scrappage program should aim to not cause major interruptions in bus service.

2.4.2 Mandatory scrappage, waivers, and exceptions

Any vehicle less than 15 years old that continues to fail I/M tests after repairs have been performed should be scrapped, and the vehicle owner should be compensated. The program should specify a maximum number of consecutive test failures allowed, or a maximum time window for repairs beyond which scrappage is mandatory. The number of failures leading to mandatory scrappage should be determined by the program implementation officials based on vehicle type and region. In China's Guangdong province, for example, vehicles failing to receive vehicle I/M qualified labels in three consecutive vehicle inspection cycles after a valid inspection face mandatory non-operation or scrappage.¹² Additional and more frequent I/M tests may be required for older vehicles, such as those over 20 years old. This practice is seen in Mexico, as well as key regions in China, where multiple I/M tests—two to four tests each year—are a requirement for older in-use HDVs. Implementing these additional testing requirements serves as a way to consistently monitor the condition of older HDVs, and also can help accelerate the earlier retirement of older vehicles and introduce newer, lower-emitting vehicles into the fleet.

Mandatory scrappage requirements may be phased in after the subsidized fleet modernization program. All yellow- and red-labeled HDVs—those over 10 years old—will then be subjected to mandatory retirement, or DPF retrofit due to their high emission rates. Announcing this mandatory scrappage/retrofit plan early enough, namely along with the fleet modernization program, can help vehicle owners plan ahead regarding their old vehicles, leading to a higher participation rate during the voluntary phase of the scrappage program.

A scrappage program should avoid placing an undue burden on key service providers (e.g., garbage collectors) and small-scale owner-operators. To lighten the burden of the program, exceptions to mandatory scrappage requirements and special-case vehicle labels can be

specified for some classes of vehicles.¹³ As an example of such an exception, a program could include an upper limit on the cost of repairs for vehicles failing a specified number of I/M tests. If the owner provides proof that the vehicle has been repaired but still does not pass the test, and that additional repairs would cost more than a certain limit, their vehicle may be eligible for a waiver. Such a waiver would allow the vehicle to continue operating, but would stipulate that the vehicle pass an I/M test before being sold. In addition, the vehicle would be given a special red label at registration, regardless of its age. As a result, the red-labeled vehicle would be denied entrance into low emission zones or face further local restrictions.

2.4.3 Dismantling of retired vehicles

Having proper enforcement of the full destruction of scrapped vehicles determines whether these retired vehicles actually are removed from the in-use fleet with the necessary dismantling, or just removed on paper. It is recommended that a third party verify that the destruction facilities are scrapping these vehicles according to government-specified standards. Dismantling facilities would have a legal responsibility to ensure that the engines are destroyed properly, with all hazardous materials removed and disposed of in an environmentally friendly manner. Fines and legal recourse should be enforced for those not complying with destruction requirements. Without proper oversight there is a high likelihood that high-emitting vehicles would continue operating and generating substantial emissions, in spite of the efforts invested in the fleet modernization program. Detailed review and recommendations on India's dismantling industry can be found in recent reports developed by Chintan and GIZ, in collaboration with the Central Pollution Control Board (CPCB).¹⁴

12 Yang, Z., Qiu, Y., & Muncrief, R. (2015). *Review and comparative analysis of in-use vehicle emission control programs in Guangdong province*. Retrieved from http://www.theicct.org/sites/default/files/publications/ICCT_Guangdong_in-use-pgms-rvw_20150629.pdf

13 California offers exemption for low-use vehicle from its engine-upgrade requirements. The low-mileage truck is the one that operates less than 20,000 miles per calendar year within California borders. Eligible trucks will need to be labeled with special labels on each door. (California Air Resources Board. (2015). *Truck and bus regulation: low-mileage work truck option*. Retrieved from <http://www.arb.ca.gov/msprog/onrdiesel/documents/faqconstructiontrucks.pdf>)

14 Chintan Environmental Research and Action Group. (2012). *The story of a dying car—understanding the economic and materials flow of End-of-Life vehicles*. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, New Delhi. Retrieved from http://www.chintan-india.org/documents/research_and_reports/ELV-Report.pdf; Ministry of Environment Forests and Climate Change. *Guidelines for environmentally sound management of end-of-life vehicles (ELVs)*. Government of India. Retrieved from http://cpcb.nic.in/upload/Latest/Latest_113_Draft_Guidelines_ELV-1_.pdf; Central Pollution Control Board. (2015, August). *Analysis of end of life vehicles (ELVs) sector in India*. Retrieved from http://cpcb.nic.in/upload/Latest/Latest_114_AnalysisOfELVsInIndia1_.pdf

2.4.4 Incentives

Incentives should be provided to all eligible participants—owners of yellow- and red-labeled vehicles—who scrap their vehicles, and consumers who are interested in purchasing BS VI vehicles. Financial incentives should include subsidies for scrapping vehicles, and additional benefits beyond covering the cost difference between a BS VI and BS IV vehicle. Potential regional and city-level incentives for BS VI vehicles could also be phased in. Indirect financial incentives—complementary policies—are designed to further motivate the interested consumers to participate the program, and potentially promote the BS VI vehicles in the long-term. Table 2 lists the proposed incentives (financial and non-financial) for the program.

