TechSci Research

India Air Pollution Control & Monitoring Study

Table of Contents

1.

Executive Summary

Since the past two decades, air pollution has become a global public health issue and is identified as a major environmental health hazard. Since the introduction of Air (Prevention and Control of Pollution) Act, 1981, various pollution control programs have been focusing on controlling air pollution in India; however, the current measures do not seem to be adequate to tackle the rising levels of air pollution, effectively.

This report presents information on current air quality and pollution scenario along with the control measures in India. Major sectors/industries responsible for air pollution include Energy, Mining, Cement, Automotive, Chemicals and Indoor Air Pollution.

Increasing energy demand and growing per capita energy consumption has led to high greenhouse gas emissions. Rising coal consumption in India has been largely responsible for deteriorating air quality. Illegal mining operations, less efficient industrial processes and lack of proper regulatory procedures followed in sectors like cement have also contributed negatively towards air quality.

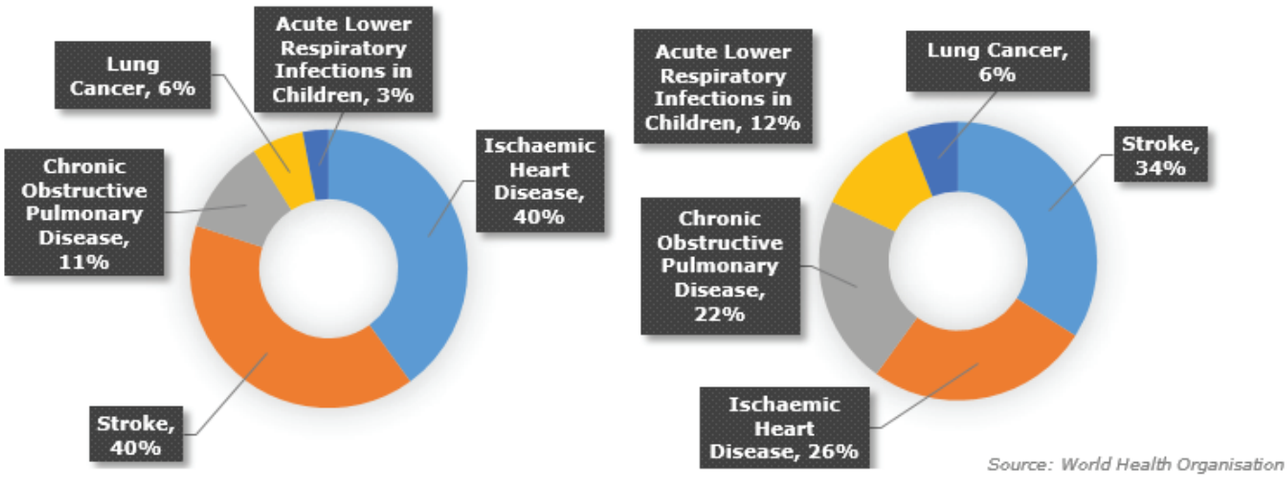
Pollution from vehicles is responsible for about two thirds of air pollution in urban areas. Moreover, in semi urban and rural areas, the vehicle emission control regulations are not being followed diligently.

Recently, indoor Air Quality has also emerged as a major concern as most Indians in urban areas spend more than most of their time indoors and poor quality can adversely affect the health and indoor environment.

Central and State Pollution Control Boards have been carrying out various control measures and have laid down various regulatory measures to address this concern. Many initiatives by public as well as private organizations have also help raising awareness towards air pollution control in India. These concerns have also increased the demand for various air pollution and control equipment such as Air Purifiers, Air Filters, Pollution masks and Pollution detection equipment.

It is necessary for the government to properly design air quality strategies in order to help the country to achieve ambient air quality goals in future.

Global Outdoor & Indoor Air Pollution Related Deaths, By Disease Type



Source: World Health Organisation

2.

Air Pollution in India: Current Scenario

Air pollution occurs when any solid, liquid, or gaseous product, introduced into the atmosphere, harms the environment. It affects our day to day activities and has recently become a serious public health issues, impacting the economic. According to World Bank Disaster Management and Climate Change Unit Report, the cost of serious health consequences from Particulate Matter pollution amounts to be around 3 per cent of India's total GDP and the total damage because of environmental degradation amounts to around USD58 billion equivalent to 5.7 per cent of the country's GDP.

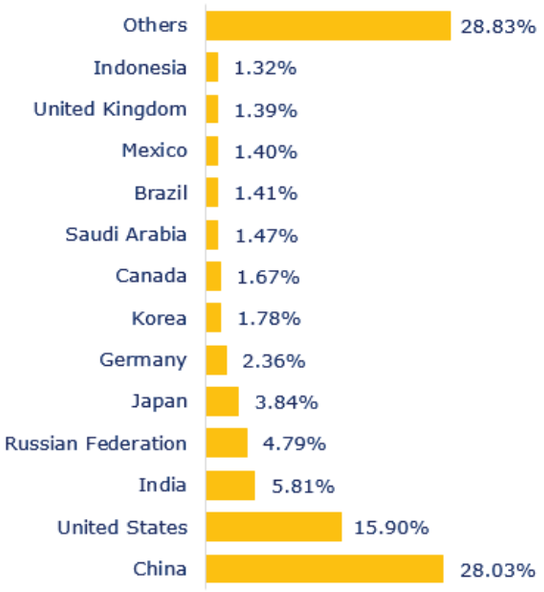
As per the data provided by World Bank, 3 of the world's 20 cities having highest PM10 levels were in India, while 10 Indian cities had highest PM2.5 levels across the globe. Gwalior was the most polluted city in India followed Allahabad and Raipur. These factors have made India one of the most polluted countries in the world. Since 1991, It has been witnessed that Indian cities fail to meet the air quality standards. Almost all cities are reeling under severe particulate pollution while pollutants such as oxides are also severely effecting air quality due to significant growth in industrial sector in India. Many of nitrogen and air toxics have begun to add to the public health deterioration.

Major sources leading to high levels of air pollution in India are:

- **Burning of Fossil Fuels:** Sulphur dioxide emitted from the combustion of fossil fuels such as coal, petroleum, and other factory combustibles
- **Agricultural Activities:** Ammonia released from agriculture related activities acts as a pollutant to the atmosphere.
- **Exhaust from Factories and Industries:** Manufacturing industries releasing pollutants such as carbon monoxide, hydrocarbons, organic compounds, and chemicals into the air thereby depleting the quality of air.
- **Mining Operations:** Dust and chemicals are released in the air causing air pollution.
- I**ndoor Air Pollution:** Household cleaning products, painting supplies emit toxic chemicals in the air and cause air pollution.

Although, India has a low per capita emission of greenhouse gases, the country is still the third largest after United States and China. At the global scale, the key greenhouse gases emitted by human activities are Carbon Dioxide, Methane, and Nitrous Oxide and Fluorinated gases.

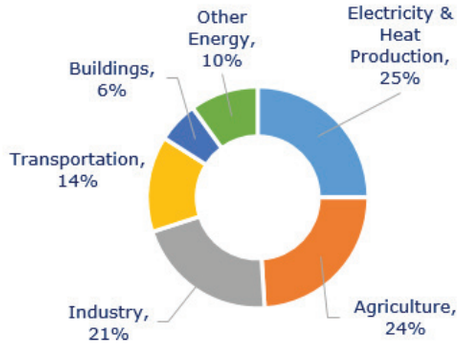
Global Share of CO2 Emissions, By Country, 2015



Source: Climate Change Performance Index

Electricity and Heat Production is the primary source of greenhouse gas emissions globally, however, in India domestic and commercial burning of biomass for cooking and other purposes has been identified as the primary source of greenhouse emissions.

