



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 7, July 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.569



Air Pollution and Their Management in the Indian Cities

Dr.Arif Khan¹, Sandeep V Lokhande²

Registrar, National Institute of Technology Raipur, Raipur, Chattishgarh, India¹

PG Student, Department of Environment Engineering, Swaminarayan Siddhanta Institute of Technology Nagpur, India²

ABSTRACT: 700 million Indians have used solid fuels in their homes for the last 30 years, contributing substantially to air pollutant emissions. The Indian economy and industrial, power generation, and transport sectors have grown considerably over the last decade, increasing emissions of air pollutants. These air pollutant emissions have caused present-day concentrations of ambient PM_{2.5} and O₃ in India to be amongst the highest in the world. Exposure to this air pollution is the second leading risk factor in India, contributing one-quarter of the global disease burden attributable to air pollution exposure. Air pollutant emissions are predicted to grow extensively over the coming years in India. Despite the importance of air quality in India, it remains relatively understudied, and knowledge of the sources and processes causing air pollution is limited. The global burden of disease study estimated 695,000 premature deaths in 2010 due to continued exposure to outdoor particulate matter and ozone pollution for India. By 2030, the expected growth in many of the sectors (industries, residential, transportation, power generation, and construction) will result in an increase in pollution related health impacts for most cities. The available information on urban air pollution, their sources, and the potential of various interventions to control pollution, should help us propose a cleaner path to 2030. In this paper, we present an overview of the emission sources and control options for better air quality in Indian cities, with a particular focus on interventions like urban public transportation facilities; travel demand management; emission regulations for power plants; clean technology for brick kilns; management of road dust; and waste management to control open waste burning. Also included is a broader discussion on key institutional measures, like public awareness and scientific studies, necessary for building an effective air quality management plan in Indian cities.

KEYWORDS: Air Pollution, Disease, Indian Cities, SOX, NOX, SO₂

I. INTRODUCTION

Air pollution exposure is a leading global risk factor (Cohen et al 2017, GBD 2016 Risk Factors Collaborators 2017, Indian Council of Medical Research et al 2017b, India State-Level Disease Burden Initiative Collaborators 2017). Exposure to air pollution is the second leading risk factor in India, contributing one-quarter of the global disease burden attributable to air pollution exposure (Cohen et al 2017, GBD 2016 Risk Factors Collaborators 2017, Indian Council of Medical Research et al 2017b, India State-Level Disease Burden Initiative Collaborators 2017). The disease burden from air pollution is costly, worsening, and disproportionately falls on susceptible populations (Landrigan et al 2017). Despite this importance, research on air pollution in India is limited and little is known about the sources and processes that contribute to air pollution in this region. Understanding the causes and processes behind the health impacts of air pollution exposure across a range of scales is critical to reduce the substantial and growing disease burden in India.

Today, air pollution has emerged as a global public health problem and is identified as a major environmental health hazard by agencies such as the World Health Organization (WHO) and governments around the world. An increase in concentration of pollutants - both gaseous and solid - is among the largest health risk in the world and according to the latest data released by WHO, indoor and outdoor air pollution were responsible for 3.7 million deaths of people aged under 60 in 2012.

Today, air pollution has emerged as a global public health problem and is identified as a major environmental health hazard by agencies such as the World Health Organization (WHO) and governments around the world. An increase in concentration of pollutants - both gaseous and solid - is among the largest health risk in the world and according to the latest data released by WHO, indoor and outdoor air pollution were responsible for 3.7 million deaths of people aged under 60 in 2012.

A recent study by Yale and Columbia University ranked India 126th out of 132 countries surveyed on environmental performance and worst for air pollution; far below all BRICS nations i.e. Brazil, Russia, China and South Africa.

According to a WHO report from 2014, Delhi had the dirtiest atmosphere of 1,600 cities around the world. 13 Indian cities feature in the 20 cities with the highest level of PM 2.5; Delhi having a PM2.5 level of 153, six times higher than the WHO safe limit of 25.