Table 2. Expected incentives for consumers

	Levers	Proposed Scheme
Direct subsidies	Scrappage credits	Direct cash incentives for scrapping qualified vehicles; Additional price discounts when purchasing BS VI vehicles; Credits can be transferred with value determined by market forces.
	Tax reduction	One time tax reduction (3%-6%) for all BS VI purchasers; Higher tax reduction rates for bus fleet.
Indirect subsidies	I/M waiver	A 5-year waiver on I/M tests for BS VI vehicles.
	Driving limitations	Free access to low emission zones (LEZs); Private buses are allowed to enter core urban areas.
	Others	Parking privileges; Other city level incentives.

2.4.4.1 DIRECT SUBSIDIES

Direct financial incentives typically are the most attractive element for consumers who are willing to participate in a fleet modernization program. This incentive should be given either in the form of a cash incentive provided when a vehicle is scrapped, or coupled with a price reduction provided for the purchase of a qualified vehicle. Subsidies should be allocated throughout the duration of the scrappage program or until the subsidies are exhausted.

Any consumer who purchases a BS VI vehicle in the first 3 years of the program should qualify for a one-time excise tax reduction, regardless of their participation in the scrappage program. The rollback of the tax could be set at around 4% (a plausible range is 3% to 6%) to remove the barrier of high capital costs when purchasing a BS VI vehicle.

The combined direct financial subsidies—scrappage credits and excise tax reduction—should be of sufficient value to cover the price gap between vehicles currently offered BS IV models and those equipped with BS VI emission control technology. Experience in China suggests that the response rate for this type of program is low if the total subsidies are less than 10% of the price for new HDVs.¹⁵

Offering higher direct subsidies to bus operators may accelerate the uptake of BS VI buses. However, funding sources and the incentive structure may be different for municipal fleets than for private owner-operators of freight vehicles and buses.

In addition to the national program, states and cities could offer additional incentives to promote a rapid switchover to BS VI vehicles. For example, Delhi's environmental compensation charge (ECC)¹⁶ could be waived for BS VI vehicles to encourage vehicles to be as clean as possible.

Appropriate language should be added in the fleet modernization program notification to prevent gaming of the system. For example, vehicles that participate in the scrappage program would have to be owned and operated within the country for at least 1-2 years to qualify for a scrappage credit to avoid vehicles being imported for the specific purpose of gaining cash incentives. To maximize the effectiveness of the program, vehicles presented for scrappage also would have to be proven to be operable. In other words, a vehicle must be in good working order, must drive to a scrappage site on its own, and must have a minimum number of working parts. This would ensure that the subsidies would be applied toward retirement of in-use vehicles, rather than inoperable ones.

2.4.4.2 SCRAPPAGE CREDITS

Vehicle owners who scrap their vehicles, whether voluntarily or by mandate, should be eligible to receive scrappage credits in lieu of cash payment. The credits could be based on the vehicle type and age, or could be a fixed amount, with higher credits suggested for buses. The credits should be fully transferable to other qualified parties.¹⁷ This paired scrappage and purchase incentive follows one of the best practices in vehicle scrappage programs: **scrapped vehicles should be replaced by the**

15 Staff interview with experts from the Vehicle Emission Control Center of the Ministry of Environmental Protection, China.

16 PTI. (2015, November 6). "Trucks entering Delhi to pay green tax from tonight." *The Economic Times*. Retrieved from http://articles.economictimes.indiatimes.com/2015-11-06/news/68071645_1_sdmc-toll-tax-green-tax

17 The qualifications of these parties can vary from region to region. The Indian government can set the rules to encourage small fleet owners, as they are generally more sensitive to price differences. Detailed suggestions on the eligibility are elaborated in the following sections.

