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ASSOCHAM
INDIA

Bio-Medical Waste & Air Pollution

Emerging Hazards and Better Understanding of Health Risks

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महानिदेशक स्वास्थ्य सेवाएँ
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Message

It is heartening to know that the Associated Chambers of Commerce and industry of India is organizing Conference on Management of Bio medical waste and Air pollution on 13th February, 2019 at New Delhi, in collaboration with Directorate General of Health Services, Department of Health and Family Welfare, Govt. of NCT of Delhi.

Safe and effective management of waste is not only a legal necessity but also a social responsibility. Lack of concern, motivation, awareness and cost factor are some of the problems faced in the proper biomedical waste management. Clearly there is a need for education as to the hazards associated with improper waste disposal. Education of the staff about the management of biomedical waste is crucial in today's health care arena.

Air pollution is one of the major man made environment risks to public health. WHO estimates that around 7 million people die every year from exposure to fine particles in polluted air that lead to diseases such as stroke, heart disease, lung cancer, chronic obstructive pulmonary diseases and respiratory infections including pneumonia.

Congratulations to ASSOCHAM, Associated Chambers of Commerce and Industry of India for organizing the National Conference on "Management of Biomedical Waste and Air Pollution"

6/2/19
(Dr. Nutan Mundeja)

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Bio medical waste management is a crucial need in the country today. There is an increasing concern about harmful effects of biomedical waste generate by health care facilities. Bio medical waste is infectious in nature. Inadequate management of biomedical waste can be associated with risks to healthcare workers, patients, communities and their environment. To ensure safe and proper disposal of biomedical waste, MoEF has notified Bio Medical Waste Management Rules, 2016 amended in 2018. The rules make hospital and owner of the medical waste treatment facility liable for all damages caused due to improper handling of waste.

Air pollution is one of the most formidable health hazards today and addressing these issues is one of the most challenging tasks facing us. The first step is to gather comprehensive details of sources of air pollution and define regional specific indices. This information will help in designing need based solutions.

Congratulations to ASSOCHAM, Associated Chambers of Commerce and Industry of India for organizing the National Conference on "Management of Biomedical Waste and Air Pollution"

(Dr. RAVINDRA AGGARWAL)

ASSOCHAM
INDIA

UDAY KUMAR VARMA
Secretary General

<u>MESSAGE</u>

We are happy to share that ASSOCHAM is organizing National Conference on Management of **Bio-Medical Wastes and Air Pollution with a theme *"Addressing Challenges and Solutions towards Sustainable Human Health"*** in collaboration with Directorate of Health Services, Government of N.C.T. of Delhi.

India has the unique opportunity to be environmentally smart, at the urban and the regional scale, and this boils down to two challenges: (a) securing greater Healthcare Establishments (HCFs) awareness of the bio-medical waste problems and commitment to action and (b) ensuring that action to tackle air pollution is seen in the context of wider social and economic development. These challenges not only pose risks to the environment but also for the human health nationwide and cannot be addressed in isolation: it is closely linked to policies for healthcare, energy, climate, transport, trade, biodiversity and other issues.

ASSOCHAM is committed to create more awareness on all the issues relating to effective management of Bio-medical Wastes & Air Pollution and the Background Paper jointly prepared by ASSOCHAM and TechSci Research is a step in this direction. I also extend my heartiest thanks to all the stakeholders including NITI Aayog, Ministry of Environment, Forest & Climate Change, UNIDO and CSIR for lending their support for this conference.

The proper understanding of the current requirements to bridge the gap across the sectors and the launch of this report is just the beginning of the revolutionary change that can be envisioned for the country, but will prove to be one of the most critical nodes in the fabric of sustainable human health.

(UDAY KUMAR VARMA)

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Bio-medical waste management and air pollution control are among the major challenges impacting the health of humans. In India, they have emerged as major health hazards, leading to several human health related risks. The health risks arising from these collectively account for a significant share of healthcare spending in the country. Notwithstanding the challenges surrounding them, it also offers an opportunity for companies to aggressively focus on this high growth segment of the healthcare market.

This report provides deep insights and actionable data related to the biomedical waste management and air pollution control in India. It highlights the problems and provides information about the various policies developed by the Government of India to control these health hazards. According to TechSci Research, the market for Biomedical waste recycling is valued at INR111 crore in 2018 and is expected to grow at a rate of 10% over the next five years. Plastic and Glass are the two major industries accounting for more than 65% of the market share and are using recycled waste as a raw material for manufacturing different products.

Increasing air pollution has given rise to various new product categories such as air pollution masks and air purifiers. According to TechSci Research, the pollution masks market in India is worth INR46 crore in 2018 and is growing at a CAGR of 19% over the past five years. Moreover, the air purifiers market in the country was valued at INR72 crore in 2018 and is growing rapidly at 30% CAGR since 2014. The report also includes actionable business insights about the incumbent industries.

Over the recent years, the regulations in India relating to the bio-medical waste management and air pollution control has become more stringent. The Government of India in collaboration with various knowledge development bodies such as Centre for Science and Environment (CSE), The Energy Resources Institute (TERI) and other government entities such as Central Pollution Control Board (CPCB), is coming up with new policies to develop the waste management and pollution control infrastructure in India. Also, the judiciary in the form of Supreme Court and the National Green Tribunal have been active in giving judgements on waste management and pollution control in India. The above policy measures and regulations will certainly help in controlling health risks due to bio-medical waste generation and air pollution over the years to come.

Message from TECHSCI

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INTRODUCTION

Bio-medical waste (BMW) includes all the waste produced during the diagnosis, treatment, or immunization of human or animal research activities pertaining to the production or testing of biological or in health camps. BMW treatment and disposal facility means any facility wherein treatment, disposal of BMW or processes incidental to such treatment and disposal is carried out. Bio-medical waste generated from health care units depends upon several factors such as waste management methods, type of health care units, occupancy of health care units, specialization of health care units, ratio of reusable items in use, and availability of infrastructure and resources.

Government of India has specified that Hospital Waste Management is a part of hospital hygiene and maintenance activities, involving the management of a range of activities such as collection, transportation, operation or treatment of processing systems, and disposal of waste.

India is likely to generate nearly 780 tons of medical waste per day by 2022, up from 550 tons per day in 2018. Expansion of health care facilities coupled with the trend of using disposables is leading to an unprecedented burden of health care related waste in the country. Waste management market in India is projected to reach USD13.62 billion by 2025, with major waste sections such as municipal solid waste management, e-waste and bio-medical waste projected to grow at a CAGR of 7.14%, 10.03% and 8.14% by 2025, respectively.

Air pollution refers to contamination of the ambient air by a substance, which has poisonous and harmful effects. Lately, in India, air pollution has reached alarming levels. According to latest estimates by the World Health Organization (WHO), about 90% of the global population is exposed to dangerous pollution levels and 14 of the world's 15 most polluted cities are in India. In fact, air pollution, especially particulate pollution in the National Capital Region, during the winter months makes the region almost inhabitable for small children and senior citizens.To evince public interest and make the understanding of air pollution lucid to the general public, an index namely the Air Quality Index (AQI) has been developed. AQI transforms air quality data of various pollutants into a single number (index value), nomenclature and color. This index is a useful resource for the planning of measures to combat pollution. For instance, recently, in the Indian city of Delhi, only odd-numbered cars were allowed to ply on odd-numbered days and even-numbered cars on even-numbered days. Similar measures had been introduced in Beijing earlier to combat

Some of the major industries that are the primary contributors to air pollution are:

Energy Industry: India produced 1,497 TWh of electricity in 2017, behind only China and the United States in terms of production. With rapid economic growth in the country, demand for power is growing at a robust pace. Power production in India is primarily based upon fossil fuels such as coal and gas, especially coal. This significantly contributes to greenhouse gases in the atmosphere such as carbon dioxide and buildup of dangerous particulate matter.

Mining Industry: This industry is another major contributor of particulate pollution, which gets scattered in human settlements through wind.

Cement Industry: Rapid economic growth and infrastructure development in developing countries like India goes hand in hand with the growth of industries like cement.

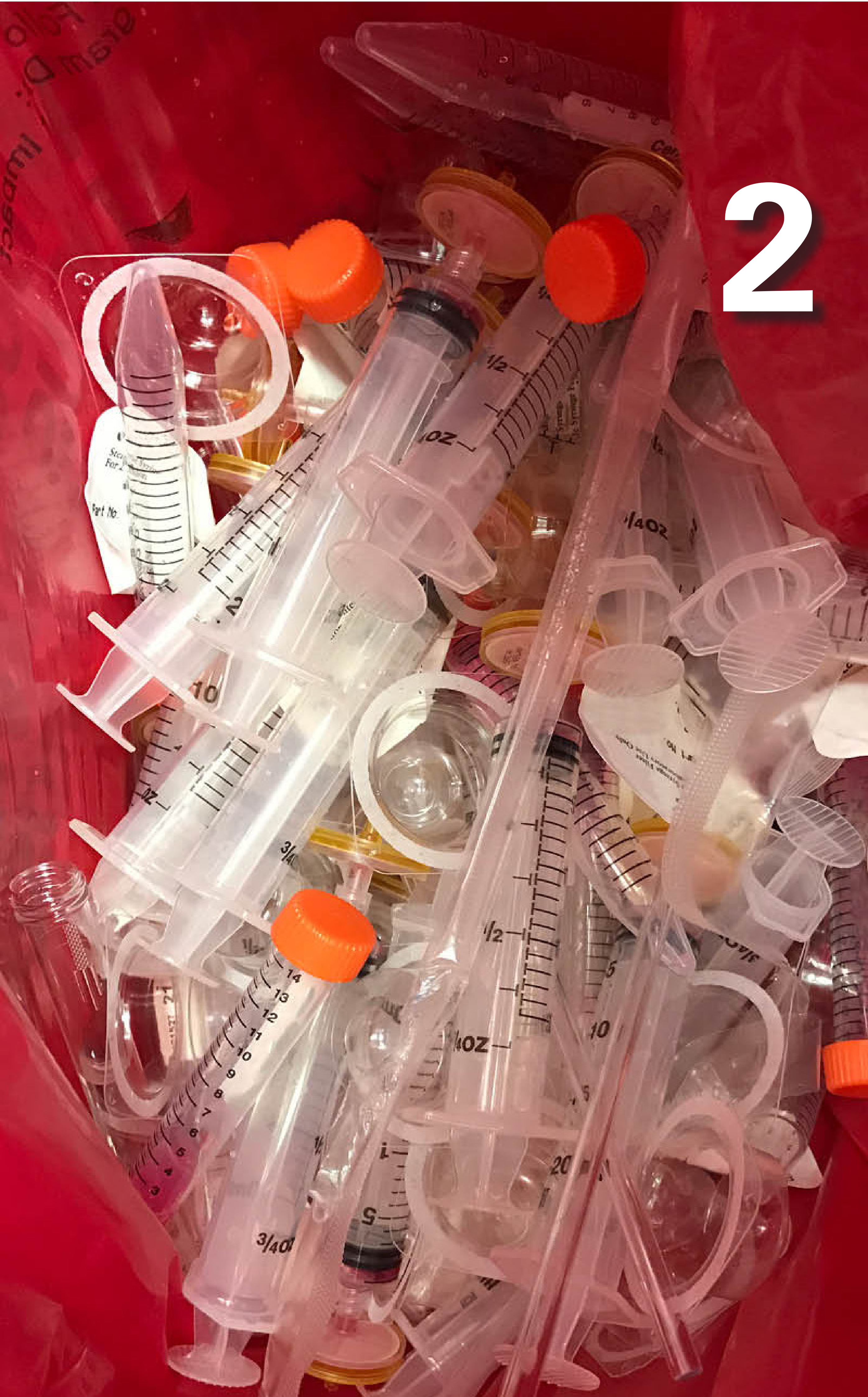
Automotive Industry: Like power production in India, transportation industry is also dependent upon fossil fuels. Government has undertaken several measures such as switching of the entire public transport in Delhi to natural gas in order to address the air pollution concerns in the region. Moreover, emission norms in India are currently guided by Bharat Stage IV (BSIV) norms. The government has also announced its plans to completely skip the BSV standard and shift to BSVI standard by 2020.

Chemical Industry: India is the third largest chemical producer in Asia and sixth largest, in terms of output, globally. Major pollutants not only include dust particles, but harmful gases and volatile organic compounds.

Indoor Air Pollution: India is one of the largest populated countries in the world, where in some areas, cooking is still done on open stoves, leading to contamination of indoor air with both particulate matter and other gases. To counter this, the government has come up with various schemes such as 'Ujjwala Yojana', under which gas connections have been provided to rural women at a subsidized rate. The government of India has provided close to 60 million connections under this scheme.

Leather Industry: Tanneries are one of the major sources of pollution for both air and water. They release unpleasant smells and gases such as H2S, NH3, Cl2 and VOCs (volatile organic compounds).

Various measures have been implemented by the government to counter the effects of air pollution such as Air (Prevention & Control of Pollution) Act, 1981, National Air Quality Monitoring Program, The Environment (Protection) Act, 1986 and National Clean Air Program. Also, under orders of the Supreme Court, a graded response plan has been prepared for the National Capital Region, which is facing severe pollution hazards. Air pollution has been taken up as the priority issue by various public sector bodies such as the Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) and private bodies such as The Energy and Resources Institute (TERI) and Centre for Science and Environment (CSE). Air pollution, which is one of the biggest modern-day challenges, is evincing interest all over the world, especially in developing countries like India and China. It is one of the biggest burdens on government spending on healthcare and has significant impact on the GDP.



2

Biomedical Waste
History and Current Scenario

IN JULY 1998, first Bio-medical Waste (BMW) rules were notified by Government of India, by the former Ministry of Environment, Forest and Climate Change (MoEFC). In India, BMW problem was further compounded by the presence of scavengers, who were collecting unprotected health care waste with no gloves, masks, or shoes for recycling.

During 2002–2004, International Clinical Epidemiology Network explored the existing BMW practices, setup, and framework in primary, secondary, and tertiary Health Care Facilities (HCFs) in India across 20 states. They found that around 80% of primary, 60% of secondary, and 50% of tertiary HCFs in India had no credible Bio-Medical Waste Management System (BMWMS).