1.1 Air pollution pathway

Exposure to air pollution is a risk factor that causes health impacts (Smith 1993, McGranahan and Murray 2003, U.S. Environmental Protection Agency 2009a). Epidemiological risk is the probability that a disease, injury, or infection will occur. The risk assessment of air pollution follows the air pollution pathway (Figure 1) from sources through emissions, concentrations, exposures, doses, to health impacts (Smith 1993, McGranahan and Murray 2003, U.S. Environmental Protection Agency 2009a). Sources are the origin of the pollutant, generally the quantity and quality of fuel used. Emissions are air pollutants released from the source and are characterised by the environment, transported, and transformed. Concentrations are the amount of an air pollutant in space and time. Exposures are concentrations of air pollutants that are breathed in and depend on pathways, durations, intensities, and frequencies of contact with the pollutant. Doses are how much of the exposure is deposited in the body. Health impacts accrue from doses, can be acute (short-term) or chronic (long-term), and are non-specific in that they have many risk factors. Monitoring and intervention can occur at any stage along this pathway. Health impacts are the primary risk indicators, though control measures at this stage are often too late and complicated due to their non-specific nature. Doses are also too late in the air pollution pathway and are poorly understood for many pollutants. Control measures and standards generally focus on sources, emissions, and concentrations, with recent efforts targeting exposures.

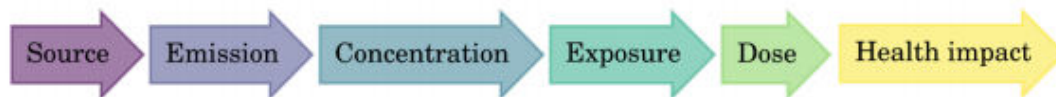


Figure 1: Air pollution pathway (Smith 1993, McGranahan and Murray 2003, U.S. Environmental Protection Agency 2009a).

1.1.1. Fundamentals of ambient air pollution

Ambient air pollution is a complex mixture of many particles and gases. Air quality is generally measured by a small subset of these particles and gases. Fine particles with aerodynamic diameters less than or equal to 2.5 micrometres (PM_{2.5}) and tropospheric ozone (O₃) are two important indicators of air quality. PM_{2.5} is the most consistent and robust predictor of health effects from studies of long-term exposure to air pollution (Health Effects Institute 2018). O₃ has been associated with increased respiratory mortality (Health Effects Institute 2018). This thesis is consistent with the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) when quantifying exposure to ambient air pollution using PM_{2.5} and O₃ as indicators. The air quality community often refers to aerosol mass as particulate matter (PM).

1.1.1.1. Aerosols

An aerosol is a solid or a liquid suspended in a gas. Aerosol matter are characterised by their size, shape, and composition (Brasseur and Jacob 2016, Seinfeld and Pandis 2016). Aerosols span three orders of magnitude in size, generally categorised into modes. The nucleation mode are particles with a diameter less than 0.01 μm , the Aitken mode are particles sized between 0.01– 0.1 μm , the accumulation mode are particles with diameters between 0.1–2.5 μm , and the coarse mode are particles with diameter between 2.5–10 μm . Particles less than 0.1 μm are ultrafine particles, less than 2.5 μm in diameter are fine particulate matter (PM_{2.5}), and particles less than 10 μm (PM₁₀) combine fine and coarse particles. Figure 2 shows the size of fine and coarse PM relative to human hair (Guarnieri and Balmes 2014). Fine and coarse particles vary in their origin, transformation, removal, composition, optical properties, and health impacts (Brasseur and Jacob 2016, Seinfeld and Pandis 2016). Aerosols are physically intricate

in shape becoming more spherical when dissolved or aged. However, they are often assumed spherical for simplicity (Brasseur and Jacob 2016, Seinfeld and Pandis 2016).