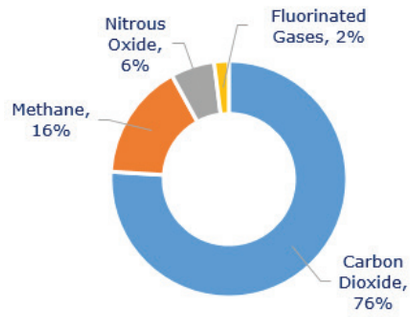
Global Greenhouse Gas Emission Share, by Economic Sector, 2014



Source: US EPA

India's bid to control its air pollution levels are hampered with Inadequate budget and low precedence given to prevention of air pollution by the state government, environment is still low in the priority of the state governments.

Global Greenhouse Gas Emission Share, 2014



Source: US EPA

budget being allocated for environmental management. Many State Boards receive almost no financial support from the State Governments and are dependent on cess. Though environmental concerns are being given greater importance at the national level, commensurate investment is hardly evident.

The total annual plan of the MoEF is currently around USD307 million, which is about 0.25% of GoI's plan budget. This is much below most developed and emerging economies.

Environment Protection Spending as a Share of Total GDP by Select Countries, 2016

Country	Environment Protection Spending (% of GDP)
Greece	1.48%
China	1.45%
Netherlands	1.43%
France	1.01%
Japan	1.00%
Italy	0.96%
Spain	0.86%
Great Britain	0.79%
Germany	0.61%
Israel	0.50%
USA	0.40%
India	0.01%

Source: US EPA

3.

Impact Analysis of Various Air Polluting Sectors

Industry	Impact on Environment	Pollutants
Energy Industry		Greenhouse Gases (CO_2, CH_4, N_2O, O_3, CFCs, HCFCs), Dust Particles, Mercury
Mining Industry		Particulate Matter, CH_4, SO_2, CO, H_2S
Cement Industry		PM2.5, PM10, SO_2, NO_2,
Automotive Industry		Lead, Particulate Matter, HC, NO_X, CO, SO_2
Chemical Industry		Volatile Organic Compounds (Acetaldehyde, Acetone, Benzene Carbon tetrachloride, Ethyl acetate, Ethylene glycol, Formaldehyde etc.), NO, SO_2, NO_2, SO_3, Cl_2, CO, CO_2, H_2SO_4
Indoor Air Pollution		Tobacco smoke, Carbon Monoxide (CO), Lead, TVOC's


High Impact


Moderate to High Impact


Moderate Impact

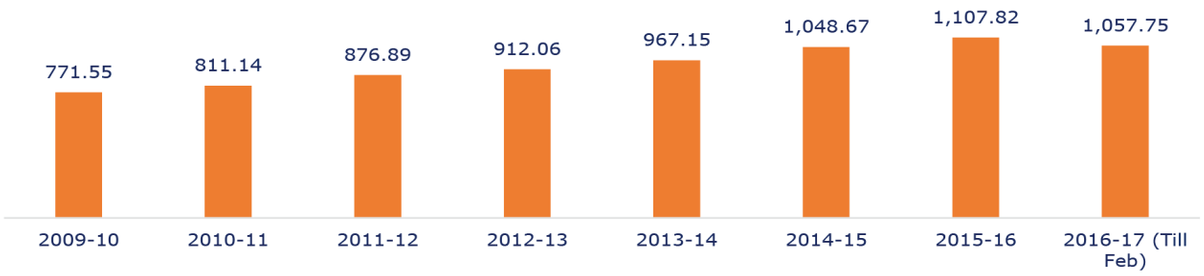

Low Impact

3.1 Energy Industry: Environmental & Health Impact

Energy sector is the single largest source of air pollution in India. Major sources of energy generation in India include fossil fuels such as coal, oil and natural gas. India is the world's fifth largest electricity generator with total installed capacity of 302.09 GW.

Coal remains the mainstay of the power generation system in India. Coal exhibits much stronger absolute growth than any other source of power generation in India. Moreover, as power plants are often located near cities, towns

India Electricity Production, in Billion Units, 2009-10 - 2016-17, (Feb 2017)



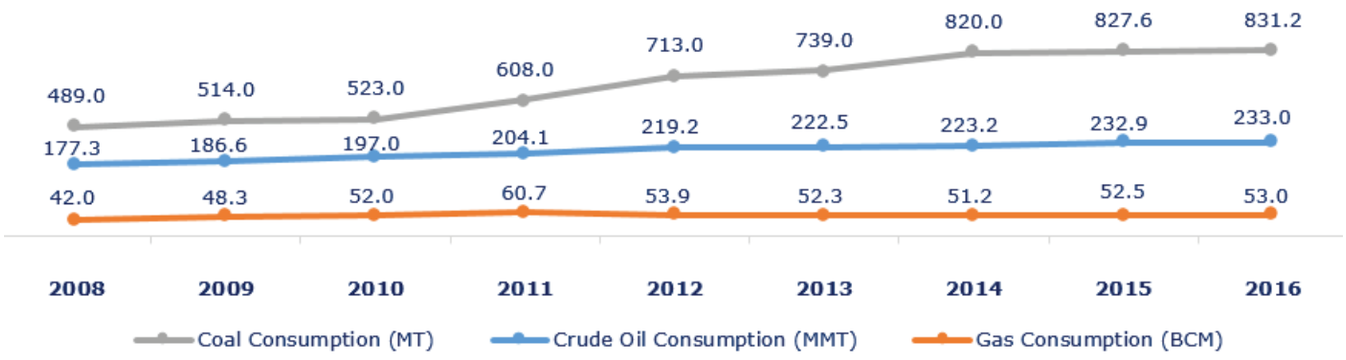
Source: Ministry of Power

Rapid industrialization coupled with the growing awareness for industrial emission control standards has given rise to industrial air quality control and monitoring across the developing nations including India. Since 1991, India has witnessed one of the fastest industrial growth due to liberalization of economy. This impressive growth has impacted air quality, as power generation leads to a significant contribution in greenhouse gases.

and villages, the potential impact on health is significant as around a quarter of the population lives in close proximity to a coal plant. Activities related to production of coal such as drilling, blasting, extraction, transportation, and crushing results in rise of dust particles in air causing pollution.

The measures taken by the Government for mitigation of dust produced by coal mining

India Electricity Production, in Billion Units, 2009-10 - 2016-17, (Feb 2017)



Source: Coal India Ltd., Ministry of Petroleum & Naturl Gas, TechSci Research

Emission Parameters Set Up for Thermal Power Plants by Ministry of Environment, Forests and Climate Change (MOEF&CC)

Emission Parameter	TPPs (Units) installed before 31st December, 2003	TPPs (Units) installed after 31st December 2003 and up to 31st December 2016	TPPs (Units) to be commissioned after 01.01.2017
Particulate Matter	100 mg/Nm3	50 mg/Nm3	30 mg/Nm3
Sulphur Dioxide (SO2)	600 mg/Nm3 for units less than 500 MW capacity 200 mg/Nm3 for units of 500 MW and above capacity	600 mg/Nm3 for units less than 500 MW capacity 200 mg/Nm3 for units of 500 MW and above capacity	100 mg/Nm3
Oxides of Nitrogen (NOx)	600 mg/Nm3	300 mg/Nm3	100 mg/Nm3
Mercury (Hg)	0.03 mg/Nm3 for units having capacity of 500 MW and above	0.03 mg/Nm3	0.03 mg/Nm3

