POLICY BRIEF

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The Energy and Resources Institute

Advancement of Fuel Quality and Vehicle Emissions Norms to Improve Urban Air Quality in India

CONTENTS

Authors

Sumit Sharma, Suresh Jain, Anju Goel, Richa Mahtta, Atul Kumar, Divya Datt, Seema Kundu, Preeti Aggarwal, and Prateek Sharma

Advisors

Leena Srivastava
S Sundar

The Energy and Resources Institute
Darbari Seth Block, IHC Complex,
Lodhi Road, New Delhi- 110 003

Tel. 2468 2100 or 4150 4900
Fax. 2468 2144 or 2468 2145
India +91 Delhi (0) 11

www.teriin.org

Ambient Air Pollution in India

- Eighty per cent of Indian cities already violate the National Ambient Air Quality Standards (NAAQS) for Respirable Suspended Particulate Matter (RSPM) concentrations. Concentration of oxides of nitrogen (NO_x) in Indian cities are close to the standards and are expected to exceed in future.
- Not just big cities, but many smaller cities are also critically polluted, with exceedence levels1.5 times more than the norm for RSPM.

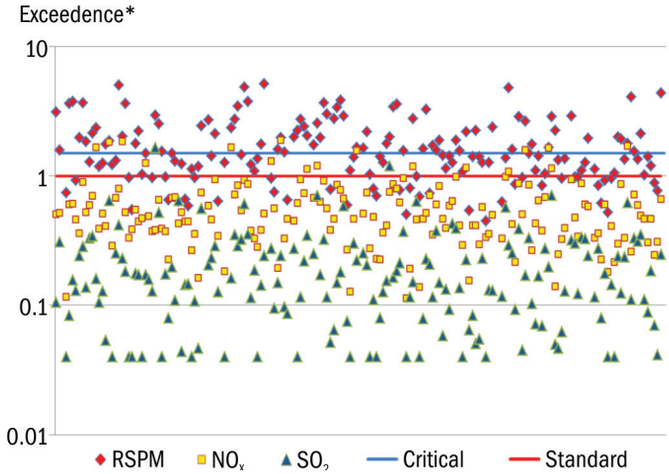

Figure 1: Annual air pollutant concentrations in Indian cities (2010) with respect to prescribed standards

Notes: Each dot represents a city.
Exceedence is the ratio of annual average pollutant concentrations to the prescribed standards in different cities.

Source: CPCB (2012)

Impacts

- Ambient air pollution has been identified as the fifth biggest cause of mortality in India (Lim *et al*., 2012). In 2010, a total of 6.2 lakh mortalities have been attributed to ambient air pollution in India.
- Fine particulate matter, especially from diesel engine exhaust, has been linked with increasing risk of lung cancer (WHO 2012).
- Air pollutants such as Ground Level Ozone (GLO) which are formed by the reactions of precursors like NO_X and Volatile Organic Compounds (VOCs) caused an estimated loss of about 5.6 million tonnes in the yields of wheat, rice, cotton, and soybeans in India in 2005. This amounts to approximately USD 1.3 billion of economic loss (Ghude *et al*., 2014).
- Black carbon which is a dominant part of the particulate matter from diesel engines exhausts is now known to have the second highest radiative forcing (Bond *et al*., 2013).
- Growing air pollution has made the capital city of Delhi rate among the top polluted cities of the world.
- Transport sector is one of the prime contributors to air pollution in cities.

Vehicular Growth

- There has been an exponential growth of vehicles in India. Total registered vehicles have increased from 5.3 million in 1981 to 159 million in 2012. If this growth continues, the vehicle numbers are expected to increase up to 468 million in 2031 (TERI projection).