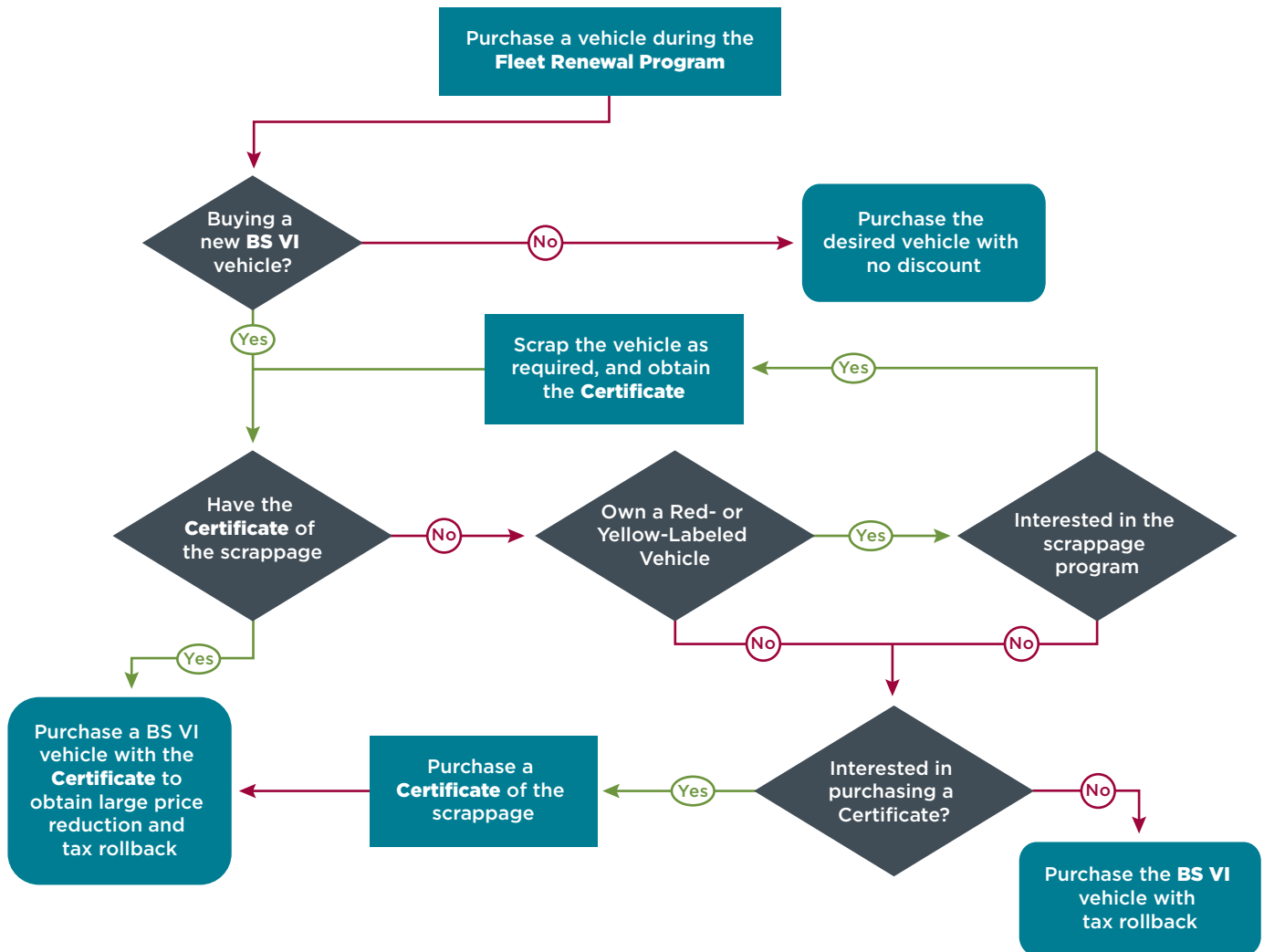


Figure 2. Purchasing procedure for consumers who plan to buy BS VI heavy-duty vehicles using scrappage credits and other direct subsidies during the fleet modernization program.

cleanest vehicles possible¹⁸—in this case, meeting BS VI standards. Figure 2 lays out the procedure of using the scrappage credits and other direct subsidies to purchase a new BS VI HDV during the fleet modernization program.

To help ensure that scrappage increases demand for BS VI vehicles, the full scrappage subsidy should be tied to new BS VI vehicle purchases. Some owners who elect to participate in the scrappage program may prefer to buy a used vehicle rather than a new vehicle. By offering the flexibility of transferable credits, these parties can still obtain a portion of the scrappage credit, and more importantly, BS VI vehicles can still be made financially attractive to other parties who have an interest in purchasing them. These credits should expire within a certain time window

(e.g., one year from scrappage) in order to stimulate the demand for BS VI vehicles.

Preferential treatment could be offered to small-fleet owners, as they will be more sensitive to the price difference between BS IV and BS VI vehicles. For example, the percentage of tax rollbacks could be set slightly higher for those owners of fleets with less than five vehicles. These direct financial subsidies could largely remove concerns regarding the high initial cost brought on by the BS VI emission control technology.

2.4.4.3 INDIRECT SUBSIDIES

Indirect financial incentives are complementary policies that offer additional privileges to consumers and give them incentives to purchase BS VI vehicles. These indirect financial incentives can serve as restrictions for the oldest, high-emitting vehicles in the fleet, forcing owners into trading in for a qualified vehicle. These types of incentives

¹⁸ Posada, F., Wagner, D., Bansal, G., & Fernandez, R. (2015). *Survey of best practices in reducing emissions through vehicle replacement programs*. Retrieved from <http://www.theicct.org/vehicle-replacement-program-best-practices-mar2015>

sometimes can be a deciding factor in tilting consumer preference toward the cleanest (BS VI) vehicles.¹⁹ Additionally, indirect financial incentives can continue beyond the subsidized scrappage program.

Cities should be encouraged to develop aggressive indirect subsidies to limit the use of high emitters in core urban areas. In China, for example, Beijing has implemented stricter driving limitations and more frequent I/M tests for older vehicles, beyond the national requirements (see footnote 9). In India, such a complementary policy could discourage continued use of older vehicles. By contrast, BS VI vehicles could be given free access to LEZs and a 5-year waiver on I/M tests.