Source: Ministry of Environment, Forest and Climate Change

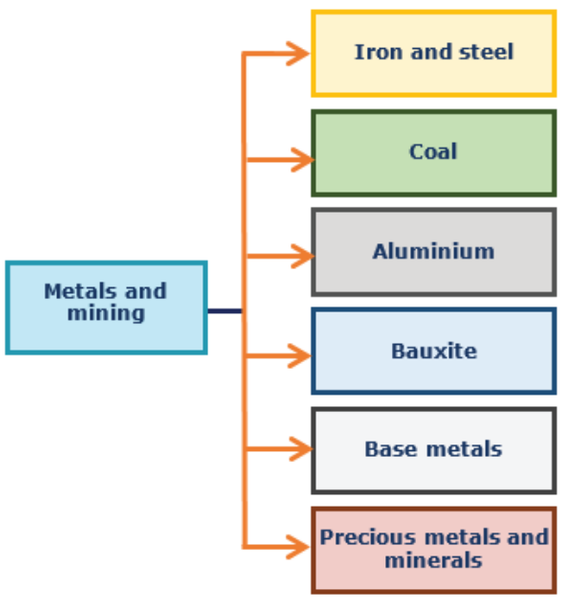
and for recycling of water include use of automatic, mobile and fixed water sprinklers, wet drilling, side discharge loaders, load haul dumpers and conveyors, plantation, effluent treatment plants are not enough to curb air pollution levels. Moreover, there is no single body charged with formulating and implementing a unified energy policy. Three energy intensive sectors (steel, cement, chemical and petrochemical sectors) give rise to the vast majority of emissions for each pollutant today and remain their dominant source by 2040. India has several ministries and other bodies, each with partial responsibility for aspects of energy policy and the related infrastructure. In 2015, Ministry of Environment, Forests, and Climate Change (MOEF&CC) has notified new environmental norms on 7th December 2015 for Thermal Power Plants (TPPs) for Suspended Particulate Matter (SPM), SO2, NOx and Hg. The EPAR also put new limits on SO2 and NOX emissions from coal-fired power plants, which are comparable in to those in place in the Europe Union and the United States. With the "Make in India" initiative, the government is seeking to rebalance the composition of economic activity towards industry-led growth. This can bring multiple benefits, but will also place additional demands on the energy sector.

Usually a unit of gross domestic product derived from industry typically uses at least ten-times as much energy as one created in the services sector with direct consequences for air quality, with Indian GDP growing at around 7% would have serious implications on air quality in India. Consequently, state and central government must focus on green energy sources to reduce the dependence on conventional energy sources.

3.2 Mining Industry

Growing infrastructure has been the driving factor for growth in mining sector in India. Power and cement industries have been aiding growth for the sector. The sector contributed USD21.86 Billion to Indian GDP in 2016. Mining of minerals plays a positive role in the process of country's economic development. In addition to the contribution towards economic growth, mining can also be a major source of degradation of physical as well as social environment.

As of FY16, India had 1,878 operating mines which are one of the major factors contributing towards air pollution. India is the fourth largest coal producing country in the world. Air pollution in coal mines is mainly due to the fugitive emission of particulate matter and gases including methane (CH4), sulphur dioxide (SO2) and oxides of nitrogen (NOx).



Coal (both surface and underground) contributes to nearly 35% of the total mineral wealth of India and causes the largest earth moving operation by volume. The mining operations like drilling, blasting, movement of the heavy earth moving machinery on haul roads, collection, transportation and handling of coal, screening, sizing and segregation units are the major sources of such emissions. Under- ground mine fire is also a major source of air pollution in some of the coal fields.

Mining Processes and Nature of Air Pollution Assocated with them

Source	Nature of air pollution
Construction of infrastructural facilities	Dust
Top soil stripping	Dust
Drilling	Dust
Blasting	Dust, CO, NOx, SO2, H2S (slurry explosives)
Excavation of ore	Dust
Waste rock dumping	Dust
Loading & unloading of ore	Dust
Material transport	Dust
Wind erosion	Dust
Conveyors and material transfers	Dust
Crushing and screening	Dust
Heavy equipment exhaust	SPM, NOx, SO2, HC
Fuel storage tanks	HC
Stock piles	Dust

Opencast mining is more severe an air pollution pro blem in comparison to underground mining. High levels of suspended particulate matter increase

respiratory diseases such as chronic bronchitis and asthma cases while gaseous emissions contribute towards global warming besides causing health hazards to the exposed population. The uncontrolled dust not only creates serious health hazard but also affects the productivity through poor visibility, breakdown of equipment, increased maintenance cost and ultimately deteriorates the ambient air quality in and around the mining site. The dust can also pollute nearby surface waters and stunt crop growth by shading and clogging the pores of the plants. Besides polluting the environment, the generation of dust means the loss of fines, which act as road surface binders. Open cast metal mining activities also significantly affect the air quality in the nearby areas. Smaller size dust particles (<2µm) may be transported to longer distance by wind and may cause impact on the people residing nearby.

Mining Processes, Magnitude of Air Pollution & Control Measures to be Adopted

Potential sources of air pollution	Magnitude of air pollution	Control measures
Drilling	High dust generation Risk of occupational hazard	• Wet drilling technology or dry drilling fitted with bag • Driller shall be equipped with closed cabin personal protective gear to reduce occupational hazard filter
Blasting	High dust generation (Impact lasts for short period)	• By improvising blasting technique and adopting controlled blasting methods • No blasting should be allowed in the areas close to human habitation – Rock breakers should be employed instead of blasting • Water spray prior to blasting
Loading of material on dumper	Air emission	• Air conditioned cabin for loading operator • Water spray on mineral ore / overburden material prior to loading
Transportation	High dust potential	• Both dumper and conveyor transportation. Provision for automatic water sprinkle system on permanent road and water spray by tankers on temporary road. • Covering of the material with turpentine in case of long haulage or in case the road is passing through in close proximity of habitation • Green belt of trees with good footage on both side of haul road. • Provision of water spay on the dumper to arrest fine dust before it is transported to crusher
Crushing of ore	High potential of dust and occupational hazard	• Automatic water spray in crusher hopper and unloading point. Suitable enclosure for the conveyor system. • Provision of bag filter in crusher unit • Barrier in form of greenbelt all around in the vicinity of the crusher to trap fugitive dust.
Storage of ore	High potential of dust and occupational hazard	• Covered storage yards with greenbelt of adequate width all around

3.3 Cement Industry: Health & Environmental Impact of Concrete

Cement & Concrete are the second most consumed substance globally after water. Rapid growth in the infrastructure & construction sector since last 2 decades has bolstered the production of cement in India. Currently India is the 2nd largest cement producer as well as consumer in the world and has 209 large cement plants. All these factors have made cement industry one of the leading air pollution generator in India. Globally, cement industry accounts for 5% of the global carbon dioxide (CO2) emissions. The amount of CO2 emitted by the cement industry is nearly 900kg of CO2 for every 1,000 kg of cement produced. Cement plants are a significant source of sulfur dioxide, nitrogen oxide and carbon monoxide additionally dust particles and foul smell are also released in the environment.

Emission	Specific pollutant	Source	Location
Gas	SO2, COx, NOx	Point sources	Raw mill and kiln stack exit
Dust	TSP, PM10 and PM2.5	Point sources	Clinker cooler and cement mill stacks exit
		Volume sources	Outlets through dust control devices

In India, most of the cement plants are not complying with the air pollution norms set up by Ministry of Environment and Forest (MoEF) in 2014, which asked the cement manufacturing companies to reduce their particulate matter emissions by a third. As of June 2016, 194 cement plants were not fully compliant.

Government has identified the cement industry as one among the highly polluting 17 category industry and require consent for establishment and operation under Water (Prevention & Control of Pollution) Act, 1974 and Air (Prevention & Control of Pollution) Act, 1981. In August 2014 Ministry of Environment, Forest and Climate Change notified revised emission norms for Particulate Matter and also introduced emission norms for SO2 and NO2 for cement industry.