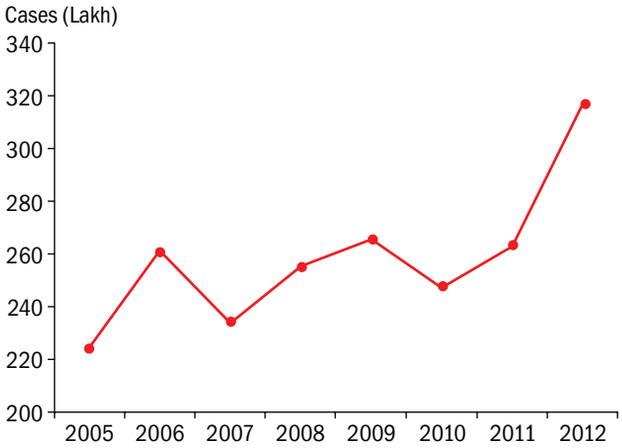

Figure 2: Yearly cases of acute respiratory infections in India
Source: MoHFW (2012)

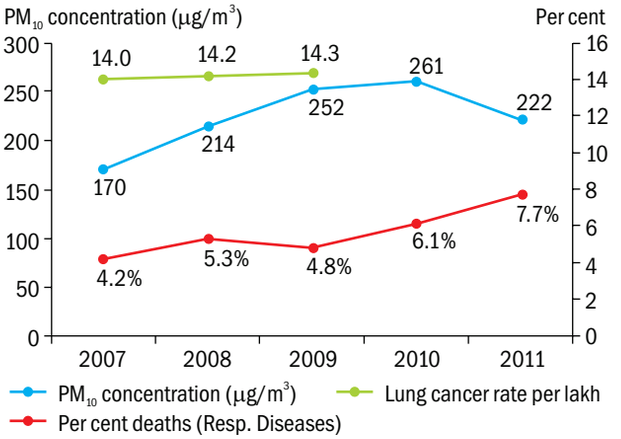

Figure 3: Increase in PM_{10} concentrations: Deaths due to respiratory illness and lung cancer incidences in Delhi
Source: CPCB (2013), ICMR (2013), GNCTD (2013)

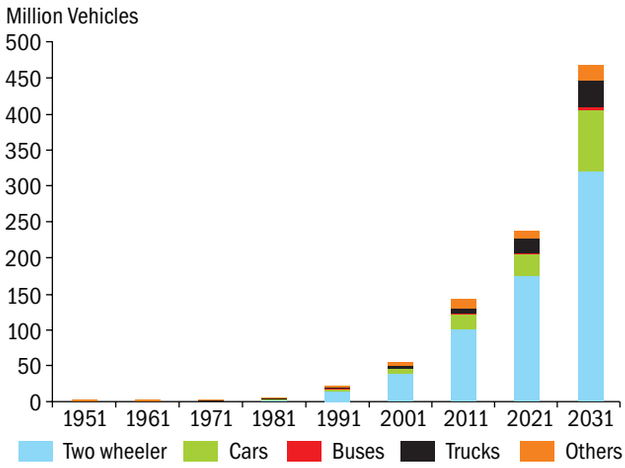

Figure 4: Growth of vehicles in India (1951–2031)
Source: MoRTH (2013), TERI (2014)

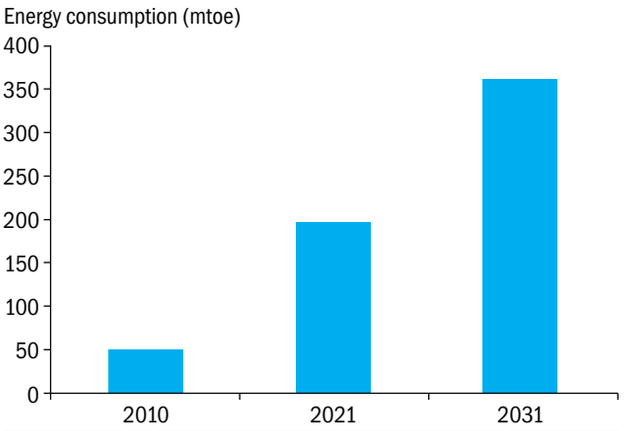

Figure 5: Energy consumption in the road transport sector of India
Source: MoRTH (2013), TERI (2014)

- Under the Business as Usual (BAU) scenario, energy consumption by the road transport sector is projected to increase by almost seven times from 50 Mtoe in 2010 to about 350 Mtoe in 2031.
- Despite some efforts to improve public transport, dependence on private vehicles is expected to persist.