In addition, complementary policies may provide extra incentives for bus operators. For example, cities may allow only BS VI certified private buses to enter core urban areas while restricting the entry of older buses to outside areas, thus further encouraging the transition to BS VI vehicles.

2.4.5 Timeline

To obtain the greatest effect, a fleet modernization program should be launched in India in April 2019, coinciding with the scheduled availability of 10 parts per million (ppm) fuel in northern India.²⁰ This would ensure that the emission control devices on BS VI vehicles could perform optimally. Note that all BS VI vehicles also can be operated using 50 ppm sulfur fuel, which is the BS IV fuel standard, but the emissions performance of such vehicles will be suboptimal.

A fleet modernization program providing direct and indirect subsidies should be designed to last four years, ending concurrently with the second year of the full phase-in of BS VI (March 2023).²¹ Approximately 1.2-2.4 million old HDVs could be scrapped from the fleet by running such a program between April 2019 and March 2023. The reduced excise tax treatment should only be provided within the designated 4-year window to ensure a smooth transition to BS VI standards. Stronger subsidies offered in a short time frame help incentivize early action, with the goal of retiring these targeted HDVs as early as possible.

19 Shao, Z., & Wagner, D. (2015). *Costs and benefits of motor vehicle emission control programs in China*. Retrieved from <http://www.theicct.org/costs-and-benefits-motor-vehicle-emission-control-programs-china>

20 The International Council on Clean Transportation (ICCT). (2013). *Policy summary: India's vehicle emission control program*. Retrieved from http://www.theicct.org/sites/default/files/publications/ICCT_Briefing_IndiaPolicySummary_20130703.pdf

21 Ministry of Road Transport and Highways. (2016). *BS VI notification*. Gazette of India. Retrieved from <http://egazette.nic.in/WriteReadData/2016/168300.pdf>. Assuming April 2020 for new type approvals and April 2021 for all models.

The scrappage program with reduced subsidies can continue for additional two years (until March 2025) with the goal of continuously removing the highest-emitting vehicles from the in-use fleet. Approximately 0.26-0.35 million old HDVs could be scrapped from the fleet by running such a program between April 2023 and March 2025.

Eventually, non-subsidized mandatory scrappage should be phased in for all red- and yellow-label HDVs. For example, starting from April 2025, red-label vehicles (>15 years old) may not be allowed to register or operate in India, indicating no pre-BS III vehicles allowed on the road. The same rule will apply to all yellow-label HDVs (>10 years old) in two years, indicating no more pre-BS IV²² vehicles allowed from April 2027 onwards, unless they are fitted with a diesel particulate filter (DPF). A subsidized DPF retrofit program can be introduced for qualified yellow-label HDVs (see more details in later section), offering a cost-effective alternative for those vehicles maintained in good condition to continue operating.

Indirect financial subsidies and regional driving restrictions can continue beyond the recommended schedule until all BS III and earlier models are fully retired or retrofitted.

The timeline should be coordinated with other pilot programs initiated at the regional level, such as BS VI early adoption and/or LEZs. States and cities with plans to implement BS VI standards ahead of the national timeline can start to scrap vehicles sooner. For example, leading regions like Delhi could move along more aggressively than the national timeline of BS VI standards. A staggered introduction of the scrappage and accelerated BS VI adoption scheme with early implementation of the fleet modernization program in leading cities and regions, namely Delhi, Maharashtra, West Bengal, Tamil Nadu, Karnataka, Gujarat, Telangana, and Seemandhra,²³ could help alleviate the administrative burden of launching such a large-scale, nationwide program. In further consideration of the logistical challenges involved in implementing a somewhat complex program for vehicle registration, testing, and subsidy provision, the planned national phase-in could set different deadlines for vehicles of different types or weight classes to balance the number of vehicles processed during a given period.

2.5 LOW EMISSION ZONES

A low emission zone (LEZ) is an area where certain vehicles are prohibited from traveling, or may only enter during

22 Based on current timeline, all HDVs less than 10 years old in April 2027 are manufactured in 2017, when BS IV emission standards are implemented nationwide in India.

23 Suggested by the ARAI ELV draft standard (see footnote 3).

designated times. In many cases the vehicles restricted from these zones are heavy-duty trucks, vehicles not meeting certain emission standards, or older vehicles equipped with little or no emission control technology. Many LEZs do not ban these vehicles outright, but collect fees or taxes when restricted vehicles enter these areas. Cities in China and Europe have actively adopted this strategy to deter high-emitting vehicles from driving in core urban areas, where population density and traffic flow are high.