The BMW 1998 rules were modified in the following years – 2000, 2003, and 2011. The draft of BMW rules 2011 remained as draft and did not get notified due to lack of consensus on categorization and standards. The Ministry of Environment, Forest and Climate Change amended the BMWM rule in March 2016. These new rules increased the coverage, simplified the categorization and authorization while improving the segregation, transportation and disposal methods to decrease environmental pollution. It has four schedules, five forms and 18 rules.

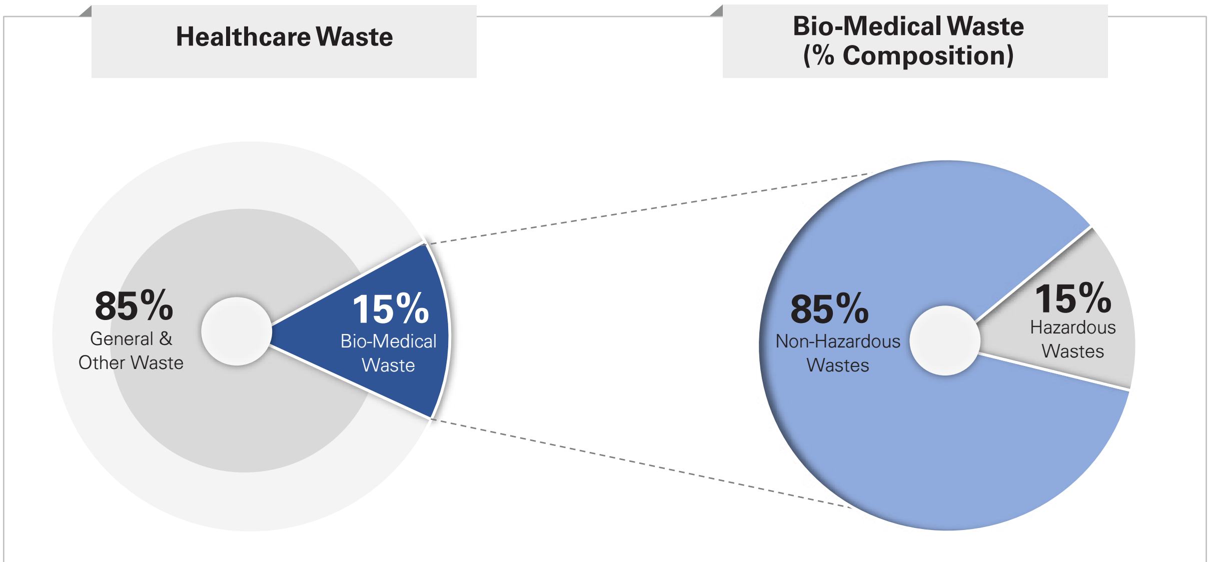
Bio-medical waste market in India is expected to grow at a rate higher than the overall health care services market in the country, on account of growing awareness level across Health Care Facilities, medical tourism, rising number of clinics, pressure from government for managing bio-medical waste, and implementation of strict rules and regulations by the Ministry of Environment, Forest and Climate Change.

> **During 2002–2004, 80% of primary, 60% of secondary, and 50% of tertiary Health Care Facilities** in India had no credible Bio-Medical Waste Management System (BMWMS) system.

India Bio-medical Waste Management Latest Amendments (2018)

- All the bio-medical waste generators such as hospitals, nursing homes, private clinics, dispensaries, veterinary institutions, pathological laboratories, healthcare facilities, blood banks, and animal houses are required to phase out chlorinated plastic bags (excluding blood bags) and gloves by March 27, 2019.
- All healthcare facilities should publish annual reports on their website within a period of two years from the date of publication of the latest Bio-Medical Waste Management Rules.
- Operators of common bio-medical waste treatment and disposal facilities shall establish a barcoding and global positioning system for handling of bio-medical waste in accordance with guidelines issued by the Central Pollution Control Board by March 27, 2019.
- Each and every person who has administrative control over the institution and the premises generating bio-medical waste shall pre-treat the laboratory waste, microbiological waste, blood samples, and blood bags through disinfection or sterilization on-site in the manner as prescribed by the World Health Organization (WHO) or guidelines on safe management of waste from health care activities and WHO Blue Book 2014 and then send to the common bio-medical waste treatment facility for final disposal.

2.1 Types of Waste Generated



Source: Central Pollution Control Board

Quantity of bio-medical waste is around 10% to 15% of the total waste generated from the Health Care Facility. This waste includes materials which have been in contact with the patient's blood, secretions, infected parts, biological liquids such as chemicals, medical supplies, medicines, lab discharge, sharps metallic and glassware, plastics, etc.

Health Care Waste

Biomedical Waste

- Human and animal anatomical waste like body parts, tissues, and organs.
- Soiled waste such as items contaminated with blood and body fluids like dressings cotton and swabs, in addition to expired or discarded medicines.

General Waste

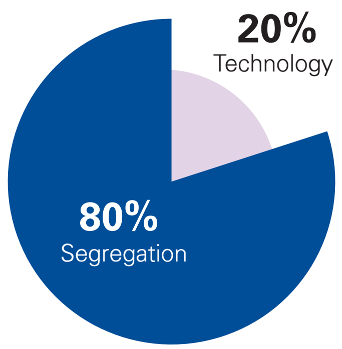
- Newspaper, paper and card boxes
- Plastic water bottles
- Aluminum cans of soft drinks
- Covering of different materials
- Compostable general waste

Other Waste

- E-Waste
- Used Batteries
- Radioactive Waste

2.2 Categories of Biomedical Waste

Medical Waste Management



Source: MOEFC

Incineration
Pathological waste and body parts, no chlorinated plastics

Autoclaving
All except body parts and pathological waste

Microwaving
All except pathological waste and metals

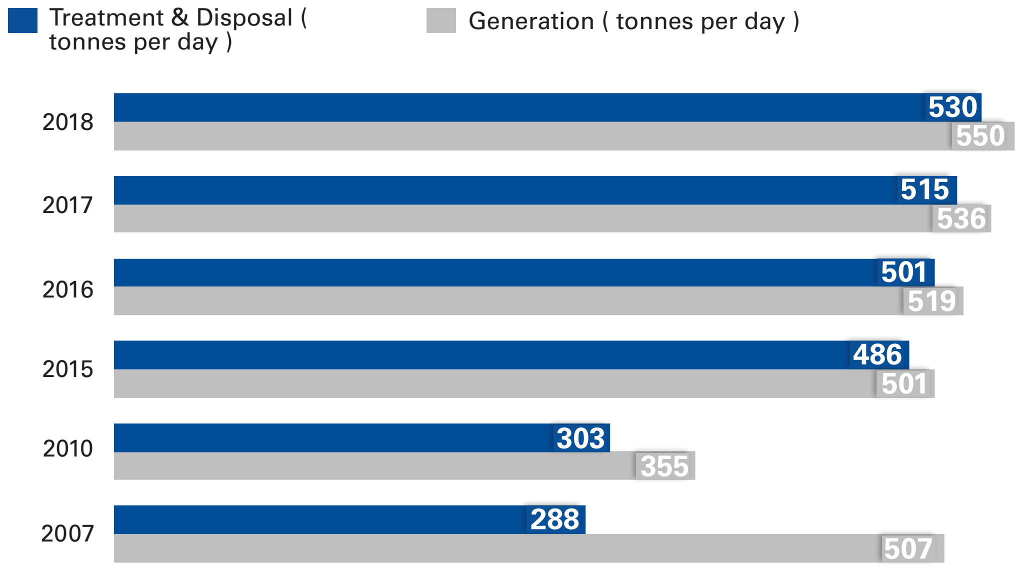
Chemical
Mainly plastics

Waste Category	Human Anatomical Waste/ Animal Waste, Microbiology and Biotechnology waste and Soiled waste	Microbiology and Biotechnology waste and Soiled waste	Waste sharps, Solid waste
Treatment Option	Incineration / Deep Burial	Autoclave/ Microwave/ Chemical Treatment	Autoclave/Microwave/ Chemical Treatment and destruction / shredding

2.3 Sources of Biomedical Waste

Waste Category	Waste Class and Description	Treatment and Disposal [Option]
No. 1	Human Anatomical Waste (Human tissues, organs, waste body parts)	Incineration / deep burial
No. 2	Animal Waste (Waste consisting of animal tissues, organs, body parts, carcasses, body fluids, blood and blood products, items contaminated with blood and fluids, waste from surgery treatment and autopsy, waste of experimental animals used in research, waste generated by veterinary hospitals, colleges, animal houses and livestock farms)	Incineration / deep burial
No. 3	Microbiology & Biotechnology Waste (Waste from laboratory, culture stocks or specimens of micro-organisms, live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, waste from production of biological dishes and devices used for transfer of cultures)	Local Autoclaving / microwaving/incineration
No. 4	Waste Sharps (Needles, syringes, scalpels, blades, glass, etc., that can cause puncture and cuts. This includes both used and unused sharps)	Disinfection using chemical treatment/autoclaving/microwaving and mutilation. Shredding and disposal in landfill / recycling (for PVC, plastics and glass area)
No. 5	Discarded Medicines (Waste comprising outdated, contaminated and discarded medicines)	Incineration or destruction and disposal in landfills
No. 6	Soiled Waste (Waste generated from soiled cotton, dressings, plaster casts, linens, beddings, material contaminated with blood including the packaging materials)	Incineration autoclaving/microwaving
No. 7	Solid Waste (Waste generated from disposable items other than the waste sharps such as tubing's, catheters, intravenous sets, etc.)	Disinfection by chemical treatment autoclaving/microwaving and mutilation/ shredding
No. 8	Liquid Waste (waste generated from laboratory and washing, cleaning, housekeeping and disinfecting activities)	Disinfection by chemical treatment and discharge into drains
No. 9	Incineration Ash (ash from incineration of any biomedical waste)	Disposal in municipal landfill
No. 10	Chemical Waste (Chemicals used in production of biologicals, chemicals used in disinfection, as insecticides, etc.)	Chemical treatment and discharge into drains for liquids and secured landfill for solids

2.4 Biomedical Waste
Generation to Handling Scenario in India



Source: Central Pollution Control Board and TechSci Research Estimates

Generation & Accumulation

Bio-medical waste is generated from biological and medical sources and activities, such as diagnosis, prevention, or treatment of diseases. Common generators of bio-medical waste include hospitals, health clinics, nursing homes, emergency medical services, medical research laboratories, offices of physicians, dentists, and veterinarians, home health care, and morgues or funeral homes.

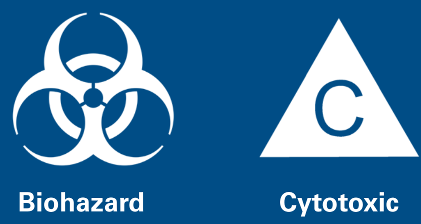
Segregation

Segregation is the most crucial step in biomedical waste management. Segregation refers to the basic separation of different categories of waste generated at the source, which results in reducing the risks as well as cost of waste handling and disposal.

- Segregation reduces the amount of waste requiring special handling and treatment.
- Segregation provides an opportunity to recycle certain components of medical waste like plastics after proper and thorough disinfection by treatment facilities. Recycled plastic materials are used for non-food grade applications.

Proper Labeling of Bins

Bins and bags carry the biohazard symbol indicating the nature of waste to patients and the public.



Collection

Biomedical waste collection involves the use of different types of container from various sources of biomedical waste like operation theater, laboratory, kitchens, corridors and wards. The containers/ bins are placed in such a way that 100% collection is achieved. Sharps are kept away in a puncture-proof container to avoid injuries and infection to the workers handling them.

Storage

Once the collection process is complete, bio-medical waste is stored in a proper place. Segregated waste of different categories is collected in identified containers. The duration of storage does not exceed for more than 8-10 hours in big hospitals (more than 200 beds) and 24 hours in nursing homes. Each container is clearly labeled to show the ward or room where it is kept. Containers are labeled as the labeling of containers helps in tracing the waste back to its source.

Transportation

Bio-medical waste is transported in trolleys or carts for carrying a small load. The bags/containers containing the waste are tied before transportation and the bags containing waste is accompanied with a signed document by the concerned person such as nurse/doctor mentioning the date, shift, quantity and destination. Special vehicles are used to prevent access to, and direct contact with, the waste by the transportation operators, the scavengers and the public. The transport containers are properly enclosed.

Devices & Treatment Technology used in Bio-Medical Waste Management

Safety Devices

- Gloves
- Masks
- Boots

Cleaning Devices

- Brooms
- Dustpans
- Mops
- Vacuum Cleaners

Storage Devices

- Dustbins
- Wheelbarrows
- Chutes

Treatment Technology

- Chemical
- Thermal
- Mechanical
- Irradiation
- Biological

Key Technologies in Health Care Waste Management in India

Technology	Process
Incineration	Incineration is a dry oxidation process through high temperature, which reduces organic and combustible waste to incombustible matter and reduces the volume and weight of the waste significantly. This is usually applied to treat the waste that cannot be recycled, reused or disposed of in a landfill site. Incineration has several advantages like it reduces landfill waste and saves costs, produces energy that can be reused, thus reducing overall energy costs. Disadvantage is pollution, as plastic waste releases dioxins and furans into the atmosphere. Incinerators are banned in Western countries and Microwave Technology is popularly used and considered safe. Lots of controversies exist regarding the use of incinerators.
Autoclave	Autoclave treeatment method uses steam to sterilize medical waste. Some equipment has additional features to aid in disposal, such as drying and compacting. Microorganisms which causes infection do not survive beyond 800°C. However, as a precaution, Ministry of Environment, Forest and Climate Change (MoEFC) has stipulated a temperature of 1210°C with 15 psi pressure to ensure the distribution of temperature for the complete destruction of microorganisms.
Pyrolysis	Pyrolysis is like incineration. This treatment process uses high heat to destroy medical waste. The process produces lower levels of pollution than incineration.
Electron Beams	Electron beams treatment process uses ionizing radiation to destroy microorganisms. Microwave technology prepares medical waste to be taken to the landfill. It is a relatively clean technology, as microwave treatments do not result in air or liquid emissions.
Bioremediation	Bioremediation is the use of microorganism metabolism to remove pollutants. In situ-Bioremediation involves treating the contaminated material at the site and ex-situ involves the removal of contaminated material to be treated elsewhere.