Share of Transport Sector in Air Pollution

- Source apportionment studies undertaken in six Indian cities reveal that the transport sector is one of the major contributors to air pollution in urban centres.
- The transport sector is one of the major sources contributing up to 50 per cent to fine particulate matter concentrations ($PM_{2.5}$), and even more dominantly to NO_x emissions in cities.
- Fuel quality and vehicular technology play important roles in defining the emissions from transport sector.

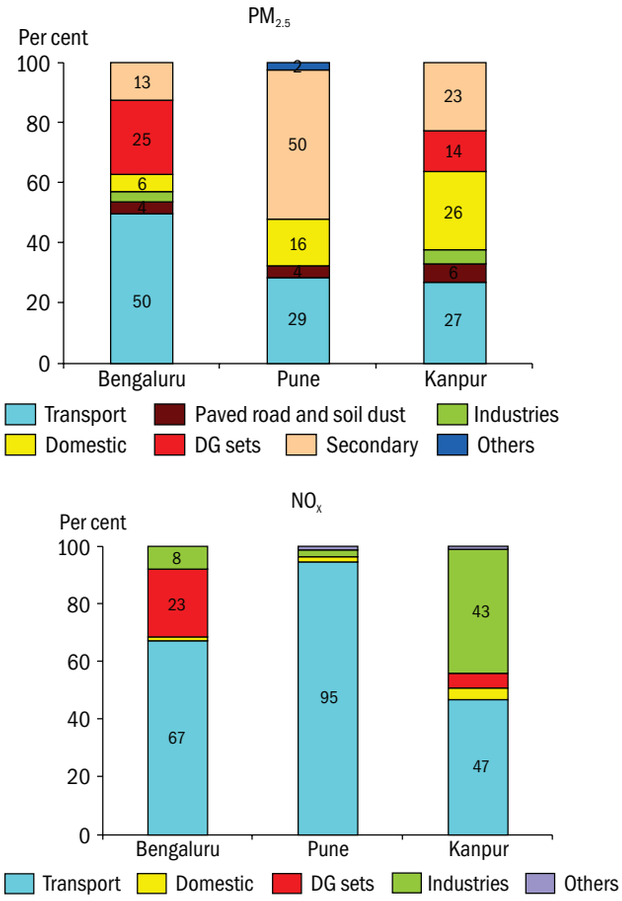

Figure 6: Contribution of different sources to $PM_{2.5}$ and NO_x in three cities
Source: CPCB (2011)

Auto Fuel Policy in India: Key Issues

- Auto Fuel Policy 2002 laid down a roadmap for introduction of cleaner fuels and vehicles in the country upto 2010.
- Based on the roadmap, 13 selected cities were moved to BS-IV norms by 2010, while rest of the country is still on BS-III norms. Therefore, there exists one set of NAAQS and dual standards for vehicle emission and fuel quality.
- The rate of increase in RSPM concentrations is much higher in cities where lower quality fuel is provided (Figure 7).
- Heavy-duty trucks still remain on BS-III standards all across the country, although they are registered in cities where BS-IV norms have been introduced.
- When BS-IV compliant vehicles move out of the cities where BS-IV fuel is available, they have to use inferior quality fuel and that could choke their engines.
- Auto Fuel Vision Committee was set up in 2013 to recommend the future roadmap on advancement of fuel quality and vehicular emission standards upto 2025. The committee has recommended the introduction of BS-IV and BS-V norms across the country by 2017 and 2020, respectively. BS-VI emission norms are recommended to be introduced by 2024.
- The roadmap recommended by the Auto Fuel Vision 2025 Committee puts India 10 years behind the US and European countries.

Auto Fuel Policy 2002		
Coverage	Passenger cars, light commercial vehicles, and heavy-duty diesel vehicles	2/3 wheelers
Entire country	Bharat Stage (BS) II – 1.4.2005	Bharat Stage-II- 1.4.2005 Bharat Stage III - Preferably from 1.4.2008 but not later than 1.4.2010
	Bharat Stage III – 1.4.2010	
13 cities	Bharat Stage II – 1.4.2003	
	Bharat Stage III – 1.4.2005	
	Bharat Stage IV – 1.4.2010	
Source: MoPNG (2002)		