Cities and states in India already are taking early steps toward implementation of LEZs. The National Green Tribunal Delhi ordered diesel vehicles over 10 years old off its streets starting in April 2015.²⁴ Subsequently, the Supreme Court of India has temporarily banned sales of diesel passenger vehicles with engine sizes larger than two liters across the National Capital Region, stopped certain commercial vehicles from entering Delhi, and imposed an environmental compensation charge on other vehicles.²⁵ Pune Municipal Corporation is considering establishment of vehicle free zones in the central part of that city.²⁶

When planning for LEZs, cities should ensure that the proposed zones would cover a large enough area to have a significant impact on citywide vehicular emissions. The size and number of LEZs will affect the efficacy of any such policy. The LEZs in European Union member states have proved to be large enough to lead to considerable driving restrictions for high emitters. With large urban LEZs in multiple cities, the total LEZ area in India may be great enough to influence truck and bus owners and operators to trade in their older vehicles for vehicles that would be permitted to enter these restricted zones.

Learning from China's experience, major cities and regions should act together in creating LEZs. Almost all major cities in China have banned yellow-labeled vehicles, at least during daytime hours, to accelerate the country's aggressive scrappage program. While Delhi's move to restrict certain types of vehicles²⁷ is significant, it is not enough to see that India as a whole makes the early

transition to BS VI HDVs. Such a transition would require that the majority of cities and states in India establish LEZs, and in turn force owners of high-emitting vehicles to actively respond to the scrappage program.²⁸

Enforcing LEZs can be difficult, but tends to improve once a labeling system has been established. One approach that has been effective is to restrict all red-labeled vehicles from LEZs entirely, and all yellow-labeled vehicles during the daytime.²⁹ Limiting red- and yellow-labeled vehicles from the LEZs tends to reduce the overall number of high emitters entering the city. Particularly during the daytime, when the public pursues more activities along roadways, emissions from high-emitting vehicles could be largely avoided. LEZ restrictions also can be extended over time to ban yellow-labeled vehicles all day long and to also limit the access of some older green-labeled vehicles.

Defining the restricted vehicles using a labeling system simplifies enforcement. Police and highway patrol officers can easily identify violators through the label affixed to the windshield. Even the public could notice these labels and report violations. Incorporating radio frequency identification (RFID) digital technology in the labels, cameras can be used to check for noncompliance making enforcement even more efficient.

2.6 PUBLIC OUTREACH

Public outreach is a key element in determining the success of government programs like fleet modernization. Well-informed owners typically are more willing to retire their older vehicles earlier, and even upgrade to better-performing vehicles—BS VI in this case—if they have information on the program details and the incentives being offered. A national fleet modernization program should therefore include a comprehensive public education component to target and engage potential participants. One good approach would be to offer workshops, advertisements, and informational written materials at a regional level to raise public awareness surrounding the fleet modernization program. Any outreach program should be tailored carefully to target potential participants and interested groups including truck drivers.

24 Hindustan Times. (2015, April 7). "Green tribunal bans all diesel vehicles over 10 years old in Delhi." *Hindustan Times*. Retrieved from <http://www.hindustantimes.com/chunk-ht-ui-indiasectionpage-topstories/ngt-bans-all-diesel-vehicles-over-10-yrs-old-in-delhi-and-adjoining-cities/article1-1334769.aspx>

25 Shah, Aditi (2015, December 16). "To clean air, Supreme Court bans sales of big diesel cars in Delhi." *Reuters*. Retrieved from <http://www.reuters.com/article/india-autos-pollution-idUSKBN0TZ0GS20151216>

26 TNN. (2016, January 16). Pune Municipal Corporation plans vehicle free zones. *The Times of India*. Retrieved from <http://timesofindia.indiatimes.com/city/pune/Pune-Municipal-Corporation-plans-vehicle-free-zones/articleshow/50634710.cms>

27 Principal Bench, New Delhi. (2015). *Before the National Green Tribunal*. Retrieved from <http://www.greentribunal.gov.in/Writereaddata/Downloads/21-2014%28PB-I%29OA11-12-2015.pdf>

28 In the move imitating the Supreme court decision in the NCR, the National Green Tribunal circuit bench in Kochi has decided to ban registration of diesel cars with engines larger than 2L across Kerala and restricted the plying of diesel vehicles older than 10 years in cities like Thiruvananthapuram, Kollam, Kochi, Thrissur, Kozhikode and Kannur. Directives such as these are likely to further encourage participation in a fleet modernization program. <http://m.thehindu.com/news/ngt-bans-diesel-vehicles-over-10-years-in-6-cities-in-kerala/article8637121.ece>

29 Beijing introduced driving restrictions on HDVs, with nonlocal trucks only allowed in the Sixth Ring Road from midnight to 6 a.m. In addition, yellow-label vehicles registered outside Beijing are restricted from the city entirely (see footnote 9).

2.7 OTHER SUPPORTING PROGRAMS

Numerous supporting programs can be conducted concurrently with a fleet modernization program to enhance its effectiveness. These include remote sensing, spot-checking, public spotters, and retrofits.

Remote sensing and spot-checking commonly are set up along the roadside to track the general fleet's average emission trend. They can be used as supplemental measurements to capture the high emitters on the road, although these methods may not be accurate in evaluating individual vehicle emission levels. Using these tools along with I/M tests offers additional measurements to identify any potential violators on the road. Spot-checking campaigns can be used to evaluate the effectiveness of the fleet modernization program, as well as other potential emission reduction programs in the future.