Value Chain of Biomedical Waste Generation

Central / State Pollution Control Board

Monitors Waste Management Facilities in India

Within Health Care Facility (HCF)

Health Care Facilities (HCFs) are primarily responsible for the management of health-care waste generated within the facilities, including activities undertaken by them in the community. Health care facilities while generating the waste are responsible for segregation, collection, in-house transportation, pre-treatment of waste and storage of waste, before such waste is collected by Common Bio-medical Waste Treatment Facility (CBWTF) Operator.

- Bio-medical Waste Generation
- Waste Segregation at Source
- Waste collection and On-site Transport
- On-site Storage
- On-site Treatment

Off-site Transport

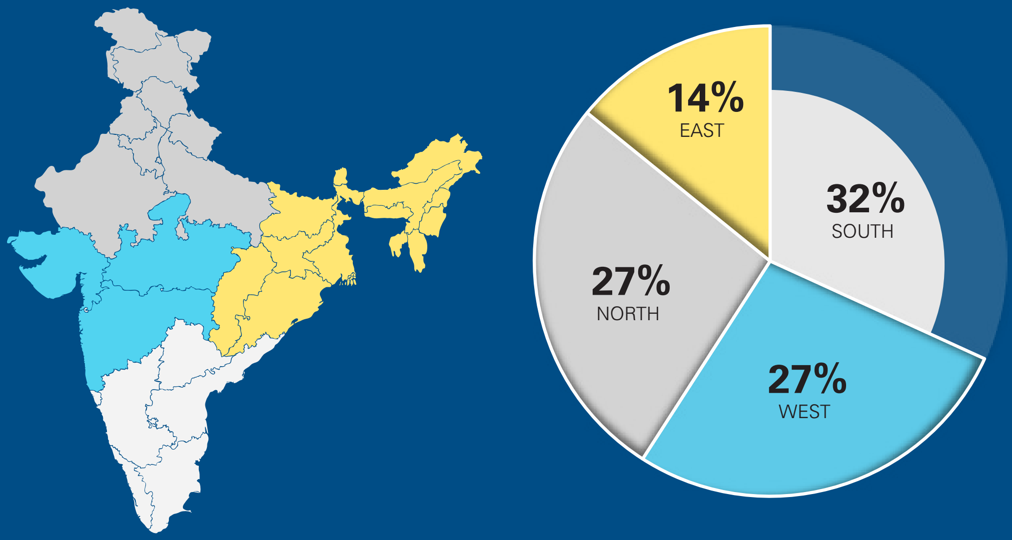
Common Bio-medical Waste Treatment Facility (CBWTF)

Treatment and disposal are the primary responsibility of CBWTF operator except for lab and highly infectious waste, which is required to be pre-treated by the HCF.

- **Landfill**
- **Underground Disposal**

2.5 Regional Differences

Share of CBWTF



Source: TechSci Research

Bio-medical Waste Management Scenario in India

Items	Number/ Quantity
No. of Health Care Facilities (HCFs)	**1,68,869**
No. of beds	**17,13,816**
No. of Common Bio-medical Waste Treatment Facilities (CBWTFs)	**226**
No. of HCFs using CBWTFs	**1,31,837**
No. of HCFs having treatment & disposal facilities	**22,245**
No. of HCFs applied for authorization	**1,06,805**
No. of HCFs granted authorization	**1,05,270**

Total no. of on-site/captive treatment equipment installed (excluding CBWTFs) by the HCFs:

No. of Incinerators	
With Air Pollution Control Device	**331**
Without Air Pollution Control Device	**217**
No. of Autoclaves	**3,112**
No. of Microwaves	**250**
No. of Hydroclaves	**15**
No. of Shredders	**5,179**

Total no. of treatment equipment installed by CBWTFs:

No. of Incinerators	**198**
No. of Autoclaves	**189**
No. of Microwaves	**3,112**

Source: Central Pollution Control Board

There are **226 CBWTFs**, including **198 operational CBWTFs** and **28 under installation CBWTFs** in the country, facilitating proper treatment and disposal of bio-medical waste in India.

Practices to Handle Bio-medical Waste

High	Medium	low

Particulars	Region			
	South	West	North	East
Volume of Waste Generation	High	High	Medium	low
Volume of Waste Treatment	High	High	Medium	low
Awareness Level	High	High	Medium	low
Safety Measures taken by HCF	High	High	Medium	low
Bio-medical Waste Segregation	High	High	Medium	low
Bio-medical Waste Collection	High	High	Medium	low
Waste Storage	High	High	Medium	low
Transportation	High	High	Medium	low
Record Maintenance	High	High	Medium	low

Source: TechSci Research

States with Highest Number of Violators

States	Number of facilities violating BMW rules
Maharashtra	4667
Kerala	1547
Bihar	1221
West Bengal	632
Uttar Pradesh	532
Tamil Nadu	507

Source: MoEFC

Top Five Bio-medical Waste Generating States

States	Bio-medical waste generated (kg per day)	Bio-medical disposal (kg per day)
Karnataka	62241	43971
Uttar Pradesh	44392	42237
Maharashtra	40197	40197
kerala	32884	29438
West Bengal	23571	12472

Source: MoEFC

2.6 Impact and Measures

Key Initiatives to Monitor and Control Bio-medical Waste by Government and Private Organizations

Key Initiatives taken by Government Organizations	Key Initiatives taken by Private Organizations
Management of bio-medical waste in accordance with the guidelines.	Appointment of authorized person to generate, collect, receive, store, transport, treat, process, dispose or handle bio-medical waste.
Daily assessment of all activities pertaining to bio-medical waste with the help of rounds in various hospital areas by the constituted BMWM Team.	Educating the hospital staff about bio-medical waste management. Health care professional training in bio-medical waste management is conducted by private health care facilities.
Regular training on "Bio-medical Waste Management & Occupational Safety" to entire hospital staff in collaboration with training cell.	Following Bio-Medical Waste Management Policy as per the Bio-medical Waste Management Rules 2016.
Segregation, packaging, transportation, and storage of BMW has been improved. Pre-treatment of laboratory waste, microbiological waste, blood samples and blood bags through disinfection or sterilization on-site in the manner as prescribed by WHO or NACO.	Creating awareness among doctors and paramedical staff.
Proper maintenance of records of bio-medical waste generated in the hospital.	Bio-medical waste is handled and disposed in a safe manner. Bio-medical waste is generated in all patient care areas and managed as per the applicable statutory regulations.
Periodic meetings of Bio-medical Waste Management Committee to monitor & supervise the activities of BMW Management in accordance with rules notified from time to time.	Color coded waste disposal bags are instantly available at waste generation sites.
Establishing a barcode system for bags or containers containing bio-medical waste for disposal.	Bio-medical waste is properly managed and disposed of to protect the environment.

2.7 Key Policies and Regulations

Key features of Bio-Medical Waste Rules 2016

- New amendment in Bio-Medical Rules includes various health camps such as vaccination camps and blood donation camps. The duty of an occupier has been revised.
- MoEFC has mandated the compulsory pre-treatment of the laboratory, microbiological waste, and blood bags on-site before disposal either at Common Bio-Medical Waste Treatment Facility or on-site.
- Use of chlorinated plastic bags, gloves and blood bags should be gradually stopped and this should be done within two years from the date of notification of these rules.
- Liquid waste should be separated at source by pre-treatment before mixing with other liquid waste.
- Government has mandated to set up a barcode system for Bio-Medical Waste Containers that is to be sent out of the premises for treatment and disposal.

- The existing incinerator should be modified to achieve the new standard within two years from the date of notification.
- The disposal register of bio-medical waste should be maintained daily and updated monthly on the authorized website.
- The operator is required to maintain all records for the operation of incineration/hydroclaving/autoclaving for a period of five years.
- The segregation, packaging, transportation, and storage of BMW has been improved. Bio-medical waste has been classified into four categories based on color code-type of waste and treatment options. In addition, untreated waste such as human anatomical waste, animal anatomical waste and soiled waste should not be stored beyond a period of 48 hours.
- Healthcare facilities are not allowed to establish on-site BMW treatment and disposal facility, if the provision of common bio-medical waste treatment facility (CBMWTF) is present at a distance of 75 kilometers.
- If there is no CBMWTF available, then the occupier can set up requisite BMW treatment facility such as incinerator, autoclave or microwave, and shredder after taking prior authorization from the prescribed authority.
- Standards for emission from incinerators have been modified to be more environmentally friendly. These are permissible limit for SPM-50 mg/nm3; residence time in secondary chamber of incinerator – two seconds; standard for dioxin and furans – 0.1 ng TEQ/Nm3.
- MoEFC will monitor the implementation of the rules yearly. The responsibility of each state to check for compliance will be done by setting up a district-level committee under the chairpersonship of District Collector or District Magistrate or Additional District Magistrate. In addition, every six months, this committee shall submit its report to the State Pollution Control Board.

Key Organizations/Intervening Bodies and their Roles

Key Organizations / Intervening Bodies

Ministry of Environment, Forest and Climate Change (MoEFC)

The Ministry of Environment, Forest and Climate Change (MoEFC) is an Indian government ministry, responsible for planning, promoting, coordinating, and overseeing the implementation of environmental and forestry programs in the country. Bio-medical Waste (Management & Handling) Rules are notified by the Ministry of Environment, Forest and Climate Change (MoEFC) and in supersession of the Bio-Medical Waste (Management and Handling) Rules, further amendments are made.

Central Pollution Control Board (CPCB)

The Central Pollution Control Board (CPCB) of India is a statutory organization under the Ministry of Environment, Forest and Climate Change (MoEFC). The central board coordinates the activities of State Pollution Control Boards by providing technical assistance and guidance and resolves disputes among them. Every municipal authority, which comes under the Municipal Solid Wastes (Management & Handling) Rules, 2000 (MSW rules, 2000), is responsible for the collection, segregation, storage, transportation, processing and disposal of municipal solid. CPCB collects necessary information from municipal authorities and provides them technical assistance.

Common Bio-Medical Waste Treatment Facility (CBWTF)

A Common Bio-medical Waste Treatment and Disposal Facility (CBWTF) is a set up where bio-medical waste generated from member health care facilities is imparted necessary treatment to reduce adverse effects that this waste may pose on human health and environment. The treated recyclable waste is finally sent for disposal in a secured landfill or for recycling. CBWTF reduces the monitoring pressure on regulatory agencies.

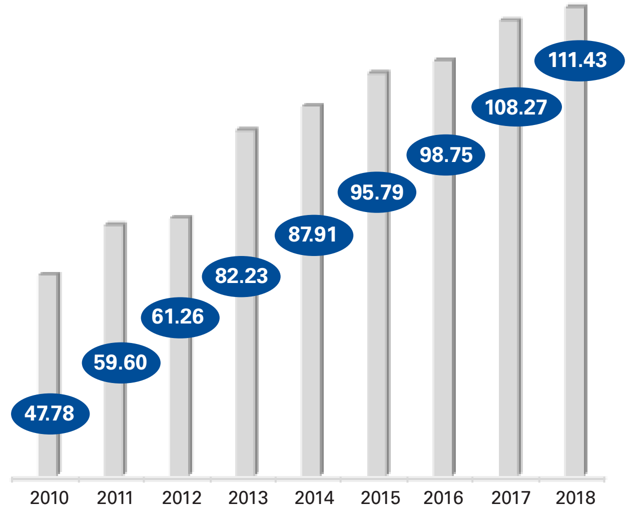
Healthcare Facilities

The HCF is responsible for pre-treatment of laboratory and microbiological waste, blood samples and blood bags through disinfection/sterilization on-site in the manner prescribed by the World Health Organization (WHO) or National Aids Control Organisation (NACO), regardless of whether final treatment and disposal happens on-site or at a common bio-medical waste treatment facility.

2.8 Opportunity Assessment in Bio-medical Waste Recyclers

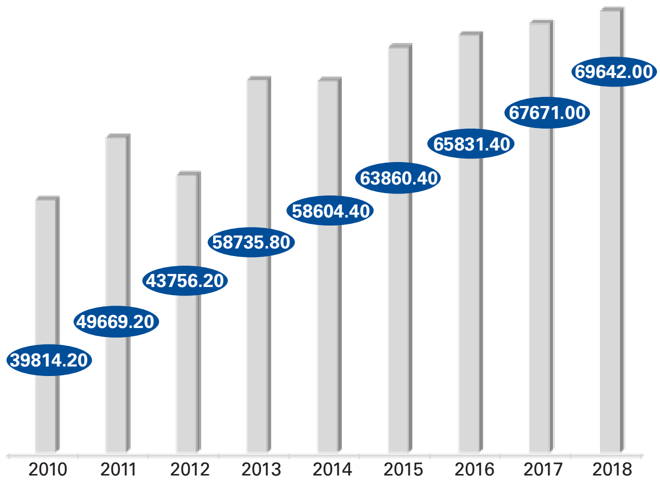
(Market Size of Bio-medical Waste Recycling, Key Players)

Market Size of Bio-medical Waste Recycling in India
By Value, 2010-2018 (INR Crore)



Source: Central Pollution Control Board and TechSci Research Estimation

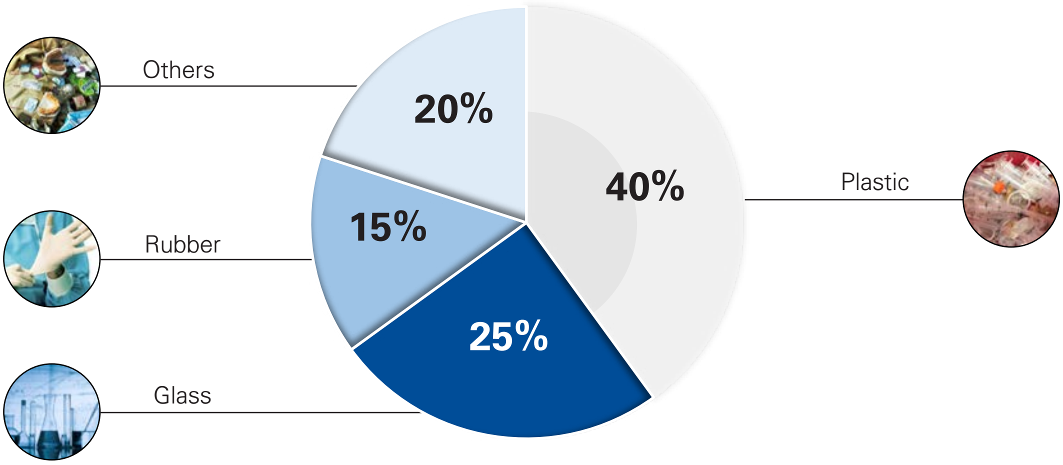
Market Size of Bio-Medical Waste Recycling in India
By Volume, 2010-2018 (Tons Per Annum)