Air pollution control technologies and equipment used in the cement industry are:

- Flexible Pulse Jet Filters
- Electrostatic Precipitators
- Wet Scrubbers
- Ordinary Bag House Method

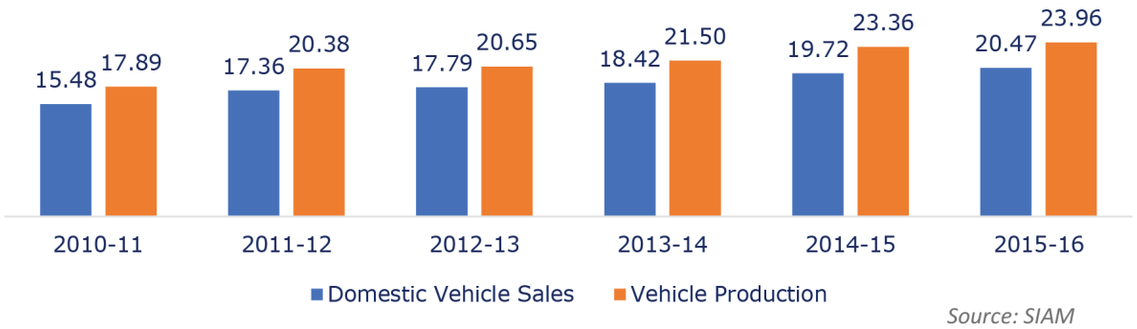
Some other measures of reducing the emissions from cement industries include switching to alternative fuels, including natural gas, biomass and waste-derived fuels such as tires, sewage sludge and municipal solid wastes. These less carbon-intensive fuels could reduce overall cement emissions by 18-24%.

3.4 Automotive Industry: Vehicles, Air Pollution & Human Health

The air pollution from vehicles in urban areas, particularly in big cities, has become a serious problem. The pollution from vehicles has begun to tell through symptoms like cough, headache, nausea, irritation of eyes, various bronchial and visibility problems.

map and safety regulations as per the Safety Road map adopted by the CMVR-TSC, respectively. Today the vehicle technology in India is at par with the international bench marks as Indian safety standards are being aligned with Global Technical Regulations (GTR) and UN Regulations. India is a signatory to

India Domestic Vehicle Sales & Vehicle Production (in Million), 2010-11 to 2015-16



Source: SIAM

The main pollutants emitted from the automobiles are hydrocarbons, lead/benzene, carbon monoxide, sulphur dioxide, nitrogen dioxide and particulate matter. The main cause of vehicular pollution is the rapidly growing number of vehicles. The other factors of vehicular pollution in the urban areas are 2-stroke engines, poor fuel quality, old vehicles, inadequate maintenance, congested traffic, poor road condition and old automotive technologies and traffic management system.

In India, vehicle technology has evolved to meet the emission and safety regulations notified as per the Auto Fuel Policy specifying the emission road

UN WP 29 1998 agreement which develops GTRs. India actively participates in the UN WP 29 body and contributes significantly so that the GTR reflect the driving conditions and requirements of the developing countries.

Pollution from vehicles especially automobiles is responsible for about two third of air pollution in urban areas. The major pollutants emitted from exhaust emissions of gasoline fuelled vehicles are CO, HC, NOx and Pb while pollutants from diesel-fuelled vehicles are particulate matter (including smoke), NOX, SO2, PAH.

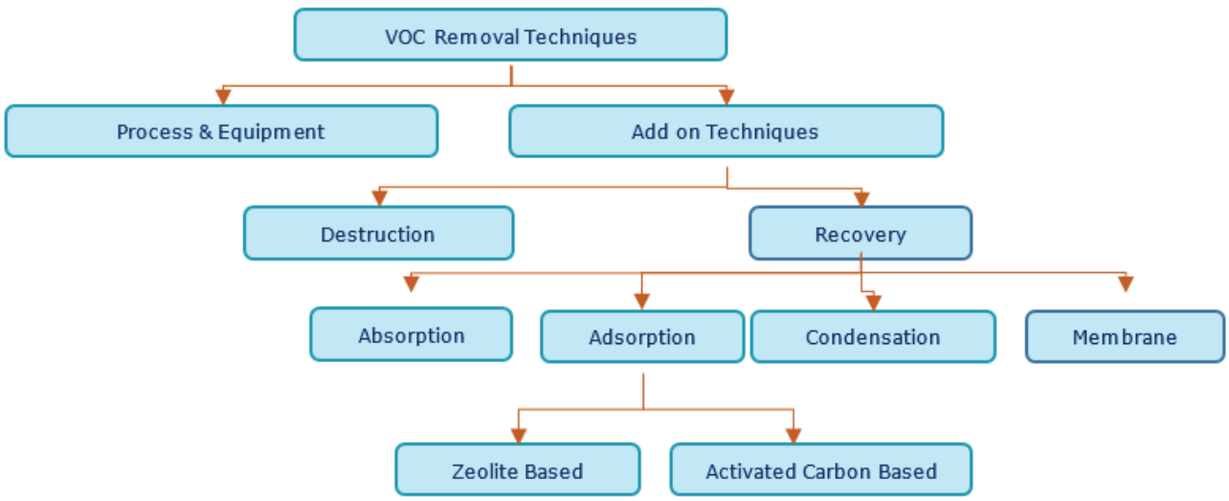
3.5 Chemicals Sector: Characterized as Major VOC contributor

The chemical industry includes producers of commodity chemicals such as organic and inorganic chemicals and industrial gases, and specialty chemicals such as pharmaceutical products and essential oils. It also includes mixing, blending, diluting, or converting basic chemicals to make chemical products and preparations, e.g. paints, pesticides, inks, detergents, and cosmetics. These industries are some of the major pollution sources in chemicals sector.

In terms of value and production volume, Indian chemical industry is the 3rd largest producer in Asia and 6th by output in the world. Indian chemical industry could grow at 11 per cent p.a. to reach size of USD224 billion by 2017. In 2016, India chemicals industry had a market size of USD139 billion. Six major chemicals produced in India are Methanol, Aniline, Alkyle Amines and its derivatives like Formaldehyde, Acetic Acid and Phenol.

Air pollution from chemical industries is not limited to dust particles but as many of these set-ups release harmful gases and Volatile Organic Compounds. Due to industrial activities, a variety of poisonous gases like NO, SO2, NO2, SO3, Cl2, CO, CO2, H2SO4 etc.

List of Volatile Organic Compounds	Available Techniques
• Acetaldehyde • Acetone • Benzene • Carbon tetrachloride • Ethyl acetate • Ethylene glycol • Formaldehyde • Heptane • Hexane • Isopropyl alcohol • Methyl ethyl ketone • Methyl chloride • Monomethyl ether • Naphthalene • Styrene • Toluene • Xylene	• Thermal Oxidation • Catalytic Oxidation • Bio filtration • Condensation • Absorption • Absorption Activated Carbon • Zeolite • Membrane Separation



3.6 Indoor Air Pollution: Struggle for Better Air Quality in Home

Chemicals, Molds, Particulates, and Poor Ventilation are the major causes of Indoor air pollution. Indians spend more than 90% of their time indoors like hours spent while sleeping, working in offices, at schools, colleges, etc. Indoor Air Quality is a major concern in India as indoor air is around 3 – 5 times more polluted than outdoor air. Poor indoor air quality can result in major adverse effects on our health and environment and indoor air pollution is classified as one of the top environmental risks to the people health.

Indoor air can be defined as the air occupied in a building at least for one hour and indoor spaces comprise of homes, offices, classrooms, shopping malls, restaurants, hospitals, hotels, etc. Indoor air quality can be characterized as inclusiveness of traits of indoor air that affects human health and well-being. Chemicals, gas cookers and gas or fueled heaters are few of the major concerns of indoor air pollution and they significantly contribute amount of pollutants in residences. Even the homes are being constructed with better protection from outdoor pollutants, the pollutants released indoor are found in higher concentration. Other pollutants which have high impact on indoor air quality constitutes of bacteria & molds, dust mites, cleaning chemicals, fumes from volatile organic compounds, air toxins and particulates.