A public spotter program allows members of the public to report on-road violators and generally requires little or no incentive to be effective. With the growing awareness of pollution coming from vehicles, the public will be more willing to actively report the license plate numbers of vehicles emitting visible smoke³⁰ and red- and yellow-labeled vehicles driving in the LEZs outside permitted hours. Based on the vehicle's registration information, vehicle owners can be tracked, penalized, and required to repair their vehicles. This program has been widely adopted in many other regions, including city Shenzhen (Guangdong province),³¹ city Qingdao (Shandong province),³² and Hong Kong³³ in China and California³⁴ in the United States.

Governments may choose to allow emission control retrofits for a limited set of vehicles meeting specific criteria. Such retrofits involve adding emission control devices—particularly Diesel Particulate Filters (DPFs)—that significantly reduce tailpipe emissions and can be operated at the same time as a scrappage program if the chassis condition is good condition. Retrofit programs often are launched on a small scale and voluntarily, because they have stricter requirements for qualifying vehicles (see footnote 30). When vehicles have a reasonable remaining service life before retirement,

usually considered to be more than 3 to 5 years, retrofit can be offered as an option, especially when fleet owners are reluctant to retire their HDVs. However, retrofitting vehicles requires a strong engineering-intensive procedure to avoid damage and ensure durability, in addition to a monitoring regime to ensure good post-retrofit emission performance. Therefore, a subsidized national retrofit plan should be launched only after scrapping the older and more polluting vehicles first to ensure that the retrofits are cost effective.

3. Quantitative analysis

We evaluate emission reductions and corresponding public health benefits of a proposed fleet modernization program over four scenarios. The objective is to clearly illustrate the impacts from existing policies, as well as those from early implementations of BS VI emission standards and a scrappage program.

The four scenarios represent different policy steps and include a *reference* scenario assuming BS IV only from 2017; an early adoption of BS VI (*leapfrog* scenario) (see footnote 21); an early adoption of BS VI with an improved compliance and enforcement program (*leapfrog compliance* scenario); and a fleet modernization program (*leapfrog scrappage* scenario), which combines BS VI early implementation and a scrappage program.

3.1 SCENARIOS

The *reference* scenario assumes India would not adopt any stringent emission standard beyond 2017 BS IV implementation as scheduled.

Due to the severity of its current air quality issues, the Union Government of India has issued a draft notification to leapfrog to BS VI standards on a more aggressive timeline, as currently proposed to 2020. This is set as the *leapfrog* scenario. Further enhancing the compliance and enforcement program would achieve an even greater improvement from the early adoption of BS VI by more effectively removing the high emitters from the in-use fleet. That approach is modeled as the *leapfrog compliance* scenario.

The fourth scenario, *leapfrog scrappage*, models the combined policy efforts of both leapfrogging to BS VI and a 6-year HDV scrappage program running from April 2019 to March 2025. In this scenario, we assume all red- and yellow-labeled vehicles would be retired immediately from the in-use fleet once they have met the scrappage program (age) criteria, regardless of whether

30 Wagner, V., & Rutherford, D. (2013). *Survey of best practices in emission control of in-use heavy-duty diesel vehicles*. Retrieved from http://www.theicct.org/sites/default/files/publications/ICCT_HDV_in-use_20130802.pdf

31 Shenzhen Human Settlements and Environment Commission of Shenzhen Municipality. Retrieved from http://www.szhec.gov.cn/ywzsk/msrdl/201601/t20160129_98205.htm.

32 Qingdao Environmental Protection Bureau. Retrieved from <http://www.qepb.gov.cn/m2/online/onlineJb/view.aspx?yj=4&m=145>.

33 Hong Kong Government. Retrieved from <http://www.gov.hk/tc/residents/environment/public/enquiries/logpollutioncomplaint.htm>.

34 California Air Resources Board. Retrieved from <http://www.arb.ca.gov/enf/complaints/smoke.htm>.

it was voluntary or mandatory.³⁵ We expect half of the consumers who scrap their qualified old HDVs would participate in the program to purchase new vehicles equipped with the latest technology—BS VI qualified in the fiscal year from April 2019-March 2020—either directly or indirectly, as some of them may transfer their credits to others who are interested. For various reasons it is expected that the other half still would prefer to purchase new BS IV vehicles. After the first year, all participants will purchase BS VI vehicles directly or indirectly due to the full implementation of the standards at nationwide.

The enforcement and compliance will be improved with the requirements stated in BS VI standards, along with the introduction of various in-use testing methods. Meanwhile, the successful removal of red- and yellow-labeled vehicles will cause the share of high-emitting vehicles from the in-use fleet to drop. The detailed assumptions and timeline are presented in Table 3.