Source: Central Pollution Control Board and TechSci Research Estimation

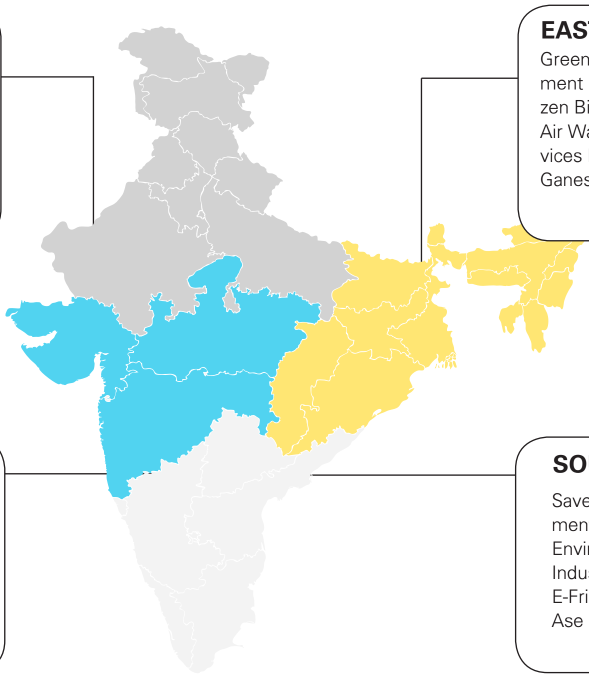
Market Share of Bio-Medical Waste Recycling in India

By Industry, By Value, 2018



Source: Central Pollution Control Board and TechSci Research Estimation

Key Players



NORTH

Synergy World, Biotic Bio-medical Waste Limited, SMS Water Grace BMW Private Limited, Eco Wise

EAST

GreenTech Environ Management Private Limited, Greenzen Bio Private Limited, Fresh Air Waste Management Services Private Limited, Shree Ganesh Recycling (SGR)

WEST

SMS Envocare, Ecoreco, E-Incarnation Recycling Private Limited, E-Coli Waste, Let's Recycle, Care BMW, Vinayak Polymers

SOUTH

Saveeco Waste Management Private Limited, Ramky Enviro Engineers, Maridi Eco Industries Private Limited, E-Friendly Waste Recyclers, Ase & Co, Sattva Enviro

2.9 Case Studies
(Reflecting Bio-Medical Waste Control & Monitoring Measures taken by other Countries)

Global healthcare industry is growing at a rapid pace, which is increasing medical waste generation in developing countries. The quantity of healthcare waste produced in a developing country ranges from 0.5 to 3 kg per bed per day. India generates nearly 550 tons of bio-medical waste per day. Growth in medical waste is resulting in significant public health and environmental concerns across the world.In developed countries, several technologies are used for medical disposal such as mechanical, thermal, irradiative, biological and chemical methods like incineration, autoclaving, landfilling, recycling, and electron beam technology. The predominant medical waste management method in developing countries is either incineration, autoclaving or landfilling.

Nowadays, autoclaving is the most common alternative treatment method used across different countries Autoclaving has the lowest capital costs as compared to other alternatives and can be used to process up to 80-90% of medical waste. Some of the developed countries such as Germany, Slovenia and Portugal are phasing out medical incinerators to avoid environmental pollution. Meanwhile, developed countries like Korea are using an online tracking system to monitor medical waste transportation. In developing countries, different waste disposal practices are used in different hospitals. For instance in some hospitals, private contractors are hired for waste disposal through incineration or landfilling.

CASE STUDY 1.
Bio-medical Waste Management in a Tertiary Care Hospital, India

Lady Hardinge Medical College (LHMC) and associated hospitals constituted a bio-medical waste management committee. Members of the committee were from infection control, microbiology units and stores, and civil and electrical sections chaired by the Director of LHMC. The senior microbiologist of LHMC was the nodal officer or waste management officer. The hospital had a good monitoring system in place, which was implemented by the BWMM team. Its feedback was used for improving the system as well as tailoring a training program.

The hospital was conducting a regular training program for all categories of health care workers. Training for doctors, nursing staff, and group C and D employees every week. Pre- and post-test evaluations were carried out. Waste disposal methods were demonstrated in the training. Postexposure prophylaxis of HIV infection and infection control practices were included in the training. At the end of the training, certificates were issued. A total of 550 doctors, 396 nurses and 144 cleaners were trained.

A team from the Department of Microbiology from the hospital conducted two studies – one to understand the awareness regarding biomedical waste management among health care workers in the same hospital and the second, to look at the impact of on-site training of health care workers on biomedical waste management. The first study found that awareness was much higher in those staff that had attended regular training sessions. The study recommended carrying out regular and refresher training to improve awareness levels. It also recommended to make training mandatory at the time of recruitment and to include it in medical and nursing curriculums. The second study found that waste segregation practices were higher in staff who attended on-site training.

Bio-medical Waste Management Team (2 Nurses and 1 Microbiologist)

Daily Hospital Visit	Common Collection Site
Check segregation	Check segregation
Monitoring disinfection of waste on-site Availability of basic items for BMWM	Check labeling
Monitoring compliance of usage of facilities by HCW	Weigh the waste
Monitor level of awareness	Monitor final disposal of the waste
Prepare waste audit	Ensure the working of incinerator
Liaison between HODs and CNOs	Provide monthly data of waste generated by both hospitals
Feedback to WMO Assist in Training Program	

CASE STUDY 2.
Phuentsholing General Hospital: A Pilot Hospital for Model Health Care Waste Management (Bhutan)

Phuentsholing Hospital is a 50-bed hospital with a running capacity of 65 inpatient beds. It is run by 144 staff including all categories of personnel. The hospital administration and management transformation (HAMT) committee was identified as the infection control and waste management committee. The focal point for HCWM was the nursing head. All units in charge were members of the infection control and Medical Waste Management Committee.

Training was conducted on infection control, waste management and patient safety for all categories of staff. Waste storage, a treatment house and a deep burial pit was constructed. A waste autoclave was procured and was under installation. Mercury-based equipment were replaced with digital and mercury-free devices. Waste bin stands and waste transportation trolleys were fabricated on-site. Risk waste was segregated at the source and treated in an autoclave and then sent to a municipal landfill. Pathological waste and sharps were disposed of in deep burial pits. Chemical waste was flushed down the drain after dilution. Burning was strictly prohibited by the National Environment Commission due to environmental concerns. General waste was sold to recyclers. The hospital planned to make it into a model hospital for HCWM in the future.

Conclusion and Recommendation

BIOMEDICAL WASTE

CONCLUSION

India generates nearly 550 tons of medical waste in a day. Hospitals segregate their waste into the required categories and then send the waste for off-site treatment. Various institutions in the country have developed good training resources. Although India has more than 190 operational off-site treatment facilities, they are not enough to treat the large quantum of waste being produced. Audit reports have identified the presence of unauthorized HCFs, unavailability of treatment and disposal facilities, inefficient segregation at the source, disposal of untreated medical waste, open burning of medical waste, dumping and mixing of BMW with solid waste, illegal selling of infected plastic waste to unauthorized recyclers, and improper working of CBWTFs as major issues in most of the Indian states.Though the country has Bio-medical Waste Management Rules, 2018, lack of staff, infrastructure and awareness is a major constraint in the implementation of the rules. India needs a stringent monitoring and evaluation framework to ensure compliance.

RECOMMENDATION

Although India's policy framework related to bio-medical waste management is well drafted, the country has fallen weak on its implementation strategy. Data discrepancy is highlighted as one of the major issues. The Central Pollution Control Board (CPCB) and State Polution Control Boards (SPCB) must map all health care facilities that require authorization for disposal of bio-medical waste, as most of the healthcare facilities which are generating bio-medical waste have never realized that they are also covered under the rules. Most of the veterinary institutions in different states have not applied for authorization under the rules due to lack of directions from respective State Pollution Control Board. A specific criterion should be made and all SPCBs should follow a standard protocol in finalizing the type of facilities that would need authorization. The data related to bio-medical waste should be updated along with the annual report. Though on-site incinerators are not allowed according to Bio-Medical Waste Management (BMWM) rules, many such facilities are installed across the country. Pollution control boards should take immediate action and shut down these facilities.

Monitoring bodies, viz. SPCBs and CPCB, should make a strict timeline and visit health care facilities and CBWTFs regularly and update their data on time. Stringent monitoring would help improve compliance. Since the health care facilities are not being monitored by pollution control boards frequently, a lack of implementation has been seen on their part. Since the existing CBWTFs are not enough to treat the quantum of medical waste generated by hospitals, India should focus on installation of more CBWTFs and should work on increasing connectivity up to the PHC level. A ground check before approval of common treatment facilities (CTFs) is necessary to avoid excess of CBWTFs, which can make them economically unfeasible. CBWTFs also need to be monitored frequently, as many hospitals have reported that these facilities do not collect the waste on time. Also, their staff are not trained and thus do not handle the waste as required. As these facilities do not let hospitals make an unplanned visit, the CPCB should issue a notice to them on the same. The SPCB should also visit them frequently. Although the rules require health care facilities to conduct training programs for staff, only a few facilities conduct them. Since now, district level monitoring committees are monitoring BMW management at the district level, they should ensure that training sessions are conducted at least biannually and include all health care staff as well as CBWTF staff. MoH/SPCB/CPCB should come up with a detailed training module and provide it to all health care facilities of the country, emphasizing on the importance of such training sessions.

A large number of hospitals in India do not have proper treatment facilities, and are thus discharging their bio-medical waste along with municipal waste without meeting the required standards. The major reason for this is the lack of technical competency and awareness level among different healthcare facilities. It is thus important for the Central Pollution Control Board to frame standard operating procedures and to provide guidance to healthcare facilities related to bio-medical waste treatment.

3

Air Pollution
History and Current Scenario

AMBIENT AIR POLLUTION has proliferated in India over the last 25 years. To monitor and control this problem, India has maintained air quality monitoring stations at a number of locations across the country for several years.

Currently, majority of the Indian population is living in areas that exceed the World Health Organization (WHO) Air Quality Guideline of PM2.5 (0-30 g/m3) for PM2.5 (Particulate matter of size 2.5 micrometers or less in diameter) and PM 10 (particulate matter with size 10 micromter

The air that people breathe is a complex mixture of a number of individual gaseous compounds and particles of complex composition. Therefore, indicator pollutants are typically used to estimate exposures for epidemiological analysis and disease burden assessment. Faridabad, Patna, Noida, Ghaziabad and Agra were among the top five most polluted cities in the world in 2018 based on PM2.5 levels just after Diwali. Air pollution is one of the biggest killers worldwide, causing almost two million deaths every year in India. This exposure leads to diseases such as lung cancer, stroke, heart disease, chronic obstructive pulmonary diseases and respiratory infections.

Top 10 Most Polluted Cities in India based on PM 2.5 (μg/m3) on November 8 2018 (The day after Deepavali in 2018)

438	Faridabad
433	Patna
414	Noida
407	Ghaziabad
406	Agra
395	Bulandshahr
393	Muzaffarpur
376	Gurugram
375	Delhi
364	Lucknow

Source: Central Pollution Control Board

3.1 National Air Quality Index
(Basis and Guidelines)

Air Quality Index (AQI) is a tool used for effective communication of air quality status to people in a way, which is easy to understand. It transforms air quality data of various pollutants into a single number (index value), nomenclature and color. Air Quality Index is categorized into six parts, namely Good, Satisfactory, Moderately Polluted, Poor, Very Poor, and Severe. Air quality sub-index and health breakpoints include eight pollutants (PM10, PM2.5, NO2, SO2, CO, O3, NH3, and Pb), for which short-term (up to 24-hours) National Ambient Air Quality Standards are prescribed.

As for the public, they usually do not easily comprehend complex findings related to air quality. This results in people losing interest. Since awareness about urban air pollution is important to those who suffer from illnesses caused by exposure to air pollution, the issue of air quality communication should be addressed in an effective way. Further, the success of a nation to improve air quality standard depends on the support of its citizens who are well-informed about local and national air pollution problems. Major Applications of Air Quality Index:

- **Resource Allocation**
  To assist administrators in distributing funds and determining priorities.

- **Ranking of Locations:**
  To assist in comparing air quality situation at different locations/cities. Thus, finding out the locations and frequency of potential hazards.

- **Enforcement of Standards:**
  To decide the degree to which the legislative standards and existing criteria are being followed. It also helps in identifying faulty standards and insufficient monitoring programs.

- **Trend Analysis**
  To find the change in air quality (degradation or improvement) which has happened over a specified period. This enables forecasting of air quality and planning of pollution control measures accordingly.

- **Public Information**
  To inform the public about the state of environment. Thus, it enables them to plan their daily activities at times when they are informed of high pollution levels.