Over 85% of rural households and around 25% of urban households use biomass for cooking leading to rising indoor pollution, which is increasing risk of respiratory and pulmonary issues. Moreover, around 30% of rural households use Kerosene as primary source of energy for lighting lanterns, which causes emission of carbon black soot and have considerable health impact.

Improving Indoor Air Quality: Measures to improve indoor air quality, the most efficient way is to eliminate or seal the sources causing pollution like asbestos

containing sources can be sealed, reduction in amount emissions from gas stoves, prevention from animal dander and usage of environment friendly cleaning chemicals. Source control is basically, the most cost effective way to control Indoor pollution. Improved ventilation is another approach for lowering the containment of pollutants from indoor air like room or bathroom exhaust fans directly remove contaminants from the room area and increase ventilation rate of the room. This would, significantly improve indoor air quality by reducing level of contaminants.

Air purifiers also play a significant role in controlling air quality indoors. Some air purifiers are highly effective in removal of particulate matter and some remove the gaseous pollutants. Installing an air purifier can be an expensive option for indoor air pollution control. However, since last few years, with increasing consumer awareness about air purifying products along with rising inclination towards lifestyle products and increasing health awareness about respiratory diseases among people coupled with factors such as increasing purchasing power, the market for air purifiers has witnessed a high growth.

Demand for air purifiers from healthcare sector is also anticipated to increase in the coming years. To ensure clean air for the patients, hospitals are increasingly installing air purifiers in their premises. With increasing tourism activities in the country, air purifying products have increasingly been accepted to clean indoor air in hotels, guest houses, etc. to provide the guest a clean indoor environment.

4.

Policy & Regulatory Landscape

Some of the major policies and regulations laid out by the Indian Government to control air pollution are The Air (Prevention and Control of Pollution) Act, 1981: This act was passed in 1981 by the Parliament and was amended in 1987 to prevent, control and abatement of air pollution. This act allows the state governments to declare air pollution control area. This Act also prevents a person or a company to establish or operate any industrial plant without the previous consent of State Pollution Control Board. The Act is governed by the Central Pollution Control Board (CPCB) followed by respective State Pollution Control Board (SPCB). Initiatives taken by the Central and State Governments to curb pollution levels in the country include,

solid waste.

- Formulation of environmental regulations / statutes
- Setting up of monitoring network for assessment of ambient air quality
- Introduction of cleaner / alternate fuels like gaseous fuel (CNG, LPG etc.), ethanol blend etc.
- Promotion of cleaner production processes
- Implementation of Bharat Stage IV (BS-IV) norms in 63 selected cities and universalization of BS-IV by 2017
- Taxation of polluting vehicles and incentivizing hybrid and electric vehicles
- Comprehensive amendments to various Waste Management Rules including Municipal Solid Waste, Plastic Waste, Hazardous Waste, Bio-medical Waste and Electronic Waste
- Notification of Construction and Demolition Waste Management Rules
- Ban on burning of leaves, biomass, municipal solid waste.
- Promotion of public transport network of metro, buses, e-rickshaws and promotion of carpooling, Pollution Under Control, lane discipline, vehicle maintenance
- Revision of existing environmental standards and formulation of new standards for prevention and control of pollution from industries
- Issuance of directions under Section 18(1)(b) of Air (Prevention and Control of Pollution) Act, 1981 to NCR States (Haryana, Uttar Pradesh, Rajasthan and NCT of Delhi) for control of air pollution in NCR and NCT of Delhi. These directions covered a series of 42 time-bound action points viz. control of vehicular emissions; road dust/re-suspension of dust and other fugitive emissions; air pollution from bio-mass burning; industrial air pollution; air pollution from construction and demolition activities; etc.
- Issuance of directions under Section 5 of Environment (Protection) Act,1986 to 22 Local bodies of NCR regarding control of burning of garbage, checking dust from construction and demolition activities.
- Installation of on-line continuous (24x7) monitoring devices by major industries.
- Revision of emission standards including thermal power plants, cement plants, etc.
- Ban on stubble burning in NCR States.

- Collection of Environmental Protection Charge on more than 2000 CC diesel vehicles at the time of registration as per the directions of Hon'ble Supreme Court.
- Phasing out of 15-year-old diesel vehicles in Delhi.
- Ban on import of fire crackers from any country under Section 31 (A) of Air Preventi

Pollution management related to transport and industries is carried out through emissions and effluents norms laid down by the Government. There are 56 emission and 45 effluent standards in respect of 77 categories of industries. The emission norms for transport sector are laid down by Ministry of Road, Transport & Highways.

The management of air pollution due to road dust is regulated under Air (Prevention and Control of Pollution) Act, 1981. The measures taken to improve the infrastructure to check pollution including data collection on pollution levels in India include formulation/revision of emission norms for various categories of industries, which requires appropriate improvement in infrastructure to comply with these norms as well as setting up of continuous ambient air quality monitoring stations. To improve the air quality standards and air quality monitoring, the government has been allocating funds to various national as well as state pollution control bodies.

Government has also laid out various measures to control air pollution which include prohibition of open burning of any kind of solid waste, control of pollution from construction and demolition activities, mechanized/vacuum cleaning of roads, promotion of battery operated vehicles, universalization of BS-IV by 2017 & leapfrogging from BS-IV to BS-VI fuel standards by 1st April 2020. Central pollution control board has set National Air Quality Index (AQI), which is a web-based system designed to provide AQI on real time

Environment Protection Spending as a Share of Total GDP by Select Countries, 2016

AQI Category (Range)	PM 10 24-hr	PM 2.5 24-hr	NO2 24-hr	O3 8-hr	CO 8-hr (mg/m3)	SO2 24-hr	NH3 24-hr	Pb 24-hr
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.5 –1.0
Moderately polluted (101-200)	101- 250	61-90	81-180	101-168	2.1- 10	81-380	401-800	1.1-2.0
Poor (201-300)	251- 350	91-120	181- 280	169-208	10-17	381-800	801- 1200	2.1-3.0
Very poor (301-400)	351- 430	121- 250	281- 400	209- 748	17-34	801- 1600	1200- 1800	3.1-3.5
Severe (401-500)	430+	250+	400+	748+	34+	1600+	1800+	3.5+

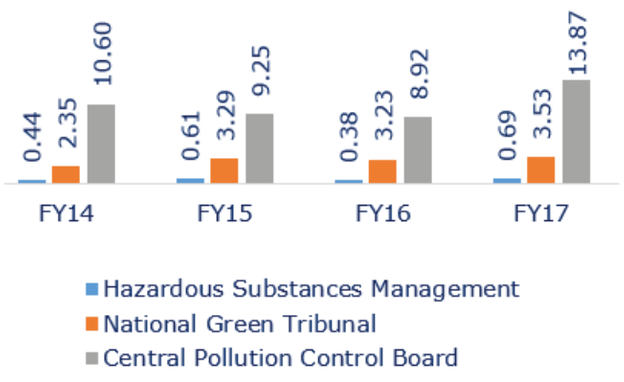
Source: OPEC, MOEF

basis considering eight pollutants i.e. Sulphur Dioxide, Nitrogen Dioxide, Lead, Ozone, PM10, PM2.5, Carbon Monoxide and Ammonia daily as prescribed in the national Ambient Air Quality Standards (NAAQS-2009).

In 2015, India, as part of its Intended Nationally Determined Contributions (INDCs), announced its commitment to reduce emission intensity of its GDP by 33 to 35 percent from 2005 levels by 2030. This goal is to be implemented between the period 2020 and 2030.