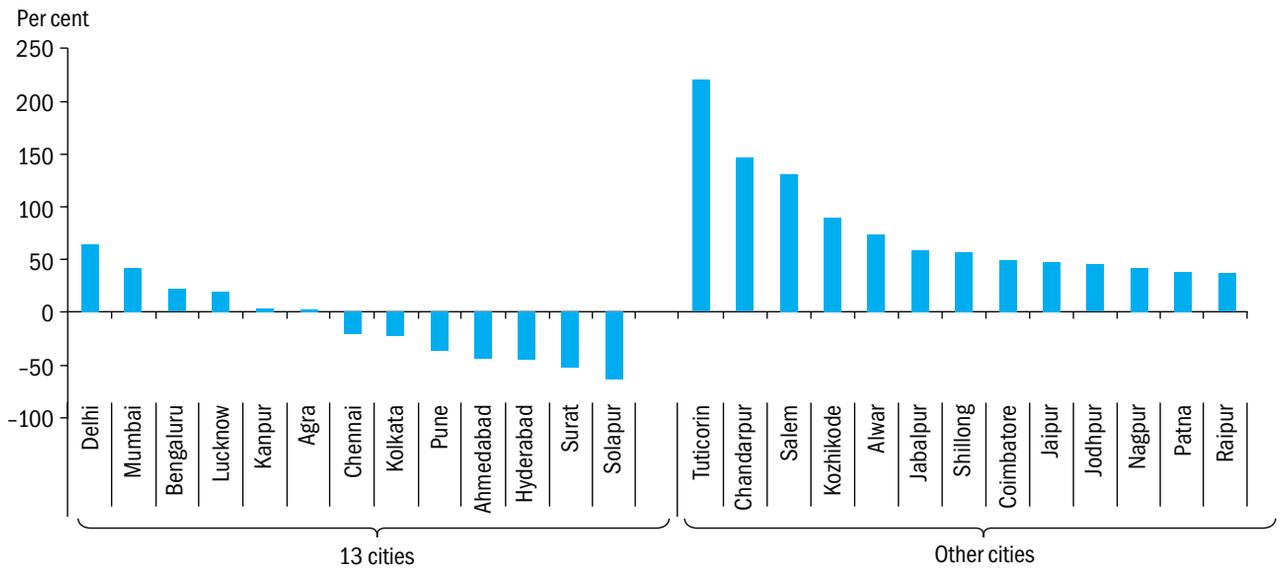

Figure 7: Percentage difference in RSPM concentrations (2002–2010) in the 13 cities where BS-IV norms were enforced in 2010 and in rest of the cities
Source: CPCB (2013)

Cost of Upgrading Fuel Quality

- Many refineries have the capacity to produce 50 ppm of sulphur (BS-IV) fuel, and with some additional investments this can be supplied uniformly all over the country.

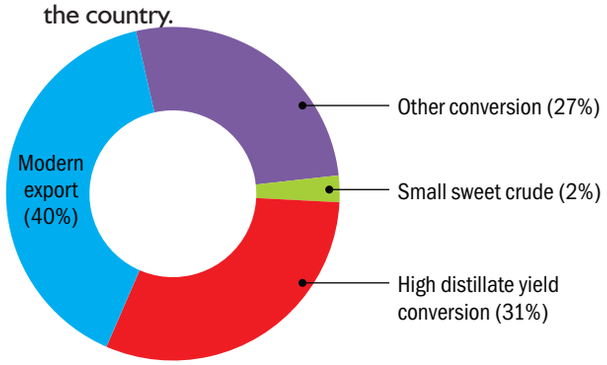

Figure 8: Classification of Indian refineries
Source: HE&MPI (2012)
Notes: Modern export refineries consist of the large export-oriented refineries of India which are highly competitive owing to the advantages of operational costs, economies of scale, advanced technology, and operational synergies and are expected to incur lower capital expenditures for Euro-V standards than most other Indian refineries.

High Distillate Yield Conversion Refineries are grouped on the basis of their cracking capacity, hydroprocessing, and reforming capacity. Most of them produce Euro-III and Euro-IV grade (Euro-III constituting the higher share) fuels.

Small sweet crude refineries include the smaller refineries running on sweet crude.

Other conversion includes the remaining refineries, which are generally moderate complexity conversion refineries. Only one has a delayed coker. Five have FCC capacity with no hydrocracking and the remaining refinery has hydrocracking capacity with no FCC. Most of these refineries are producing Euro-III or Euro-IV grade equivalent gasoline and diesel, though some in 2010 still produced fuel meeting BS-II and BS-III specifications.