- **Scientific Research**
  As a tool for reducing a large dataset to a comprehensible form that gives better insight to the researcher while conducting a study of the state of the environment.
  The AQI values and corresponding ambient concentrations (health breakpoints), as well as associated likely health impacts for the identified eight pollutants, are as follows:

AQI Category, Pollutants and Health Breakpoints

AQI Category (Range)	Good (0-50)	Satisfactory (51-100)	Moderately (101-200)	Poor (201-300)	Very Poor (301-400)	Severe (401-500)
PM10 , 24-hr (g/m3)	**0-50**	**51-100**	**101-250**	**251-350**	**351-430**	**430+**
PM2.5 , 24-hr (g/m3)	**0-30**	**31-60**	**61-90**	**91-120**	**121-250**	**250+**
NO2 , 24-hr (g/m3)	**0-40**	**41-80**	**81-180**	**181-280**	**281-400**	**400+**
O3 , 8-hr (g/m3)	**0-50**	**51-100**	**101-168**	**169-208**	**209-748***	**748+***
CO , 8-hr (mg/m3)	**0-1.0**	**1.1-2.0**	**2.1-10**	**10-17**	**17-34**	**34+**
SO2 , 24-hr (g/m3)	**0-40**	**41-80**	**81-380**	**381-800**	**801-1600**	**1600+**
NH3 , 24-hr (g/m3)	**0-200**	**201-400**	**401-800**	**801-1200**	**1200-1800**	**1800+**
Pb , 24-hr (g/m3)	**0-0.5**	**0.5-1.0**	**1.1-2.0**	**2.1-3.0**	**3.1-3.5**	**3.5+**

Source: Central Pollution Control Board
*One hourly Monitoring (for mathematical calculations only)

AQI	**Associated Health Impacts**
Good (0–50)	Minimal Impact
Satisfactory (51–100)	May cause minor breathing discomfort to sensitive people
Moderately Polluted (101–200)	May cause breathing discomfort to people with lung diseases such as asthma, and discomfort to people with heart diseases, children and older adults.
Poor (201–300)	May cause breathing discomfort to people on prolonged exposure, and discomfort to people with heart diseases
Very Poor (301–400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases.
Severe (401-500)	May cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart diseases. The health impacts may be experienced even during light physical activities.

3.2 Pollution Levels

Particulate Matter in Key Cities

Components of particulate matter (PM) include finely divided solids or liquids such as fly ash, dust, aerosols, soot, smoke, fumes, mists and condensing vapors that can be suspended in the air for extended periods of time. Particles originate from a variety of sources and may be directly emitted or formed in the atmosphere by transformation of gaseous emissions.

Primary PM sources are derived from both human and natural activities. A significant portion of PM sources is generated from a variety of human activities, such as industrial processes, construction and demolition activities, agricultural operations, combustion of wood and fossil fuels, and entrainment of road dust into the air. Natural sources include windblown dust and wildfires. Steps taken by the government to curb increasing air pollution includes ban on truck entry in cities, restrictions on industrial activities, ban of waste burning in Delhi, introduction of green tax, ban imposed by Supreme Court on bursting firecrackers on Diwali, implementation of BS-VI norms, etc.

PM 10 Level in Key Cities

PM 10	2015	2016	2017	2018	2019
Agra	280.2	244.9	482.96	317	-
Kanpur	235.9	238.5	476.3	431.1	-
Varanasi	465	313.9	410.39	317.59	288.17
Noida	207	303	374.25	404.55	509.88
Lucknow	214.42	334.4	429.71	291.42	-
Ghaziabad	374.5	319.3	454	284	534.75

Source: Central Pollution Control Board

PM 2.5 Level in Key Cities

PM 2.5	2015	2016	2017	2018	2019
Agra	428	426	393	405	385
Kanpur	420	134	394	421	410
Varanasi	472	409	373	401	321
Noida	-	-	498	431	451
Lucknow	344	317	421	403	356
Ghaziabad	-	-	497	421	457
Faridabad	452	359	370	386	466
Gaya	278	305	346	408	389
Muzaffarpur	467	376	352	426	381
Patna	491	379	368	425	427
Kolkata	-	-	-	360	387
Delhi	392	289	349	420	458

Source: Central Pollution Control Board

3.3 Major Pollutants and their Impact on Population

Pollutant	Effects
Ozone - Ozone, a gaseous pollutant, is formed during photochemical smog in the atmosphere. At the ground level, it is a highly toxic pollutant.	Ozone near the ground can cause several health problems including Asthma attacks, sore throats and coughs. Short-term overexposure to ozone may even lead to premature death. Long-term exposure may cause permanent damage to lung tissues.
Carbon Monoxide - It is an odorless, colorless gas, which is produced by the burning of carbon-based fuels including petrol, diesel, and wood.	Carbon monoxide makes it difficult for body parts to get the oxygen they need to run effectively leading to people feeling dizzy and confused and gives them headaches. In high concentrations, it is fatal.
Nitrogen Dioxide - Nitrogen Dioxide (NO2) is a reddish-brown gas that is emitted from power generation and industrial and traffic sources such as cars and buses.	Exposure to nitrogen dioxide has been associated with a variety of health effects, including respiratory symptoms such as coughs and short of breath. Also, NO2 is an important constituent of particulate matter and ozone. Nitrogen dioxide can also react in the atmosphere to form acid rain and ozone.
Particulate Matter - Particulate matter (PM) are inhalable and respirable particles composed of nitrates, black carbon, ammonia, sodium chloride, sulphate, mineral dust and water. It includes particles with a diameter of less than 10 microns (PM10), including fine particles less than 2.5 microns (PM2.5). Black carbon, also known as a "short-lived climate pollutant (SLCP)", is a major component of PM2.5 and one of the important drivers of climate change.	Effects associated with exposures to both PM2.5 and PM10 include premature death and respiratory and cardiovascular disease problems. Children, individuals with pre-existing heart and lung disease (including asthma), older adults, and persons with lower socioeconomic status are at the greatest risk of effects associated with PM exposures.
Sulphur Dioxide - Sulphur dioxide (SO2) is primarily produced from the burning of fossil fuels (coal and oil) and the smelting of mineral ores that contain Sulphur.	Exposure to SO2 impacts the respiratory system and lung functions, as well as causes irritation of the eyes. Inflammation of the respiratory tract from SO2 can aggravate asthma and chronic bronchitis, in addition to increasing the risk of infection, leading to increased hospital admissions and visits to emergency rooms.

3.4 Health Hazards of Air Pollution

Air pollution is leading to major health problems in both developing and developed countries. It is not only the ambient air quality in the cities but also the indoor air quality in the rural and urban areas that are causing problems. In fact, in the developing countries, highest air pollution exposure occurs in the indoor environment. Air pollutants that are inhaled have a serious impact on health, affecting the lungs and the respiratory system. These pollutants are also deposited on plants, soil, and in the water, further contributing exposure to humans. Some of the most common are:

- **Respiratory and Lung Diseases -** Major respiratory and lung diseases caused by air pollution include asthma, chronic obstructive pulmonary disease (COPD) and pneumonia.

- **Cancer -** The International Agency for Research on Cancer (IARC) has classified outdoor air pollution as a cancer-causing agent (carcinogen).

- **Cardiovascular Problems, Heart Disease and Stroke -** Exposure to air pollution, and PM2.5, have been associated (at varying degrees of certainty) with a range of cardiovascular effects including heart failure, thrombosis, ischemic heart disease, stroke, arrhythmias, and hypertension.

- **Neurobehavioral Disorders –** Presence of PM2.5 in ambient air has adverse effects on the central nervous system and brain may cause neurological diseases including Parkinson's disease, Alzheimer's disease and other forms of dementia.

- **Premature Death -** Ambient air pollution (outdoor air pollution) is one of the major causes of diseases and deaths, globally. Maternal exposure to ambient air pollution is associated with adverse birth outcomes, such as low birth weight, premature death, pre-term birth and small gestational age births.

3.5 Major Industries Contributing Air Pollution in India

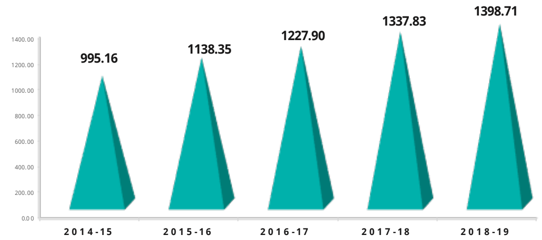
Industry	Impact on Environment	Pollutants
Energy Industry	Moderate to High Impact	Greenhouse Gases (CO2, CH4, N2O, O3, CFCs, HCFCs), Dust Particles, Mercury
Mining Industry	High Impact	Particulate Matter, CH4, SO2, CO, H2S
Cement Industry	Low Impact	PM2.5, PM10, SO2, NO2,
Automotive Industry	Moderate to High Impact	Lead, Particulate Matter, HC, NOX, CO, SO2
Chemical Industry	Moderate Impact	Volatile Organic Compounds (Acetaldehyde, Acetone, Benzene Carbon tetra-chloride, Ethyl acetate, Ethylene glycol, Formaldehyde etc.), NO, SO2, NO2, SO3, Cl2, CO, CO2, H2SO4
Indoor Air Pollution	High Impact	Tobacco Smoke, Carbon Monoxide (CO), Lead, TVOC's
Leather Industry	Moderate Impact	Volatile Organic Compounds, CL2, NH3

High Impact **Moderate to High Impact** **Moderate Impact** **Low Impact**

Energy Industry: Environmental & Health Impact

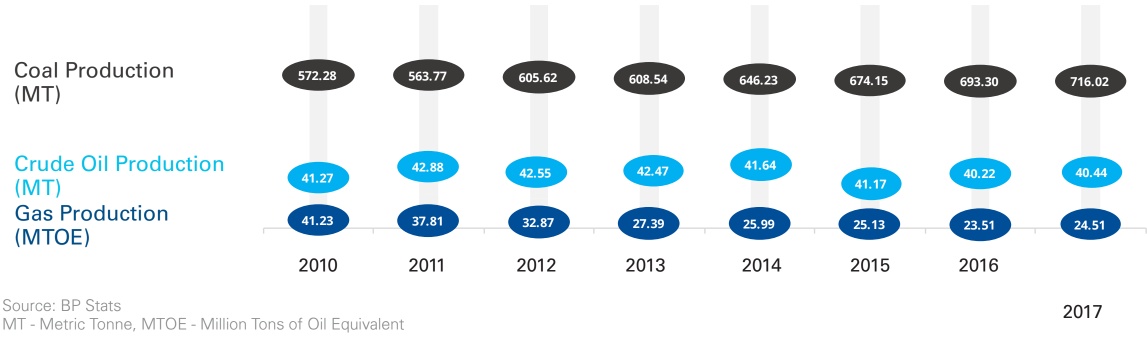
Energy generation results in more pollution than any other industry in India. Major sources of energy generation in India include fossil fuels such as coal, oil and natural gas. India generated around 1,497 TWh of electricity in the year 2017 ahead of Russia, Japan, Germany and Canada in electricity generation. Factors like industrial expansion and rising per capita income are boosting power demand across the country. This in turn is impacting the air quality, as power generation leads to a significant contribution in greenhouse gases. 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 the country. Moreover, as power plants are often located near cities, towns and villages, the potential impact on health is significant. Activities related to the production of coal such as drilling, blasting, extraction, transportation, and crushing give rise to dust particles in the air causing pollution.

India Electricity Production,
in Billion Units, 2014-15 – 2018-19



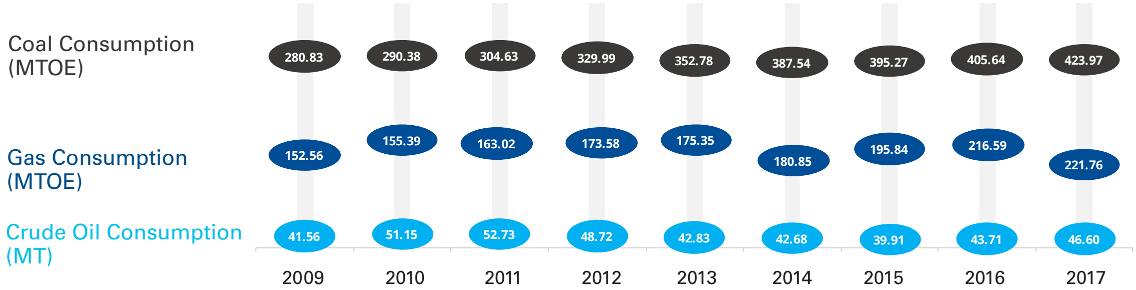
Source: Central Electricity Authority

Gas Production (MTOE), Crude Oil Production (MT), Coal Production (MT), 2010-2017



Source: BP Stats
MT - Metric Tonne, MTOE - Million Tons of Oil Equivalent

Crude Oil Consumption(MT), Gas Consumption(MTOE), Coal Consumption (MTOE) 2009-2017



Source: BP Stats
MT - Metric Tonne, MTOE - Million Tons of Oil Equivalent

Some of the steps to curb pollution from coal include fitting drills with dust collection systems / wet drilling, black topping concreting of coal transportation roads, etc. Efforts have been made for use of more belt conveyors, rail, etc., for coal transportation and to rationalize road transportation to reduce pollution. Massive tree plantation in and around mines also reduces the impact of air pollution on neighboring areas. Moreover, there is no single body for formulating and implementing a unified energy policy. Three energy intensive sectors (steel, cement, and chemical & petrochemical sectors) give rise to majority of emissions for each pollutant today and are expected to remain dominant sources until 2040.

As per the report "Breathe India" by NITI Aayog, the government is planning to reduce emissions by optimizing the power sector. Power plants with inefficient power generation contribute heavily to air pollution. These inefficient power plants should be replaced by efficient super-thermal plants or with power generators that are based on renewable energy. Usually, a unit of gross domestic product derived from industry typically uses at least 10 times as much energy as one created in the services sector with direct consequences for air quality. With Indian GDP growing at around 8%, this would have serious implications on air quality in India.

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
mg/Nm3 - milligrams per cubic metre

Mining Industry

Airborne emissions occur at every stage of the mining cycle, They include mobilizing large amounts of material and waste piles containing small size particles, which are easily dispersed by the wind.

The main sources of air pollution in mining operations are:

- **Particulate matter transported by the wind and exhaust emissions from mobile sources (heavy equipment, cars, trucks, etc.) increase these particulate levels.**
- **Gas emissions from the combustion of fuels in stationary and mobile sources, mineral processing and explosions.**

All activities carried out during ore extraction, processing, handling, and transportation depend on equipment, processes, generators, and materials emit hazardous air pollutants such as particulate matter, nitrogen oxide, carbon monoxide and sulphur dioxide. The dust can also pollute nearby surface waters and stunt crop growth by shading and clogging the pores of the plants.