Table 3. The four quantitative benefits scenarios

Scenario	BS IV implementation	BS VI implementation	High emitters on the road
Reference	<ul style="list-style-type: none"> • 2016 in key states • 2017 nationwide 	n/a	15% of vehicle fleet
Leapfrog	<ul style="list-style-type: none"> • 2016 in key states • 2017 nationwide 	2020	15% of vehicle fleet
Leapfrog compliance	<ul style="list-style-type: none"> • 2016 in key states • 2017 nationwide 	2020	Reduced to 12.5% of vehicle fleet by 2023 and 10% by 2025
Leapfrog scrappage (from April 2019 - March 2025)	<ul style="list-style-type: none"> • 2016 in key states • 2017 nationwide 	2020	Reduced to 12.5% of vehicle fleet by 2023 and 10% by 2025

3.2 EMISSION REDUCTIONS

3.2.1 PM emissions

The *leapfrog scrappage* scenario can effectively drop emissions immediately after the program is implemented, as shown by the lowest line in Figure 3. When modeling the scrappage program, vehicles more than 10 years old

³⁵ The model assumes that all HDVs reaching 10 years of age during the period between 2019 and 2025 will be scrapped immediately. Due to this simplification, the impacts of the scrappage program will be more aggressive, especially at the beginning of the scheduled timeline. In practice, consumers might choose any time during the program to retire their vehicles regardless of the age of the vehicle, or opt not to participate in the program even with the subsidies.

are assumed to be replaced by new vehicles earlier than their natural retirement age during the 6-year period when the program is in effect. Considering the fact that newer vehicles normally drive more than older vehicles, the scrappage program potentially will increase the total vehicle activity in India. Even so, the 6-year scrappage program could still successfully reduce the PM emission level contributed from India’s HDV fleet, even with the rapid expansion of the vehicle market.³⁶

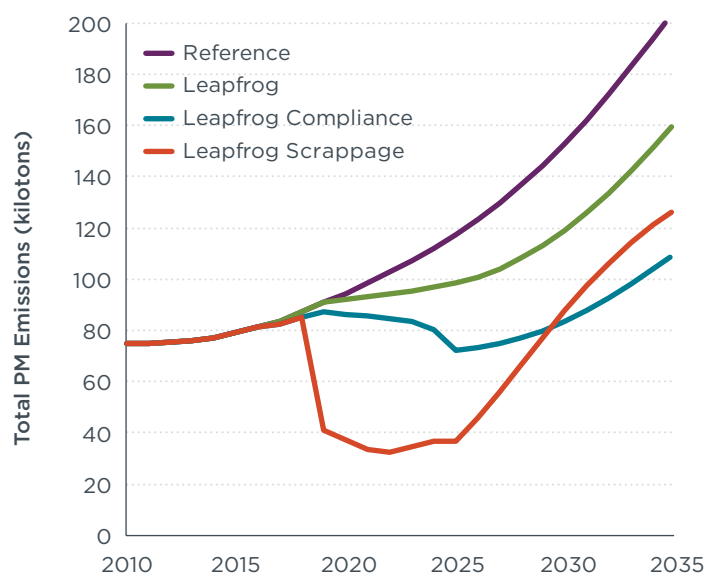


Figure 3. HDV PM emissions in India, 2010 - 2035.

India’s HDV PM emissions will continue to increase dramatically in coming decades if left uncontrolled, as illustrated by the *reference* scenario in Figure 3. The BS VI standards alone cannot stop the increase, although early adoption will yield additional benefits especially in the near term. Implementing BS VI by 2020 (*leapfrog* scenario) would cumulatively save 405 kilotons of PM emissions by 2035 when compared with current timeline (*reference* scenario). In addition, improved compliance and enforcement programs along with the BS VI *leapfrog compliance* scenario can further help slow the HDV PM emissions increase in coming decades. Adoption of a mandatory scrappage and retrofit program post-2025 will be needed to keep lowering the PM emissions further.

3.2.2 NO_x emissions

The *leapfrog scrappage* scenario fleet modernization program would achieve the maximum reduction of

³⁶ Refer to Bansal and Bandivadekar’s report (see footnote 1) for detailed discussions on the Indian vehicle market expansion.

emissions from HDVs in India cumulatively.³⁷ Consistent with the conclusions from PM trends, Figure 4 demonstrates that the *leapfrog scrappage* scenario offers the best solution for India to reach NO_x emissions reduction goals. NO_x emissions will drop significantly once the scrappage program begins phasing in, although they will start to rise again after 2025 due to the increased vehicular activity assumed to follow the scrappage program.

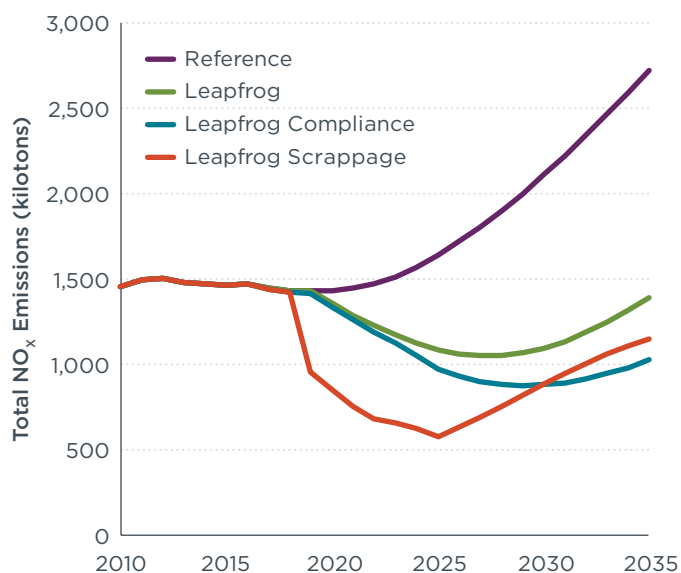


Figure 4. HDV NO_x emissions in India, 2010 - 2035.