India's realization of INDC goals is contingent upon the support on finance, transfer of environmentally sound technologies and capacity building to be provided from available domestic and international sources. A preliminary estimate suggests that at least USD 2.5 trillion (at 2014-15 prices) will be required for meeting India's climate change actions between now and 2030.

Funds Allocated by Indian Government to Hazardous Substances Management, National Green Tribunal & Central Pollution Control Board, FY14-FY17 (USD Million) Funds Released Various



Source: Ministry of Environment Forest & Climate Change

State Pollution Control Boards Under National Air Quality Monitoring Programme (NAMP), FY14-FY17 (Till Oct) in USD Thousand

Name of Monitoring Agency	2013-14	2014-15	2015-16	2016-17 Till Oct 2016
Andhra Pradesh SPCB	130.0	117.9	0.0	0.0
Assam SPCB	133.7	120.7	0.0	0.0
Chandigarh PCC	30.6	0.0	0.0	0.0
Chhattisgarh ECB	0.0	0.0	23.5	0.0
Gujarat SPCB	58.6	0.0	0.0	0.0
Goa SPCB	136.7	109.6	119.8	0.0
Himachal Pradesh SEP & PCB	85.8	0.0	155.8	0.0
Karnataka SPCB	0.0	5.4	103.8	0.0
Kerala SPCB	0.0	99.6	0.0	0.0
Maharashtra SPCB	114.9	0.0	0.0	251.0
Meghalaya SPCB	35.3	0.0	120.7	0.0
Madhya Pradesh SPCB	0.0	0.0	0.0	122.8
Mizoram SPCB	91.3	27.2	83.3	0.0
Nagaland SPCB	20.9	13.9	0.0	56.3
Orissa SPCB	0.0	88.2	0.0	0.0
Punjab SPCB	0.0	119.9	0.0	0.0
Puducherry	0.0	0.0	0.0	78.6
Rajasthan SPCB	0.0	0.0	64.9	0.0
Tamil Nadu SPCB	67.7	36.3	0.0	0.0
Uttar Pradesh SPCB	147.5	0.0	111.7	0.0
Uttarakhand EP&PCB	56.8	0.0	62.9	0.0
NEERI	0.0	108.4	209.4	342.9
IIT Kanpur	6.9	57.1	0.0	0.0

Source: Central Pollution Control Board

5.

Initiatives by Private Organizations & NGOs

Down to Earth

Down to Earth is an Indian science and environment NGO which was started by environmentalist Anil Agarwal, in 1992. The organisation creates awareness among people regarding the harmful effects of air pollution in India as well as globally.

Clean Air Asia India

Clean Air Asia India is an international non-governmental organization working in India to improve air quality and contribute to more liveable and healthy cities. The organisation plans work with state and central government to chalk out effective plans to improve air quality and to help key stakeholders including non-environment NGOs to focus on clean air quality.

Blueair: Clean Air India Movement (CLAIM)

Blueair, an air purifier and filter manufacturing company launched Clean Air India Movement (CLAIM) across the country in May 2015. Through this mission, the organisation means to engage, educate and encourage Indian citizens to adopt air friendly measures. The company also organises events to raise awareness regarding air pollution in India.

HDFC Ergo

Under its CSR Program, the company distributed 10,000 pollution masks among school students in 2017 in Delhi ahead of the Republic Day celebrations due to high levels of air pollution. The company raised awareness among students, teachers and supporting staff. Through this initiative, 10,000 washable and re-usable pollution masks were distributed among the students of 8 government schools.

6.

Case Study: Air Pollution Levels in Delhi NCR

Booming infrastructural development and growing migration has resulted in Delhi, becoming the sixth-most populated metropolis in the world (second largest if the entire NCR is included). These factors have also resulted in high levels of particulate matter and harmful gaseous substances in the region. Air pollution in Delhi is caused mainly by industry. As many as 10,000 people a year may die prematurely in Delhi as a result of air pollution.

The recent example of severe air pollution is a proof of the criticality of current air pollution situation in New Delhi. During late October and early November, air pollution levels in Delhi region reached extremely high levels, in some areas, such as the Pitampura suburb of north Delhi, PM2.5 levels increased to around 1,000 whereas PM10 levels were more than 1,500μg/m³. According to WHO recommendation the annual average levels of PM2.5 & PM10 should be below 60 & 100.

The main factors that were highlighted for this abnormal increase in the air pollution levels were pollution caused by crackers, the burning of crop stubble, especially paddy by farmers across the states of Punjab, Haryana and Western UP during the post monsoon harvest period. Average annual levels of PM10 in Delhi is around 166 making it 11th most populated city in the world.

Vehicles, road dust, industries and construction accounts for around 90% of particulate matter levels in the region. Central and state government taken some steps to control the air pollution levels however, these steps have not been enough to tackle the rising levels of air pollution in Delhi region.

7.

Air Pollution Control Measures in China

Air pollution has become a major issue in China and poses a threat to Chinese public health. Air pollution has become China's major health concern in the recent years. China has been the world's fastest-growing major economy, growing at an average rate of 10% since past 30 years till 2015. The country's government has been taking strict actions to control the air quality in China. The State Council issued an Action Plan for the Prevention and Control of Air Pollution in September 2013 and a four colour alert system based on air quality index was introduced in 2013 and updated in 2016 under which, it provides colour based alert system depending upon the air quality for the next 24 hours.

Air Quality Index	Categorisation
101-150	Slight Pollution
151-200	Moderate Pollution
201-300	Heavy Pollution
301-500	Hazardous Pollution

- **Blue Alert:** Means heavy air pollution levels in next 24 hours. Factories are asked to reduce their emissions
- **Yellow Alert:** Means hazardous air pollution levels in next 24 hours or heavy air pollution levels for next three days. Quarries should suspend some of their operations, streets and construction sites should be sprinkled with water.
- **Orange Alert:** Means Alternate Heavy pollution levels and Hazardous pollution levels for three consecutive days. Suspension of all the operations at construction sites and quarries, partial or complete shutdown of factories, banning of fireworks, cancellation of outdoor activities in schools along with measures taken during yellow alert.
- **Red Alert:** Means average of heavy pollution levels for four consecutive days, hazardous pollution levels for two consecutive days or average AQI over 500 for one day. Schools should be shutdown, flexible working hours in public organisations, along with measures taken during orange alert.

China is now taking its air quality seriously and it currently spends USD2.6 billion to control air pollution in Beijing alone. Moreover, the country also spends around 1.45% of its total GDP on environmental control. According to Techsci Research, this level of commitment is necessary by Indian government to control air pollution levels in India.

8.

Air Pollution Control & Monitoring Products Market Overview

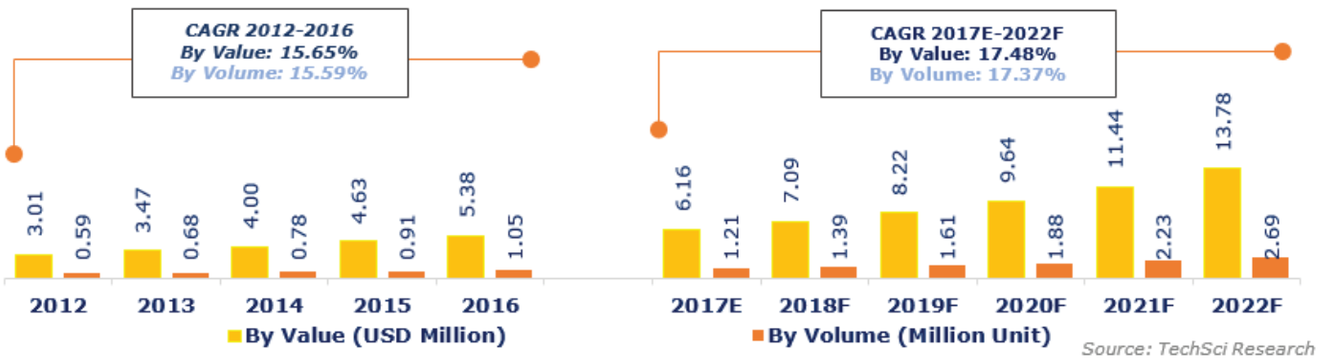
Pollution Masks:

Pollution Masks is the one that filters out airborne particles and prevent consumer form exposure to harmful gases. A Pollution Masks consist of a high-quality filter that fits on face accordingly and works effectively to prevent consumers against the inhalation of harmful pollutant particles as small as PM 2.5 and gases such as NO2, SO2, etc. In 2016, India pollution masks market generated revenue worth USD5.38 million, and is anticipated to reach USD13.78 million by the end of 2022. According to WHO the number of deaths in India caused by air pollution is only a 'fraction less' than the number of deaths caused by tobacco usage, and adds that three per cent of the GDP is lost due to air pollution.