Mining Processes and Nature of Air Pollution Assocated with them

Industry	Impact on Environment
Construction of Infrastructure Projects	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

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.
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

Cement Industry: Health & Environmental Impact of Concrete

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

Cement and concrete are the second most consumed substances, globally, after water. Rapid growth in infrastructure & construction sector over the last two decades has bolstered the production of cement in India.

Currently, India is the 2nd largest cement producer as well as consumer in the world. The Asian country has 210 large cement plants with a cumulative installed capacity of over 350 million tonnes. Moreover, there are over 350 mini cement plants with an estimated production capacity of 11.10 million tonnes in the country. Globally, cement industry accounts for 5% of the global carbon dioxide (CO2) emissions. The amount of CO2 emitted by the cement industry is nearly 900 kg of CO2 for every 1,000 kg of cement produced. Cement plants are a significant source of sulphur dioxide, nitrogen oxide and carbon monoxide. Additionally, they release dust particles and foul smell in the environment.

The size of cement particles makes it a potential health hazard, as these are respirable and reach the internal organs especially lungs, leading to lung diseases. Cement particles can cause allergic reactions that interfere with breathing, chronic bronchitis, asthma, emphysema, lung cancer, pneumonia, tuberculosis and cough.Indian government has categorized cement industry into red category of industries based on their pollution load. Red category covers industries which have a pollution index score of 60 and above. 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 that can reduce 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%.

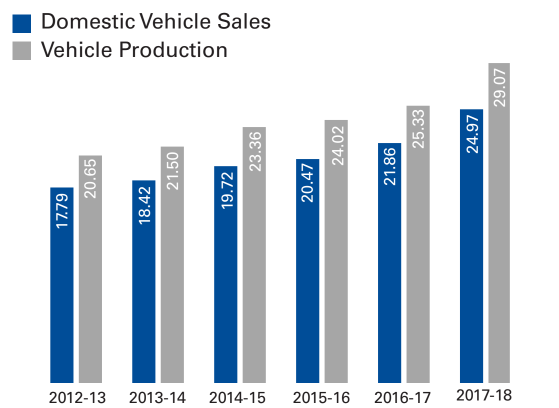
Automotive Industry: Vehicles, Air Pollution & Human Health

Air pollution from vehicles in urban areas has become a serious problem. Long-term exposure from vehicular pollution may cause health issues such as cough, headache, nausea, irritation of eyes, and various bronchial and visibility problems. Vehicles in major metropolitan cities are estimated to account for 70% of CO, 50% of HC, 30-40% of NOx, 30% of SPM and 10% of SO2 of the total pollution of these cities, of which two-third is contributed by two-wheelers alone.

In India, vehicle technology has evolved to meet the emission and safety regulations notified as per the Auto Fuel Policy, specifying the emission road map and safety regulations as per the Safety Road map adopted by the Central Motor vehicles - Technical Standing Committee (CMVR-TSC) respectively. Today vehicle technology in India is at par with the international benchmarks, as Indian safety standards are being aligned with Global Technical Regulations (GTR) and UN Regulations.

India is a signatory to UN WP 291998 agreement, which develops Global Technical Regulations (GTRs).

India Domestic Vehicle Sales & Vehicle Production (Million), 2012-13 to 2017-18



Source- Society of Indian Automobile Manufacturers

India actively participates in the 'United Nations-World forum for Harmonization of vehicle regulations' body and contributes significantly, so that the GTRs reflect the driving conditions and requirements of the developing countries.

Emission Norms for Passenger Cars

Norms	CO (g/km)	HC+ NOx (g/km)
1991Norms	14.3-27.1	2.0(Only HC)
1996 Norms	8.68-12.40	3.00-4.36
1998Norms	4.34-6.20	1.50-2.18
India stage 2000 norms	2.72	0.97
Bharat stage-II	2.2	0.5
Bharat Stage-III	2.3	0.35 (combined)
Bharat Stage-IV	1.0	0.18 (combined)

Source: CPCB

Emission Norms for Heavy Diesel Vehicles

Norms	CO (g/km)	HC (g/kmhr)	NOx (g/kmhr)	PM (g/kmhr)
1991 Norms	14	3.5	18	-
1996 Norms	11.2	2.4	14.4	-
India stage 2000 norms	4.5	1.1	8.0	0.36
Bharat stage-II	4.0	1.1	7.0	0.15
Bharat Stage-III	2.1	1.6	5.0	0.10
Bharat Stage-IV	1.5	0.96	3.5	0.02

Source: CPCB

The Emission Standards for Bharat Stage VI (BS-VI)

	Mass of Carbon Monoxide (CO) (mg/km)		Mass of Non-Methane Hydrocarbons (NMHC) (mg/km)		Mass of Oxides of Nitrogen (NOx) (mg/km)		Mass of Particulate Matter (PM) (mg/km)	
Category	PI	CI	PI	CI	PI	CI	PI	CI
M (M1 & M2)	1900	1750	170	290	150	180	25	25

Source : ARAI (Automotive Research Association of India)

Note - India has Skipped BS-5 norms to implement the BS-6 norms.
PI - Positive (Spark) Ignition Engine
CI -Compression Ignition Engine
M - Vehicles with at least four wheels and used for the carriage of passengers (e.g. standard car with 2, 3, 4 doors)

Chemical Industry: Characterized as Major Volatile Organic Compound (VOC) Contributor

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 segments are some of the major pollution sources in the industry.In terms of value and production, Indian chemical industry is the 3rd largest producer in Asia and 6th largest by output, globally. Indian chemical industry is forecast to grow at 8-10% to reach USD300 billion by 2025. In 2017, India chemical industry stood at USD150-155 billion.

Air pollution from chemical industry is not limited to dust particles, as many of these set-ups release harmful gases and volatile organic compounds.

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

Indoor Air Pollution: Struggle for Better Air Quality at Home

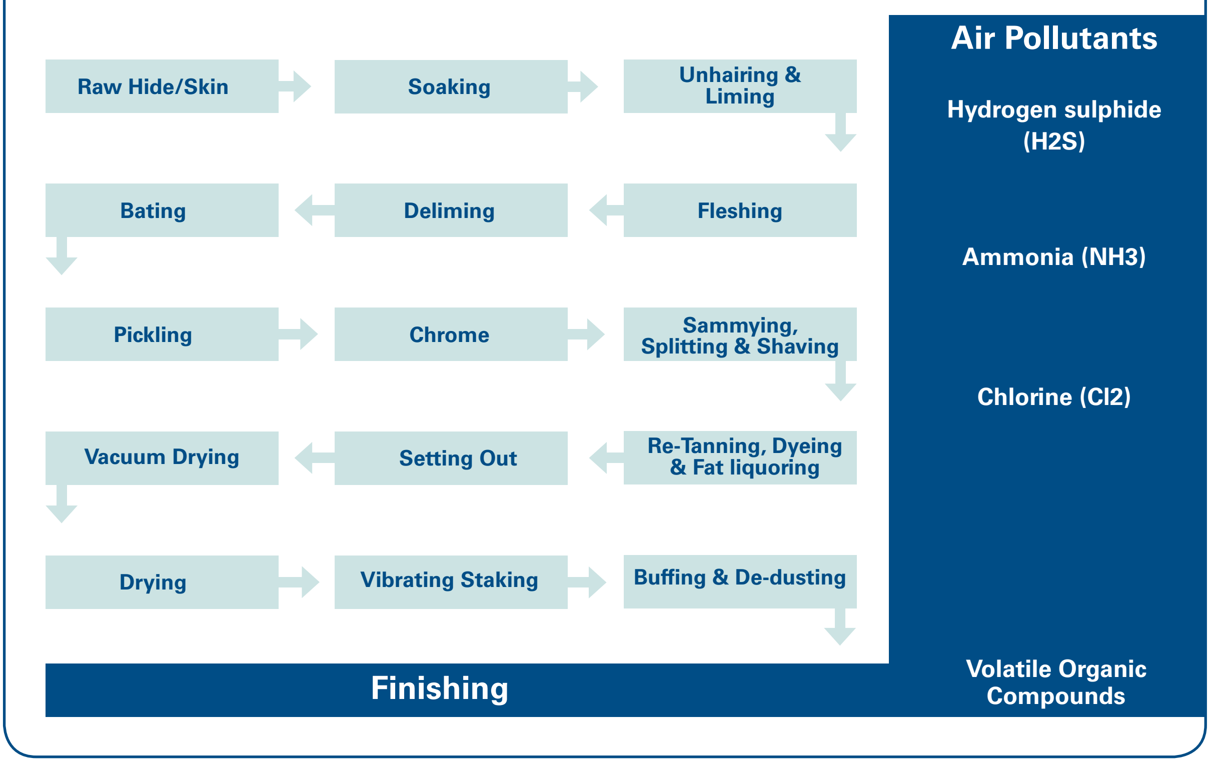
Indoor air pollution is one of the major concerns across the globe yet ignored often. It can be worse than outdoor air pollution, owing to enclosed areas which enable potential pollutants to build up more than open spaces. Approximately 40% of the global population still use solid fuels (such as crop waste, wood, coal, and dung cakes) and kerosene in open fires and inefficient stoves for cooking and other purposes. Over 85% of rural households and around 25% of urban households use biomass for cooking. These cooking practices are inefficient and use fuels that produce high levels of household air pollution with a range of harmful pollutants. In poorly ventilated homes, indoor smoke can be 100 times higher than acceptable levels for fine particles. Exposure is particularly high among young children and women. Moreover, around 30% of rural households use kerosene as the primary source of energy for lighting lanterns, which causes emission of carbon black soot and has a considerable health impact. One of the most important steps in the prevention of indoor air pollution is education.

Air purifiers play a significant role in controlling air quality indoors. With growing economy, demand for air purifying products is also increasing.

Leather Industry

Leather industry is also one of the major sources of pollution. Tanning industry waste poses a serious environmental impact on air and water (with its high oxygen demand, discoloration and toxic chemical constituents). Waste from tanneries contains a complex mixture of both inorganic and organic pollutants. The problem related with gaseous pollutants from a tannery includes unpleasant smell, hydrogen sulphide and dust. The effect of noxious odors may lead to nausea. Tanneries also emit various air pollutants such as H2S, NH3, Cl2 and VOCs (Volatile organic compounds).

Flow Chart for Leather Processing



3.6 Impact and Measures

Key Initiatives to Monitor and Control Air Quality By Government

Diesel Ban and Green Tax

In 2015, the Supreme Court (SC) imposed a ban on the sale of all diesel vehicles with engines more than 2000 cc. The ban was later lifted; however, SC imposed a 1% cess on such vehicles, with the amount to be deposited with the Central Pollution Control Board. In 2016, the government also announced a 'green tax' of 2.5% on small cars and 4% on bigger cars and SUVs.

Liquefied Natural Gas (LNG)
LNG, a new concept in India, is being aggressively promoted by Ministry of Road Transport and Highways. While LNG is already in use in the industrial sector, it is not commercially available for the automotive industry in the country. However, the government is setting up LNG storage depots at ports to make the fuel a conventional alternative to CNG. LNG is much cleaner than CNG.

IKEA: Better Air Now
IKEA is focusing on one of the largest, global environmental issues by launching its "Better Air Now" campaign. Initiating with India, IKEA wants to turn rice straw - a rice harvesting residue that is traditionally burned and contributes heavily to air pollution – into a new renewable material source for IKEA products.

Bharat Stage VI
With the successful implementation of BS-VI norms in India in 2020, India will remain the only country to have completely skipped an emission norm (BS-V) to jump directly to the next one. India was originally supposed to adopt BS-VI in 2024. Emissions from BS-VI vehicles will be lesser than the present generation BS-IV vehicles.

Uber: Lower the Window Drive
Uber has partnered with local and government stakeholders, aimed at reducing number of private vehicles running on Delhi roads. Under the Lower the Window Drive program, Uber is offering discounts and incentives that would encourage people to leave their cars at their home, thereby maximizing the passenger carrying capacity of shared vehicles and public transport.

3.7 Key Policies & Regulations in Place

Some of the major policies & regulations laid out by the Indian government to control air pollution are:

- **The Air (Prevention & Control of Pollution) Act, 1981**
  Is an act to provide for the prevention, control and abatement of air pollution.

- **National Ambient Air Quality Standards (NAAQS)**
  The objectives of air quality standards include indicating the levels of air quality necessary with an adequate margin of safety to protect the vegetation, property and
  public health.

- **National Air Quality Monitoring Program (N.A.M.P.)**
  Central Pollution Control Board has launched a nationwide program of ambient air quality monitoring known as National Air Quality Monitoring Program (NAMP). The network includes 731 operating stations covering 312 cities/towns in 29 states and 6 union territories of the country. The objectives of the N.A.M.P. are to determine the status and trends of ambient air quality, identify non-attainment cities, obtain the knowledge and understanding necessary for developing preventive and corrective measures, ascertain whether the prescribed ambient air quality standards are violated and understand the natural cleansing process undergoing in the environment through pollution dilution, dispersion, wind based movement, dry deposition, precipitation and chemical transformation of pollutants generated.

- **The Environment (Protection) Act, 1986**
  It is an Act to provide for the protection and improvement of environment.

- **Graded Response Action Plan for Delhi & NCR**
  In accordance with the order carried by Supreme Court, a Graded Response Action Plan has been prepared for implementation under different Air Quality Index (AQI) categories, namely, Moderate & Poor, Very Poor, and Severe as per National Air Quality Index. A new category of "Severe+ or Emergency" has been added.

- **National Clean Air Programme**
  -The government has started National Clean Air Programme (NCAP) as a national level strategy to tackle the rising air pollution problem across the country in a comprehensive manner. The overall objective is to augment and evolve effective ambient air quality monitoring network across the country besides ensuring comprehensive management plan for the prevention, control and abatement of air pollution.

Key Organizations/Intervening Bodies and their Roles

Key Organizations / Intervening Bodies

Central Pollution Control Board (CPCB)

The Central Pollution Control Board (CPCB), statutory organization, was constituted in September 1974 under the Water (Prevention and Control of Pollution) Act, 1974. Further, CPCB was entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981. It serves as a field formation and also provides technical services to the Ministry of Environment and Forests of the provisions of the Environment (Protection) Act, 1986. Major functions of the Central Pollution Control Board include advising the central government on matters concerning prevention, control of water and air pollution, co-ordinate the activities of the state board and resolve disputes among them, plan and organize training of persons engaged in program on the prevention, control or abatement of water and air pollution, and disseminate information in respect of matters relating to water and air pollution and their prevention and control.