Due to the rapid growth of the motor vehicle fleet in India, NO_x emissions from HDVs soon will start to increase rapidly if no further policy efforts are undertaken. This is shown by the *reference* scenario line. The commitment to BS VI can slow the NO_x rebound, and even maintain lower NO_x emissions levels than those seen currently. The leapfrog scenario can yield additional emission reductions of 12,093 kilotons of NO_x cumulatively over the next 15 years, with savings continuing beyond 2035.

Table 4 summarizes the cumulative PM and NO_x savings from the *reference* scenario between 2010 and 2035, quantitatively indicating that the maximum benefits come from the *leapfrog Scrappage* scenario fleet modernization program even with the increased activities assumed from those replaced vehicles.

37 Figures 3 and 4 show that after 2030 the leapfrog compliance scenario produces lower levels of PM and NO_x than the leapfrog scrappage scenario. However, as shown in Table 3, the cumulative benefits (as well as near-term reductions) are substantially greater in the leapfrog scrappage program.

Table 4. Cumulative PM and NO_x emission reductions between 2010 and 2035, by scenario

	Cumulative emission reductions, 2010-2035	
	PM (KILOTONS)	NO _x (KILOTONS)
Reference	0	0
Leapfrog	405	12,093
Leapfrog Compliance	867	14,806
Leapfrog Scrappage	1,175	18,228

3.2.3 Health impacts

Emissions from vehicles, especially fine particulates, affect air quality. The degradation of air quality in turn jeopardizes public health by raising the risk of lung cancer, cardiopulmonary disease, acute respiratory infection and other illnesses, resulting in increased premature mortality rates.

If nothing is done to curb vehicular emissions, the premature death rate in India will continue to rise over the coming decades and in 2035 will be more than five times greater than in 2010. The increased mortality rate is due to the growing number of people centralized in urban areas, which is leading more people to be exposed to vehicular emissions.

Removing high-emitting vehicles from the in-use HDV fleet can be effective in improving the air quality in India, even with the expansion of the vehicle market and urban population growth. Table 5 illustrates the comparative avoidance of premature mortality for the reference and three alternative scenarios.

Table 5. Premature mortality avoided in 2025 and 2035, by scenario

	Annual premature mortality avoided	
	2025	2035
Reference	0	0
Leapfrog	3,340	15,459
Leapfrog Compliance	7,665	33,418
Leapfrog Scrappage	19,153	29,302

4. Summary and Conclusions

Although the fleet modernization program discussed in this paper is focused on India's heavy-duty vehicle fleet, adopting such a program would be an efficient step in improving the air quality and public health in India. The in-use HDV fleet currently is less than 3% of the fleet share but contributes the majority of PM and NO_x emissions from on-road vehicles. Older and poorly

maintained HDVs have a higher likelihood of emitting disproportionately high levels of pollutants.

Adoption of BS VI standards by itself will reduce HDV emissions in India, but the near-term benefits are restricted because older, poorly maintained vehicles will still contribute a majority of the in-use fleet emissions in the near-term. A scrappage program would remove these high-emitting vehicles from the in-use fleet on an accelerated timeline and effectively reduce both PM and NO_x emissions. Early implementation of the BS VI standards ensures that replaced vehicles can be equipped with the most advanced emission control technology. By combining the scrappage program and BS VI promotion, the fleet modernization program maximizes emissions reduction from motor vehicles in both the near- and long-term, and smooth India's transition to BS VI standards by offering subsidies and incentives.

Over the next 20 years India can avoid more than 428,000 premature deaths due to urban vehicular emissions by implementing a fleet modernization program similar to

one of those described in this report, despite the growth expected in the vehicle market. The maximum benefits of such a program can be achieved by conducting a subsidized scrappage program along with early adoption of BS VI standards starting as soon as 2019. Additional benefits could begin to accrue even sooner if key regions with serious air quality issues were to move in this direction ahead of a national program.

Both direct and indirect subsidies are key in supporting a scrappage program, as is the early introduction of the cleanest vehicles available. Sufficient financial subsidies, offered by government and manufacturers, can reduce, or even eliminate the price gap led by the technology improvement between BS IV and BS VI vehicles. Non-financial incentives, such as LEZ access and other privileges, complement financial incentives, offering additional motivation for consumers favoring BS VI vehicles, which results in a "win-win-win" for government, manufacturers, and consumers.