Backed by rapid urbanization, increasing purchasing power, expanding urban population base and depleting air quality, India pollution masks market grew at a CAGR of 15.65%, in value terms, during 2012-2016.

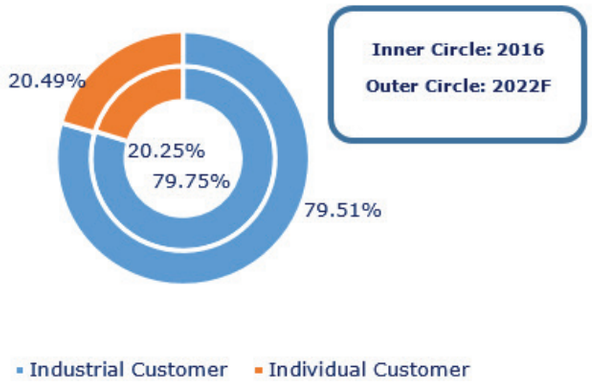
Owing to rising health concerns, consumers are spending heavily on life saving products, including pollution masks. Rising concerns about the harmful effects of air pollution in developed as well as developing countries is increasing the awareness about benefits of pollution masks. Pollution masks are increasingly being recommended to patients having respiratory diseases and pollen allergies

India Pollution Masks Market Size, By Value (USD Million), By Volume (Million Unit), 2012-2022F



Source: TechSci Research

India Pollution Masks Market Share, By End User, By Value, 2016 & 2022F



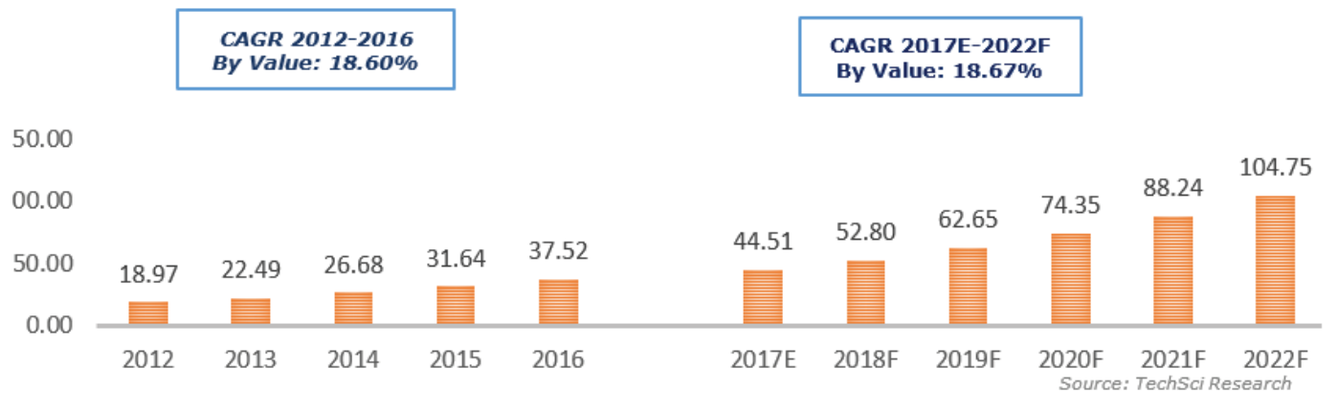
Source: TechSci Research

Air Quality Monitoring Equipment:

Increasing enforcement of stringent government regulations, this factor is reflecting positively on the demand for air quality monitoring equipment, in India.

With awareness about environmental degradation and the ill effects caused to human beings by air pollution on the rise, the idea of saving the environment has emerged as a corporate responsibility. This scenario

India Air Quality Monitoring Equipment Market Size, By Value (USD Million), 2012-2022F



Source: TechSci Research

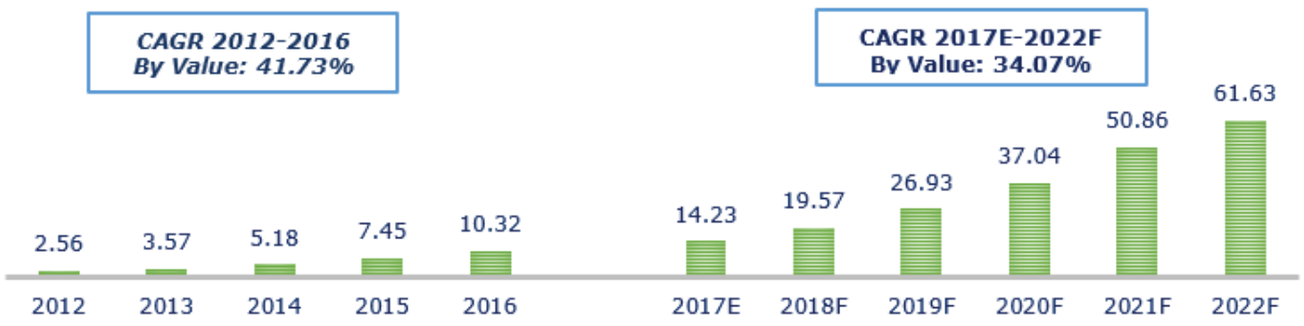
Increasing efforts by various government and non-government associations to develop environment friendly industries has also been affecting the market in a positive direction.

Key products within the market include Air Pollution Sampler, Anemometers, Gas Analysers and Detectors, Particle Counter, and Nitrogen Oxides (NOX) and Electrostatic Precipitators (ESP) Control Systems. Indoor air quality is a growing concern in recent past in India, consequently, these air quality monitors are now being installed in many indoor areas such as offices, retail, hospitals etc. In the industrial sector, power, cement, steel and textile sector are the major demand generating sector for the market.

the demand for pollution control technologies and has in turn expanded the air pollution control equipment in India.

Apart from the demand driven by industrial growth, the air pollution control equipment market has received adequate growth impetus from the Ministry of Environment and Forest through the revision of National Ambient Air Quality Standards (NAAQS). The recent revision has lifted the cap between industrial and residential areas. During the forecast the market is expected to cross USD104 million by growing at a CAGR for 18.67%.