SAFAR (System of Air Quality and Weather Forecasting and Research)

SAFAR is a research-based initiative of integrating air quality with health advisories and food security. It is a research-based management system, where strategies to tackle air pollution are designed, keeping in mind the country's economic development.

(MoEFCC) Ministry of Environment, Forest and Climate Change

The Ministry of Environment, Forest and Climate Change (MoEFCC) is the nodal agency in the administrative structure of the Central Government for the promotion, planning, co-ordination and overseeing the implementation of India's environmental and forestry policies and programs. The ministry's primary focus is the implementation of policies and programs related to conservation of the country's natural resources including its lakes and rivers, biodiversity, forests and wildlife, ensuring the welfare of animals, and the prevention of pollution.

The Energy and Resources Institute (TERI)

The Energy and Resources Institute (TERI) is a research institute in New Delhi, specializing in the fields of environment, energy and sustainable development. The focus of this institute is on promoting efficient use of resources, increasing sustainable practices and minimizing the impact on environment and climate.

Centre for Science and Environment (CSE)

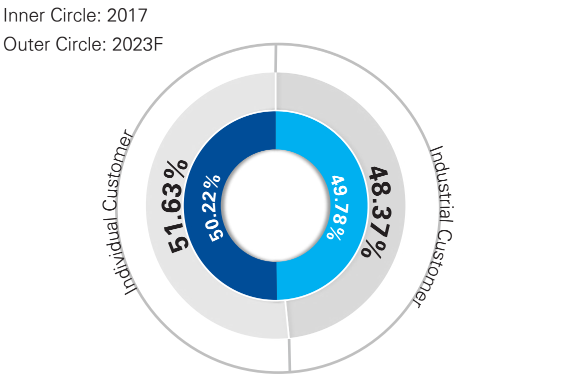
The Centre for Science and Environment (CSE) is a public interest research and advocacy organization based in New Delhi.

3.8 Opportunity Assessment in Air Pollution Control Products Suppliers

Pollution Masks

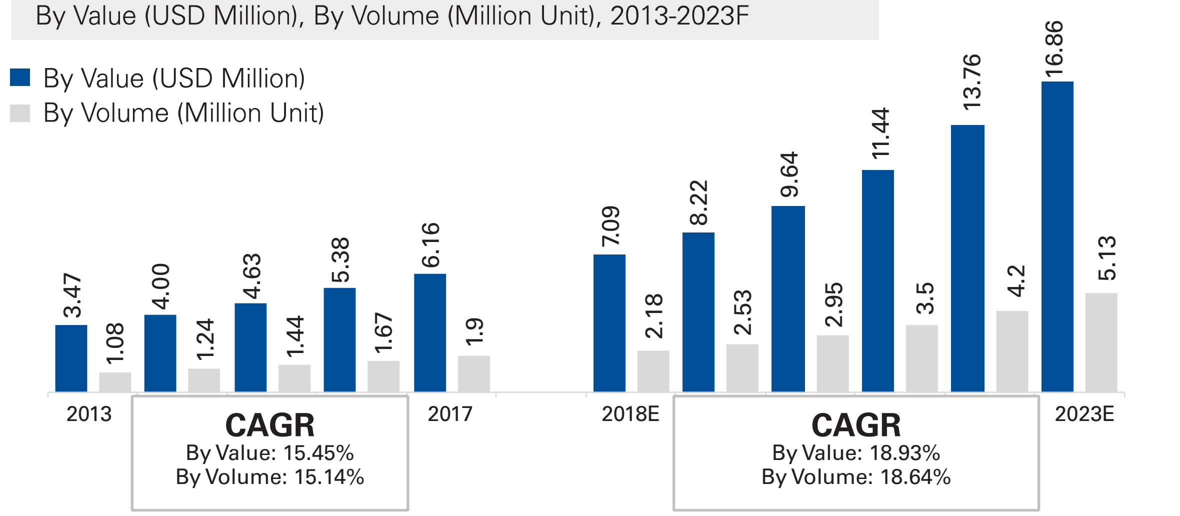
Pollution mask filters out airborne particles and prevents users from exposure to harmful gases. A pollution mask consists of a high-quality filter that fits on the face accordingly and works effectively to prevent the user against the inhalation of harmful pollutant particles as small as PM 2.5 and gases such as NO2 and SO2. In 2017, India pollution masks market generated revenue worth USD6.16 million and is forecast to reach USD16.86 million by the end of 2023. Backed by rapid urbanization, increasing purchasing power, expanding urban population base and deteriorating air quality, India pollution masks market grew at a CAGR of 15.45%, in value terms, during 2013-2017.

India Pollution Masks Market Share
By End User, By Value, 2017 & 2023F



Source: TechSci Research

India Pollution Masks Market Size,
By Value (USD Million), By Volume (Million Unit), 2013-2023F



Source: TechSci Research

Residential Air Purifiers

Residential sector accounted for a revenue share of around 22% in the overall India air purifiers market in 2017, on account of increasing airborne diseases in the country, due to rising air pollution.

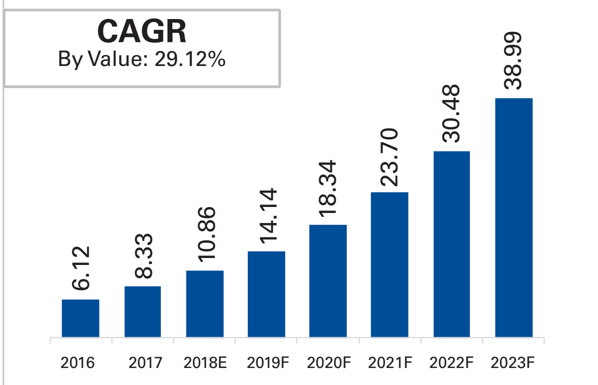
Initially, people with respiratory and other breathing related diseases were targeted as the major end users of air purifiers. Rising air pollution, both outdoor as well as indoor, is solely responsible for increasing the number of asthma and COPD (Chronic Obstructive Pulmonary Disease) patients. This is resulting in a significant opportunity for air purifiers in the residential sector.

Presence of high concentration of PM2.5 and PM10 in the air leads to high pollution levels in northern parts of India, especially Delhi NCR, which is among the most polluted regions in the country. As a result, demand for

residential air purifiers from northern India is increasing.

Air purifier manufacturing firms, in order to spread awareness about the harmful effects of air pollution, are organizing several small knowledge camps at malls and at other point of sales in tier II cities, which in turn is positively influencing the country's air purifier market. Increasing construction activities including the establishment of buildings and townships in tier II cities, such as Varanasi, Amritsar and Ludhiana are deteriorating the air quality in these regions, thus demand for air purifiers is anticipated to grow at a robust pace from these regions in the coming years.

India Residential Air Purifiers Market Size,
By Value (USD Million), 2016-2023F



Source: TechSci Research

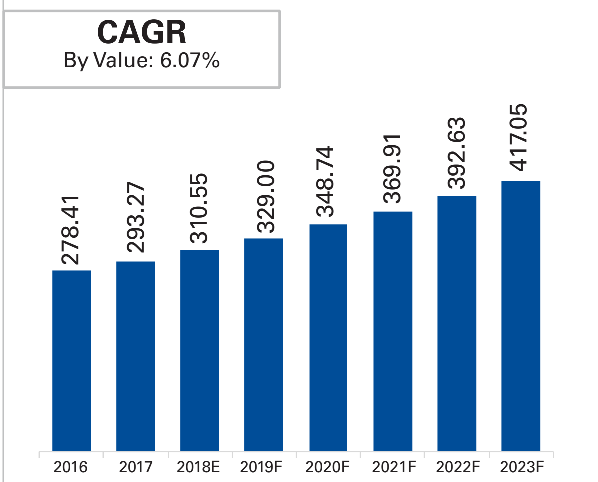
Industrial Air Filters

Air filters are devices used to remove particulate contaminants such as dust, pollen, molds and bacteria from the air. Air filters remove contaminants from the air by trapping particulates as soon as they come in contact with the surface of the fiber media.

Rising production in automotive industry, increasing number of pharmaceutical plants and food processing units, and growing installation of air filters in cement manufacturing units are driving market of air filters in India. In 2017, industrial air filters market stood at USD293.27 million and is forecast to grow at a CAGR of 6.07% to cross USD392.63 million by 2023. Also, the need for frequent replacement of air filters in the construction sector is spurring demand for air filters.

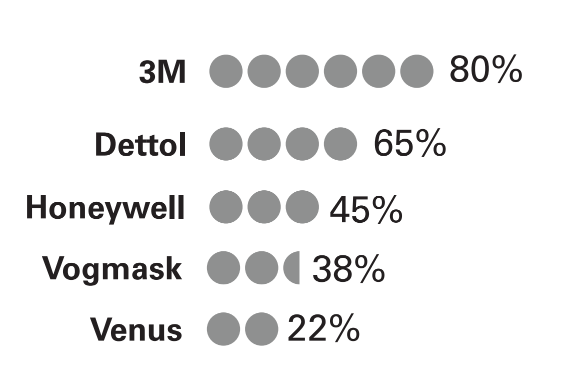
Sales of HVAC air filter segment witnessed high penetration in commercial sector in comparison to residential sector, thereby fueling air filters market in India.

India Industrial Air Filters Market Size
By Value (USD Million), 2016-2023F



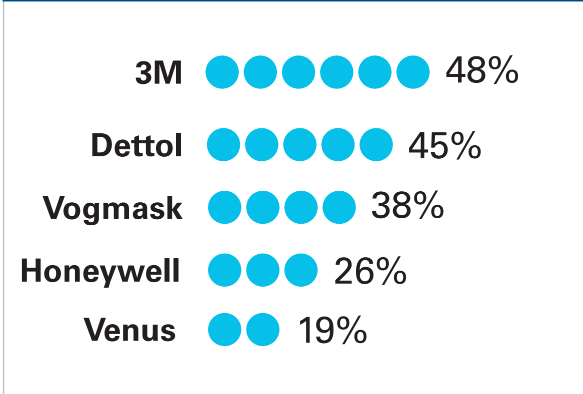
3.9 Consumer / End User Insights

India Pollution Mask - Brand Awareness, 2017 (N= 200)



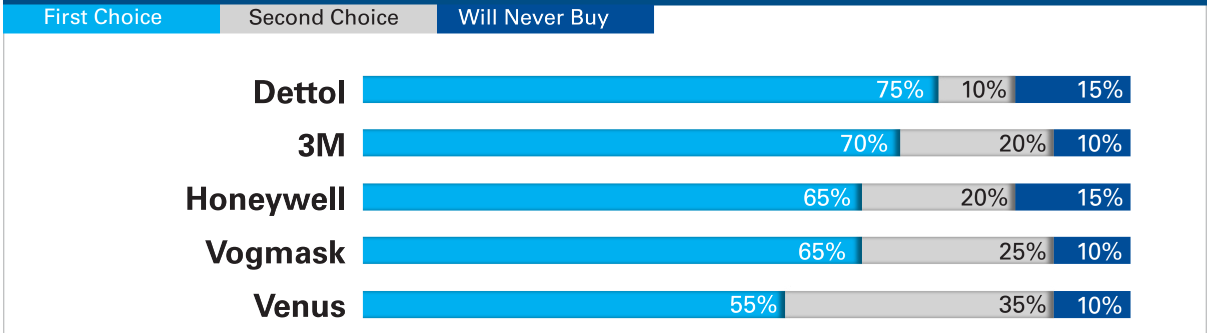
Source: TechSci Research

India Pollution Mask - Brand Recall, 2017 (N= 200)



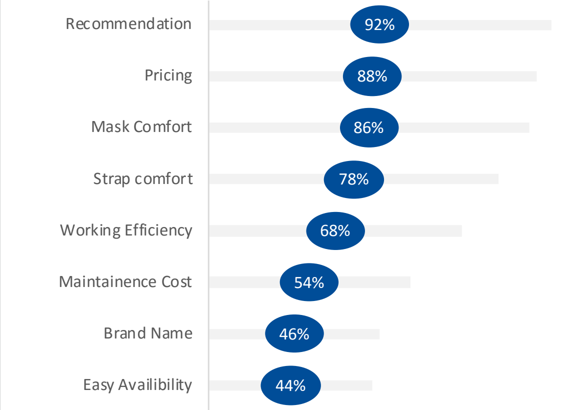
Source: TechSci Research

India Pollution Mask - Brand Propensity, 2017 (N= 200)



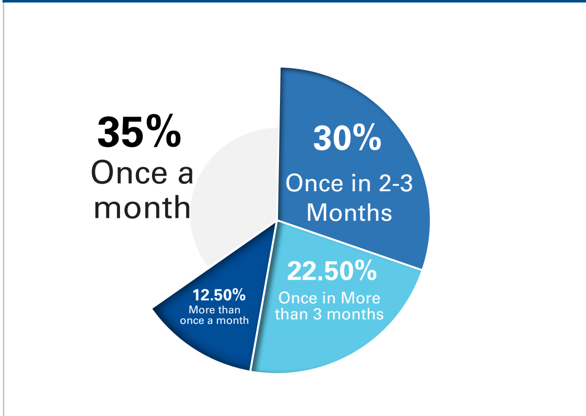
Source: TechSci Research

India Pollution Mask - Factors Influencing Purchase Decision, 2017 (N= 200)



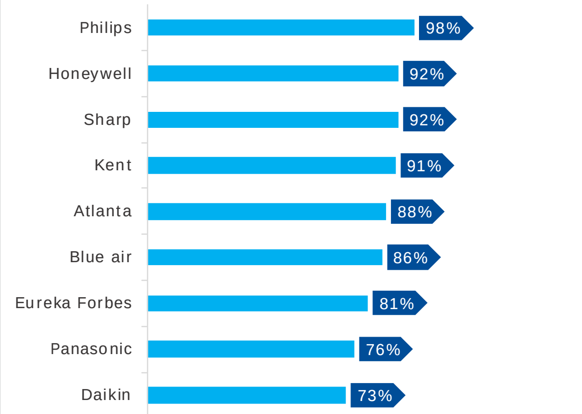
Source: TechSci Research

India Pollution Mask - Purchase Frequency, 2017 (N= 200)