- A reputed agency has estimated an investment cost of ₹ 25,000 crore for upgrading the refineries to produce 10 ppm (EURO-V equivalent) fuel in the country (HE&MPI 2012). However, the industry estimates higher investments of about ₹ 80,000 crore (AFV&PC 2014).
- The industry estimates of capital investments for refinery upgradation can be recovered through a small increase in the price of the fuel by ₹0.75 per litre for next 7 years. The corresponding health benefits range between ₹1.1– 1.9 per litre of fuel during 2016–2030.

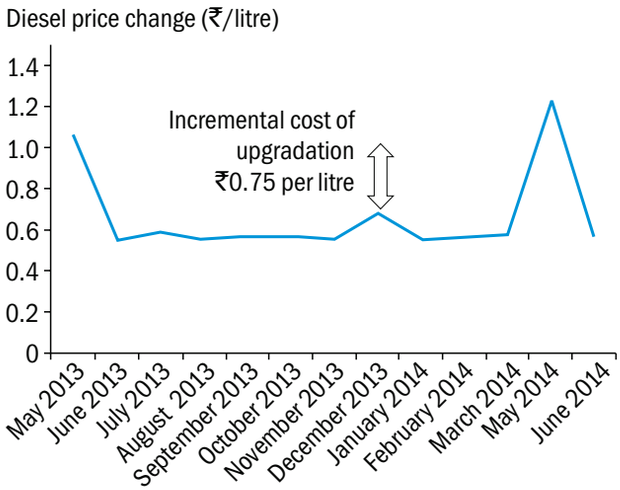

Figure 9: Incremental cost of upgradation of refineries as per industry estimates to produce 10 ppm fuel in India compared with monthly diesel price increase

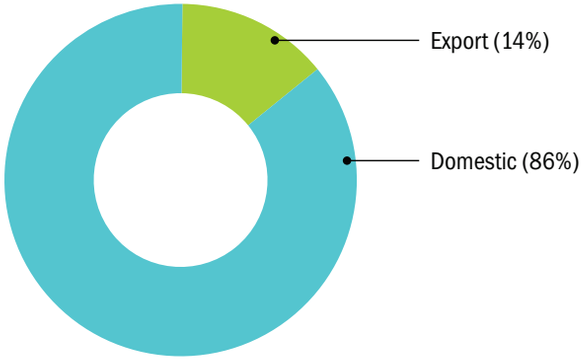

Figure 10: Share of domestic and exported vehicles in India (2011–12)
Source: SIAM (2013)

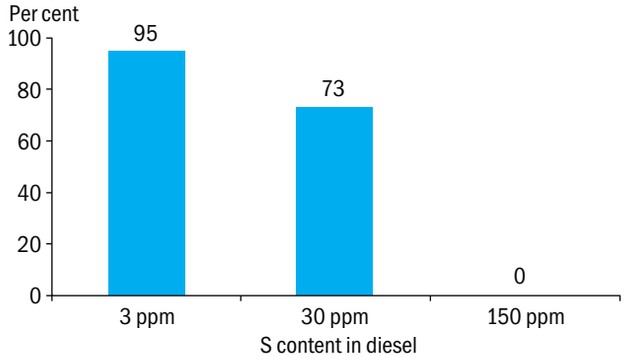

Figure 11: PM removal efficiency of a DPF using different quality of fuels
Source: ICCT (2012)

Vehicular Stocks and Technologies

- In 2011–12, the automobile industry registered 12 per cent domestic growth and 25 per cent growth in exports.
- While many of the automobile companies are already manufacturing Euro-V compliant vehicles, these have not yet been introduced in the Indian market.
- One of the primary reasons for absence of Euro-V vehicles is the unavailability of the required quality of low sulphur (10 ppm) fuel. The automobile industry claims that engines might be affected if run on higher sulphur fuels. In diesel-powered vehicles, advanced tail-pipe treatment technologies, such as Diesel Particulate Filter (DPF), Selective Catalytic Reduction (SCR), etc., are available; however, they require 10 ppm sulphur fuel to work at their best efficiencies.