India Residential Air Purifiers Market Size, By Value (USD Million), 2012-2022F



Source: TechSci Research

Residential Air Purifiers:

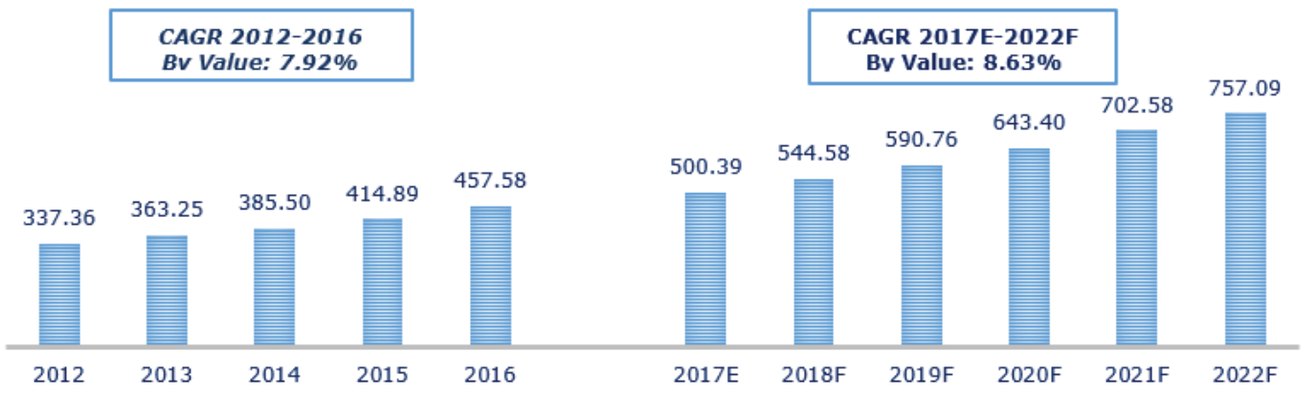
Residential sector accounted for a revenue share of around 22% in the overall India air purifiers market in 2016 and this is projected to reach more than 24% by 2022, on account of growing awareness among consumers about indoor air pollution and the increasing incidence of air borne diseases in India, due to the air pollution.

Initially, people with respiratory and other breathing related diseases were the major end users of air purifiers. However, with increasing awareness, people are using air purifiers to prevent air borne diseases. Respiratory diseases such as Bronchitis and Asthma are growing at an alarming rate in India, affecting a large number of people. As per WHO reports, around 12 million people in India are suffering from Chronic obstructive pulmonary disease (COPD) and around 26.3 million people are suffering from acute respiratory diseases. Rising air pollution, both outdoor as well as indoor, is solely responsible for this phenomenon. This creates significant potential for air purifiers in the residential and institutional sector.

Pollution in Northern parts of India especially Delhi NCR, which is also counted among the most polluted regions in India with high concentration of PM10 in air. As a result, the demand for residential air purifiers from northern India has been increasing.

Air purifier manufacturing firms are selling products directly to companies and institutions, without putting any effort on advertising or marketing front. This is due to the fact that air purifiers are considered a niche product in markets like India, wherein, a massive percentage of people still live below the poverty line. In such as scenario, the demand limits to a specific section of the society for which the product is affordable.

India Air Filters Market Size, By Value (USD Million), 2012-2022F



Source: TechSci Research

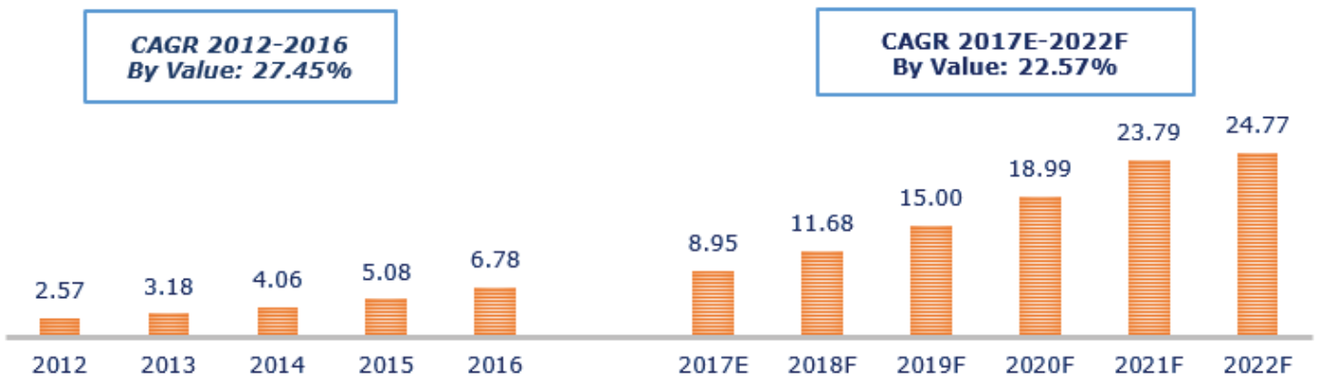
Air Filters Market:

With rising vehicle production and increasing installation of air filters in cement manufacturing units across the country, the market of air filters in India grew at a robust CAGR of 13.14%, in value terms, during 2012-2016 and generated revenues worth USD862 million in 2016. Also, the need for frequent replacement of air filters in the construction sector is spurring demand for air filters throughout region.

Sales of HVAC air filter segment witnessed high penetration in commercial sector in comparison to residential sector, thereby fueling air filters market in India. Majority of the revenues in APAC air filters market are generated from power plant industry in India. In 2013, the country registered 71 gas turbine power plants in contrast to China with around 25 and Japan with 40 gas turbine plants. Moreover, sales of bag house air filters in India was also driven by presence of coal fired power plants in the country, wherein India had around 147 coal fired power plants, followed by China with ~80 plants.

Rising concerns about harmful effects of air pollution in developed as well as in developing economies is propelling demand for air filters among people. Demand for air filters in residential sector is also increasing owing to rising penetration in lung related diseases and allergies. Rising tourism sector and strong growth in the hospitality sector is pushing demand for air filters from the commercial sector.

India Industrial Air Purifiers Market Size, By Value (USD Million), 2012-2022F



Source: TechSci Research

Industrial Air Purifiers:

Industrial segment consists of factories, warehouses, etc. Industrial segment accounted for a revenue share of 15% in India air purifiers market in 2015. The industrial segment mostly employs electrostatic precipitator filter type air purifiers, which removes fine particles such as dust and smoke, from a flowing gas using force of an induced electrostatic charge, thereby minimally impeding the flow of gases through the unit.

In India, due to the high prices of air purifiers, companies used masks to reduce the impact of pollution on employees working in factories, warehouses and other industrial establishments. Electrostatic precipitator filter type air purifiers were introduced and used as they were more efficient and effective as compared to masks. Although, awareness about using air purifiers in industrial spaces is rising, high prices associated with air purifiers makes these products less affordable. Thus, the value share of industrial segment in India air purifiers market is expected to decline during the forecast period.

9.

Conclusion

In the current need of the hour it is necessary for Indian Government and pollution monitoring agencies to design better norms which can help in reducing the air pollution levels. Pollution control norms in many sector such as cement and mining sectors are still outdated, this is partly due to the outdated process and machinery used by many industries. A more robust environmental impact assessment should be done. Vehicle emissions have resulted in increased levels of NO2 and Sulphur. In many parts of the country vehicle pollution control norms are still not followed diligently.

Control of air pollution in India is mainly focused on urban centres with major spending and monitoring being done only in major cities consequently neglecting the rural and semi urban centres. A recent case witnessed was high air pollution levels in Delhi and other central parts of India in 2016 the rural areas were totally ignored initially as the actual source of pollution was the rural areas of UP, Punjab and Haryana where the source of pollution was high stubble burning by the farmers during the post-harvest season. An equally controlled check is also necessary in these areas to improve the air quality across the country.

States Governments are also required to play a pivotal role in air quality control by establishing a policy and regulatory framework. Initiatives such as institutional mechanisms for medical research and monitoring in the area of air pollution with a view to influence policies can be done to get better insights about the actual situation. India needs to increase its revenue spending to prevention and control of pollution as the current spending on air pollution control is not enough affect much on air quality.

Lessons can be taken from policies such as reduction of sulphur dioxide levels which resulted due to various measures taken such as reduction of sulphur in diesel, use of LPG instead of coal as domestic fuel conversion of diesel vehicles to CNG.

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