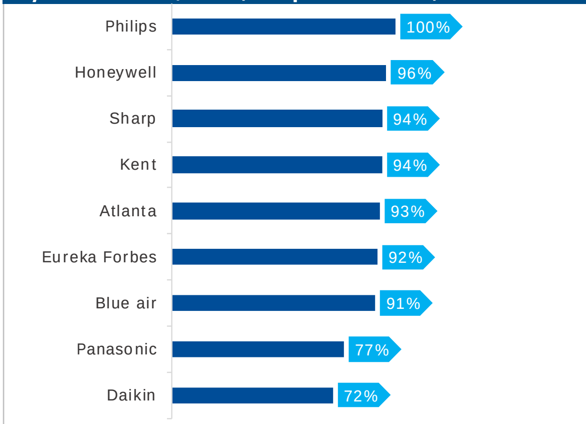
Source: TechSci Research

India Air Purifiers - Unaided Brand Awareness Level, By Select Brand, 2017 (Sample Size = 200)



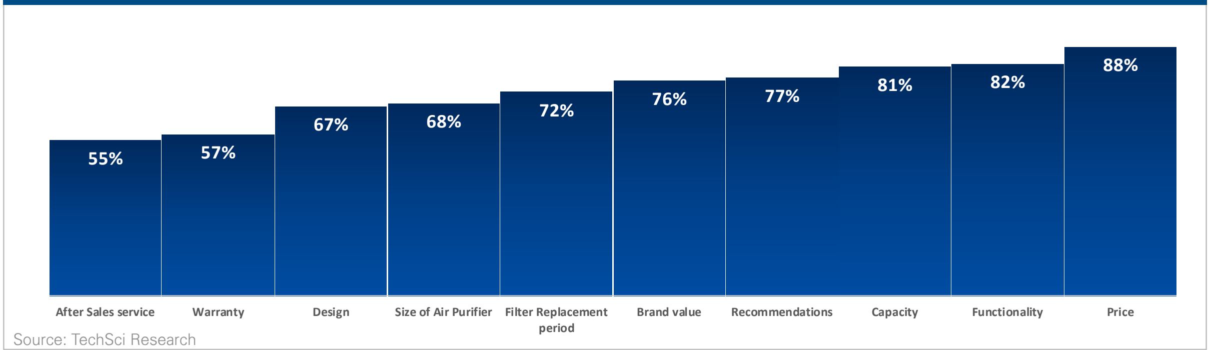
Source: TechSci Research

India Air Purifiers-Aided Brand Awareness Level, By Select Brand, 2017 (Sample Size = 200)



Source: TechSci Research

Factors Influencing Purchase Decision (Sample Size = 200)



Source: TechSci Research

3.10 Case Studies

CASE STUDY 1. Gas Replaces Coal to Clean Up Krakow

Krakow used to witness poor air quality due to coal burning for residential heating. Largely uncontrolled, residential coal burning contributes to high concentrations of fine particulate matter (PM10 and PM2.5) and NOx. PM10 concentrations in Krakow exceeded EU safety limits on 188 of the 365 days in 2014. Fine particulate emissions alone contribute to an estimated 45,000 premature deaths across Poland. Health impacts caused by coal-related emissions include respiratory and cardiovascular diseases (such as chronic obstructive lung disease, asthma, heart attack or stroke), lung cancer, birth defects, irritation to the eyes and throat, and nose bleeding. Due to pressure by numerous protests, petitions and a billboard campaign, local officials in Krakow approved a city-wide ban on coal and wood burning for home heating in 2013. However, in August 2014, a regional court declared Krakow's coal ban unconstitutional. After further campaigning by local environmental groups in Krakow – and under growing pressure from the European Commission to comply with EU air quality rules – the Polish government eventually adopted an "anti-smog" law in 2015, which gave local authorities broad powers to regulate coal burning in the residential sector.

Krakow City Council moved swiftly, and in January 2016, it reintroduced the city-wide coal ban with an updated deadline of 2019 to completely phase out coal stoves from home heating. But without financial support, replacing coal-fired stoves with gas-fired ones would be costly for most of the households. Early-critics of the Krakow coal ban liked to point out that the measure would hurt the poor residents in the city who are more likely to use coal for home heating than wealthier citizens. Krakow offers a number of grants and other financial incentives to reimburse up to the full cost of replacing coal-fired boilers. The city also offers targeted subsidies to protect its poorest residents from the increased heating bills following the switch to cleaner fuels, particularly to natural gas.

Krakow's case shows that targeted measures, such as fuel subsidies and grants for poor households, can go a long way to address some of the concerns with increased natural gas use, particularly those related to higher heating bills and high upfront cost of switching to cleaner fuels. Sustained lower natural gas prices, greater infrastructure robustness, and the abundance of flexible LNG supplies in the global gas market should also help reduce the cost of switching from coal to gas in residential heating.

CASE STUDY 2. LNG Fueled Transportation- Rotterdam

Rotterdam is the second-largest city in one of Europe's most prosperous countries, but it is still facing environmental challenges. In 2014, the lifespan of a Rotterdam resident was three years shorter than the average Dutch citizen due to the high levels of air pollution. The Port of Rotterdam is implementing initiatives to improve city-wide and regional air quality by lowering emissions through the expanded use of LNG as a fuel for inland waterway vessels. LNG emits less SOx, PM, CO2 and NOx than traditional bunker fuels, such as heavy fuel oil, diesel fuel or marine gasoil. The Rotterdam Climate Initiative (RCI), which was introduced in 2010, aims to improve air quality in the port, the city and the surrounding industrial areas. As a port city, many of Rotterdam's air pollution challenges start from port operations, port-related traffic and nearby industrial facilities. The industrial sector has played a leading role in advancing the climate initiative. The widespread adoption of LNG in the port is one of the initiative's major pillars. Because LNG is considered a cleaner alternative fuel, the European Union is strongly supporting LNG refueling points at maritime and inland ports. Rotterdam started LNG bunkering operations in August 2016 and planned to install three LNG fueling berths. During 2017, Shell supplied Rotterdam with an LNG bunkering vessel. In addition to growing its LNG bunkering capabilities, the port-initiated LNG truck loading facilities will boost its ability to supply smaller quantities of LNG to both Rotterdam and landlocked cities across the Netherlands, facilitating emission reductions in road transportation.

The port of Rotterdam's efforts in suppressing air pollution around the port and city have shown that this can be done without impacting economic growth. Despite a steep increase in maritime traffic between 2005 and 2015, GHG emission levels in the port of Rotterdam stayed flat with associated drops in NOx (13% reduction), SOx (55% reduction), and PM (27% reduction) concentrations between 2004 and 2012. This air quality improvement is mostly due to the port's clean air action program, which started in 2006. Key measures include giving economic incentives to green vessels such as discounts on port dues and providing onshore power supply. More widespread use of LNG in and around the port of Rotterdam will further improve local air quality in the area and demonstrate that major port cities can become more sustainable without losing business.

Conclusion and Recommendation

AIR POLLUTION

CONCLUSION

Air pollution has become one of the biggest challenges for both developed and developing economies. To an extent, it is even threatening the existence of the human race due to its effects like global warming and acid rain. The government is slowly waking up to the disastrous situation and trying to improve the declining quality of life in Indian cities.

RECOMMENDATION

Air pollution is a huge global problem, especially in fast developing countries. The impacts have become evident with the change in weather patterns across the world due to global warming. Governments across the world are slowly waking up and are drafting measures in various summits like Paris Convention and Tokyo Convention. However, some of the major developed parts of the world such as the United states, which alone contributes to a third of the air pollution, have backed out of these pacts. Developing countries like India and China in Asia and the African continent will continue to contribute to a growing load of carbon emissions across the world. Thus, it becomes evident that both developed and developing economies need to come together on a common platform and join hands to fight this menace. Moreover, exchange of clean technologies from the developed world needs to be increased.

In India, the government is still slow in terms of implementing strong measures to curb pollution. The government has recently framed the norms for the automotive industry, named Bharat VI, which will be implemented in 2020. Presently, India has much primitive norms like Bharat Stage IV. Also, countries across the world need to decrease their dependence on fossil fuels and look for more cleaner sources of energy.

ASSOCHAM
THE KNOWLEDGE ARCHITECT OF CORPORATE INDIA

EVOLUTION OF VALUE CREATOR

ASSOCHAM initiated its endeavour of value creation for Indian industry in 1920. Having in its fold more than 400 Chambers and Trade Associations, and serving more than 4,50,000 members from all over India. It has witnessed upswings as well as upheavals of Indian Economy, and contributed significantly by playing a catalytic role in shaping up the Trade, Commerce and Industrial environment of the country.

Today, ASSOCHAM has emerged as the fountainhead of Knowledge for Indian industry, which is all set to redefine the dynamics of growth and development in the technology driven cyber age of 'Knowledge Based Economy'.

ASSOCHAM is seen as a forceful, proactive, forward looking institution equipping itself to meet the aspirations of corporate India in the new world of business. ASSOCHAM is working towards creating a conducive environment of India business to compete globally.

ASSOCHAM derives its strength from its Promoter Chambers and other Industry/ Regional Chambers/Associations spread all over the country.

VISION

Empower Indian enterprise by inculcating knowledge that will be the catalyst of growth in the barrierless technology driven global market and help them upscale, align and emerge as formidable player in respective business segments.

MISSION

As a representative organ of Corporate India, ASSOCHAM articulates the genuine, legitimate needs and interests of its members. Its mission is to impact the policy and legislative environment so as to foster balanced economic, industrial and social development. We believe education, IT, BT, Health, Corporate Social responsibility and environment to be the critical success factors.

MEMBERS – OUR STRENGTH

ASSOCHAM represents the interests of more than 4,50,000 direct and indirect members across the country. Through its heterogeneous membership, ASSOCHAM combines the entrepreneurial spirit and business acumen of owners with management skills and expertise of professionals to set itself apart as a Chamber with a difference.

Currently, ASSOCHAM has more than 100 National Councils covering the entire gamut of economic activities in India. It has been especially acknowledged as a significant voice of Indian industry in the field of Corporate Social Responsibility, Environment & Safety, HR & Labour Affairs, Corporate Governance, Information Technology, Biotechnology, Telecom, Banking & Finance, Company Law, Corporate Finance, Economic and International Affairs, Mergers & Acquisitions, Tourism, Civil Aviation, Infrastructure, Energy & Power, Education, Legal Reforms, Real Estate and Rural Development, Competency Building & Skill Development to mention a few.

INSIGHT INTO 'NEW BUSINESS MODELS'

ASSOCHAM has been a significant contributory factor in the emergence of new-age Indian Corporates, characterized by a new mindset and global ambition for dominating the international business. The Chamber has addressed itself to the key areas like India as Investment Destination, Achieving International Competitiveness, Promoting International Trade, Corporate Strategies for Enhancing Stakeholders Value, Government Policies in sustaining India's Development, Infrastructure Development for enhancing India's Competitiveness, Building Indian MNCs, Role of Financial Sector the Catalyst for India's Transformation.

ASSOCHAM derives its strengths from the following Promoter Chambers: Bombay Chamber of Commerce & Industry, Mumbai; Cochin Chambers of Commerce & Industry, Cochin: Indian Merchant's Chamber, Mumbai; The Madras Chamber of Commerce and Industry, Chennai; PHD Chamber of Commerce and Industry, New Delhi.

Together, we can make a significant difference to the burden that our nation carries and bring in a bright, new tomorrow for our nation.

The Associated Chambers of Commerce and Industry of India

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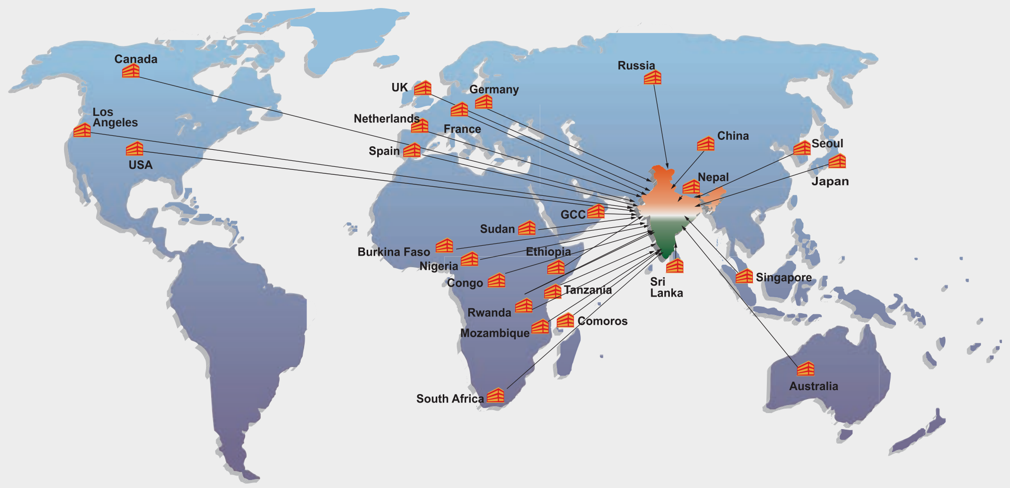
ASSOCHAM OVERSEAS 28 OFFICES



The pictorial presentation of the world map does not purport to be the political and geographical maps of the world and India and is not drawn to scale. This is only indicative.

ASSOCHAM International Department

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About TechSci Research

TechSci Research is a research-based management consulting firm providing market research and advisory solutions to its customers worldwide, spanning a range of industries. TechSci Research's core values are value, integrity and insight. Led by a team of dynamic industry experts, TechSci Research provides its customers with high value market research and advisory services that helps them identify new market opportunities, growth engines and innovative ways to capture the market share. As a result, TechSci's client leads rather than follow market trends. Not bound by legacy, TechSci's cutting-edge research model leverages its decades of research knowledge and an increased use of technology as engines of innovation to deliver unique research value. Provided as an alternative to traditional market research, TechSci Research reports do not just deliver data and knowledge rather highlights the insights in a more usable and interactive format for its clients.

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