Advancement of Vehicular Emissions and Fuel Quality Norms: Scenarios

- An analysis was carried out to estimate emission reduction under a BAU and two alternate scenarios (ALT-1 to ALT-2) assuming different time frames for introduction of advanced fuel quality and vehicle emission standards.
- In the BAU scenario, $PM_{2.5}$ emissions grow from 102 kt/yr to 282 kt/yr (2.8 times) in the next two decades leading to further deterioration of air quality which is already critically polluted.

Scenario	Description
BAU	Based on current plans and policies of the government (BS-III all across the country and BS-IV in 13 cities)
ALT-1	BS-IV all across the country by 2015 and BS-V in 2020
ALT-2	BS-IV all across the country by 2015, BS-V fuel by 2018 and BS-VI emission norms in 2020

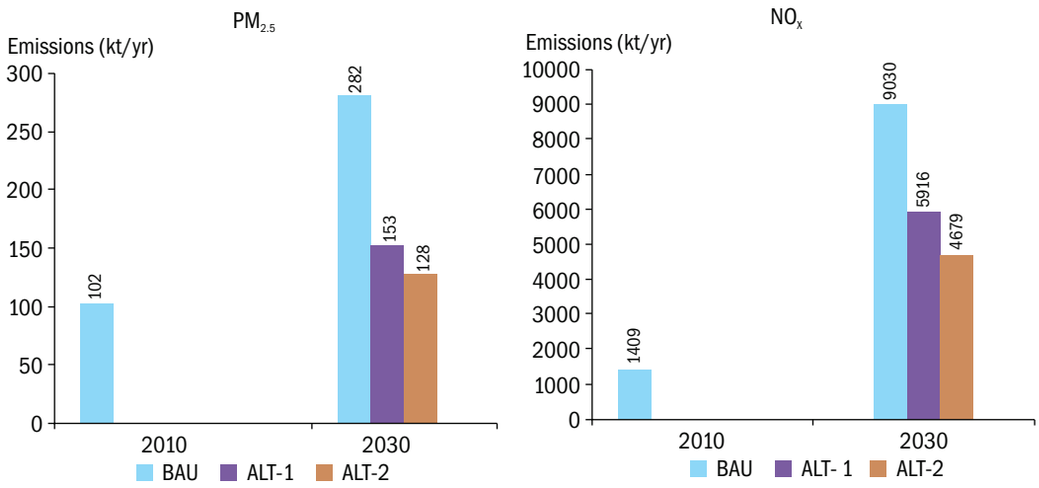

Figure 12: $PM_{2.5}$ and NO_x emissions from the road transport sector in India under different scenarios

- An advancement to BS-V standards by 2020 (ALT-1) can result in significant emission benefits (46 per cent). However, introduction of BS-VI emission standards (ALT-2 scenario) by 2020 which involve the use of advanced tail-pipe treatment devices can reduce the PM emissions to lowest possible levels.

Projected Health Benefits and Costs

- The range of cost estimates are based on varying estimates of initial investments on refineries and vehicular stocks. The range of benefits is estimated based on varying estimates of Value of Statistical Life (VSL) with growing per capita incomes.
- Introduction of BS-V/BS-VI norms in the country by 2020 would result in reduction of more than 15,000 and 17,000 mortalities each year in ALT-1 and ALT-2 scenarios, respectively, from 2030 onwards. Additionally, it amounts to 0.16 and 0.18 million Disability Adjusted Life Years (DALYs) saved annually in ALT-1 and ALT-2 scenarios, respectively. The avoided mortalities and DALYs are about 35 per cent of the total caused by emissions from road transport sector.
- Economic estimates of avoided mortality if valued using the concept of Value of Statistical Life (VSL) (Shanmugan 1997; Madheswaran 2007; Simon *et al*., 1999; Bussolo and O'Connor, 2001) ranges between ₹ 3.4–₹ 5.9 trillion and ₹ 3.9–₹ 6.7 trillion cumulatively during 2016–2030 for ALT-1 and ALT-2 scenarios, respectively. This is about 0.1–0.2 per cent of the projected GDP.
- The figures mentioned above are still an underestimate, considering that only avoided mortality from reduced PM_{10} has been considered. Impacts of other pollutants have not been considered.
- Benefits soon outweigh the costs incurred on initial capital investments and operation costs of refineries and additional costs on vehicular stocks.