1.1.1.2. Ozone

O₃ is a secondary gaseous pollutant produced in the atmosphere. O₃ production and loss are controlled by different mechanisms in the stratosphere and troposphere. Photolysis of O₂ controls stratospheric O₃ production following the Chapman mechanism (Brasseur and Jacob 2016, Seinfeld and Pandis 2016). In the troposphere, where ultra-violet (UV) radiation is not energetic enough to photolyse oxygen (O₂) directly, production of tropospheric O₃ is driven by photochemical oxidation of VOCs and carbon monoxide (CO) in the presence of NO_x. O₃ production is complex and non-linearly dependant on temperature, radiation intensity, spectral distribution, precursor concentrations, among many other factors (Brasseur and Jacob 2016, Seinfeld and Pandis 2016). NO_x is emitted mainly as nitric oxide (NO). NO is oxidised to NO₂ by organic-peroxy (RO₂) or hydro-peroxy (HO₂) radicals released during VOC oxidation. VOC oxidation is initiated mostly by reaction with hydroxyl (OH) radicals. NO₂ photolysis produces NO and a ground-state oxygen atom, O(3P), which reacts with O₂ to form O₃. O₃ photolysis produces electronically excited oxygen atoms, O(1D), which react with water vapour to produce the OH radical, which can then further oxidise VOCs. O₃ can react with NO to produce NO₂, which is an important O₃ sink in urban areas, where NO concentrations are very high, leading to low O₃ abundances. VOCs are biogenic and anthropogenic, including methane (CH₄), alkanes, alkenes, aromatic hydrocarbons, carbonyl compounds, alcohols, organic peroxides, and halogenated organic compounds. VOC lifetime can vary from an hour to a decade (Brasseur and Jacob 2016, Seinfeld and Pandis 2016).

Chemical production and loss of O₃ show complex dependencies on O₃ precursor concentrations. Isopleths are used to illustrate the dependency of O₃ production of NO_x and VOC concentrations, depicting lines of constant O₃ production rate and regimes where O₃ is insensitive to VOC abundance (NO_x-limited) and relatively insensitive or inversely related to NO_x abundance (VOC-limited) (Brasseur and Jacob 2016, Seinfeld and Pandis 2016). The majority of the troposphere is NO_x-limited. Biogenic and anthropogenic VOCs are important precursors in rural and urban areas, respectively, though O₃ and precursors of O₃ can be transported long distances. Transport of stratospheric O₃ is an additional minor source to tropospheric O₃. The dominant sinks of tropospheric O₃ are photochemical loss, dry deposition, as well as direct reactions with HO₂ and OH (Brasseur and Jacob 2016, Seinfeld and Pandis 2016).

1.1.2. Air pollution sources

1.1.2.1. Sectors

Throughout the year in India, there are air pollutant emissions from transport (on- and offroad), residential (cooking, lighting, and water heating), industry, power generation, diesel generators (including agricultural pumps and tractors), open waste burning, natural and anthropogenic dust (combustion, industry, and resuspended road). In winter, there are additional emissions from residential heating, commercial heating, and agricultural burning. There are also emissions from informal industrial activities including brick kilns, food operations, and agricultural processing (Venkataraman et al 2018).

Residential, industrial, and power generation sectors in India all primarily combust solid fuels (wood, crop residue, dung, and coal). Emission factors from solid fuel use are often three orders of magnitude larger in residential uses relative to those in a large-scale facility, due to advanced combustion control, fuel quality control, post-combustion emission control systems, and legislative and reporting requirements (Shen et al 2010, Wang et al 2012). Power generation and industrial activities are key in eastern and southern India. The majority (57%) of electricity is produced by coal (Global Alliance for Clean Cookstoves and Dalberg Global Development Advisors 2013). Indian coal has low sulphur contents, high ash and moisture contents, and low net calorific values, with implications for SO₂ and PM emissions. Approximately one-quarter of coal is imported into India (Sahu et al 2017). The majority of India's thermal power plants do not adhere to regulations, do not use flue-gas desulphurisation, and have low energy efficiencies, leading to high air pollutant emissions (Venkataraman et al 2018). India's brick kilns use predominantly traditional technologies, such as Bull's trench kilns (76%) and clamp kilns (21%), using fired-brick walling materials and coal (Venkataraman et al 2018). Agricultural burning of solid fuels is primarily in the northwest (Punjab and Haryana). Natural dust is a strong source of PM in the northwest near the Thar Desert.