Key Recommendations

- Vehicular sources are one of the major contributors to urban air pollution. In order to bring down future ambient air pollutant levels, it is imperative that emissions from these sources are controlled. One of the ways to accomplish this is to have stringent emission and fuel quality norms.
- The transport sector emissions will grow manifold and will offset the impact of control measures taken in the past. Thus, by the year 2030, the $PM_{2.5}$, NO_X, CO, and VOC emissions will grow many times under the BAU scenario. The resulting emissions will only make the air quality worse than the current levels which are already alarmingly high. Reductions could be achieved through adoption of a uniform fuel quality across the country and advancement of current emission and fuel quality norms to more stringent levels.
- The Government of India should consider earlier introduction of BS-V fuels than those recommended in the Auto Fuel Vision (AFV 2025) Report, by

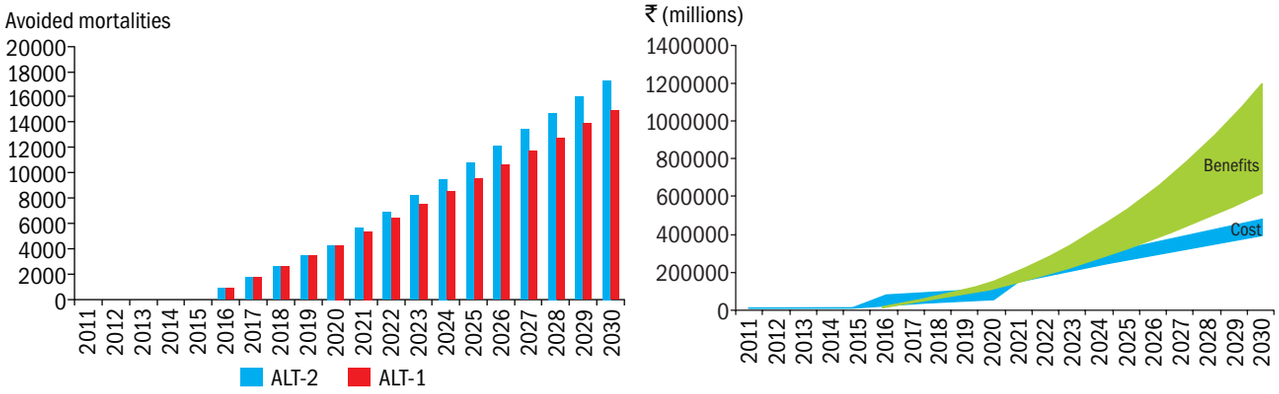

Figure 13: Avoided mortalities (ALT-1/2) and its economic benefits compared against annualized investments (ALT-2) during 2016–30

requiring and enabling the Indian refineries to leapfrog from BS-III to BS-V fuels by 2018. Alternately, GOI can explore the possibility of diverting the current exports of Reliance Industries Limited–Special Economic Zone (RIL-SEZ) and arranging for imports as necessary.

- The fuel cost of refinery upgradation should be reflected in the cost of fuel. Financial support to the refinery in any other manner would result in subsidizing the rich at the cost of poor.
- With the introduction of BS-V fuel (i.e., ULSF with 10 ppm sulfur) by 2018, the auto industry should move directly to BS-VI emission standards by 2020. This would also facilitate the use of after treatment devices (e.g., diesel particle filters) as retrofits for vehicles already in use.
- The benefits of the adoption of these advanced norms outweigh the costs of implementation. The initial costs of refinery upgradation can be met with a slight increase in the fuel price.
- The commissioning of an effective inspection and maintenance system is also necessary to control emissions from in-use vehicles.
- Other than transport, stringent measures are required to control emission from industries, power plants, and diesel generator (DG) sets.

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For more information, contact:

Sumit Sharma

The Energy and Resources Institute (TERI)
Darbari Seth Block,
IHC Complex, Lodhi Road,
New Delhi- 110003

Tel: 24682100 or 41504900
Fax: 24682144 or 24682145
Web: www.teriin.org
E-mail: sumits@teri.res.in

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