The total vehicle fleet in India is currently approximately 150 million, where between 67–82% are two-wheelers including scooters, motorcycles, and mopeds due to their low cost (Pandey and Venkataraman 2014, Guttikunda and Mohan 2014). Approximately one-sixth is from fourwheelers including cars and jeeps, and small shares are from other modes of transport (Pandey and Venkataraman 2014, Guttikunda and Mohan 2014). The vehicle fleet is predominately in urban areas (Pandey and Venkataraman 2014, Guttikunda and Mohan 2014). There is little use of public vehicles, largely due to a lack of infrastructure (Venkataraman et al 2018). Between 2000 and 2015, the number of households grew by a 1.39% per year, installed capacity of electricity generation grew by 6.89% per year, industrial cement production grew by 5.06% per year, passenger-kilometres increased by 6.54% per year, and freight-kilometres increased by 3.61% per year (Venkataraman et al 2018). The next section focuses on residential emissions and solid fuel use in detail.

1.1.2.2. Residential emissions and solid fuel use

Using solid fuels to create fire is arguably the defining task in human history (Wrangham 2010). Until approximately 1850, everyone used solid fuels for cooking (Smith 2017b). The fraction of the global population using solid fuels decreased to 62% in 1980 and further decreased to 41% in 2010 (Bonjour et al 2013). The majority of the global population now use clean fuels, gas and electricity, which is a sign of substantial development (Smith 2017b). However, the absolute number of solid fuel users has remained the same between 1980 and 2010 (approximately 3 billion globally, with 700 million in India) (World Health Organization 2015, Bonjour et al 2013). The absolute number of solid fuel users is important when considering absolute emissions. Substantial development between 1990 and 2010 halved the number of extremely poor people (Gapminder 2018) and many in India now have mobile phones and motorbikes (Smith and Sagar 2014). However, most of the Indian population earn between 2 and 8 dollars per day (Gapminder 2018), still using traditional Indian stoves (Chulhas) with solid biomass (primarily brushwood) (Smith and Sagar 2014). Energy consumption per capita in India is 25% of the global average. This poverty is a fundamental reason for solid fuel use.

II. MAJOR CAUSES OF AIR POLLUTION IN INDIA

As of Jan 2015, coal-powered thermal power plants account for 60.72% of India's total power generation, according to data available from Central Electricity Authority (CEA). Coal plants happen to be one of the leading sources of SO₂ and NO₂.

Growing number of cars in Indian cities - Private & commercial vehicles account for 66.28% of the total consumption of diesel*. Low standards for vehicle emissions & fuel have resulted in increased levels of Nitrogen Oxides & Sulphur.

As per Census 2011, 87% of rural households and 26% of urban households depend on biomass for cooking. Burning of biomass is a leading cause of indoor air pollution and is responsible for respiratory and pulmonary health issues in approximately 400 million Indians.

The proportion of rural households using kerosene as a primary source of energy for lighting is almost 30%. Kerosene lanterns used in rural areas are a primary source of emission of black carbon soot and cause significant health impact, particularly in the case of women and children.

III. IMPACT OF AIR POLLUTION IN INDIA

Air pollution, both indoor (household) and outdoor, has had a significant impact on the health of citizens as well as the economy. The adverse effects of air pollution are not just restricted to the urban areas but also impact rural areas, where a majority of the population relies on kerosene and burning of biomass for lighting and cooking purposes respectively.

Air pollution is among the leading causes of death in India -

The Global Burden of Disease Report has ranked outdoor air pollution as the fifth leading cause of death in India and indoor air pollution as the third leading cause. Outdoor air pollution was responsible for 6,20,000 deaths in 2010, increasing six-fold from 1,00,000 deaths in 2000. Moreover, a research study by researchers at the University of



Chicago, Harvard and Yale estimated that high Particulate Matter (PM) concentration is responsible for reducing the life expectancy by 3.2 years for 660 million Indians living in urban conglomerates.

Negative impact on agricultural productivity-

A recent research study “Recent climate and air pollution impacts on Indian agriculture” by scientists at the University of California, San Diego suggests the adverse impact of air pollution caused by Short-Lived Climate Pollutants (SLCPs) on agricultural productivity. They observed that the yield of wheat in 2010 has reduced by almost 36% and that of rice by 20% when compared to figures from 1980, negating for climate change. SLCPs such as ozone and black carbon are released into the atmosphere by motor vehicle exhausts and rural cook stoves respectively. These SLCPs remain in the atmosphere for short periods.

Cost of Air pollution amounts to 3% of the GDP –

A World Bank report titled ‘Diagnostic Assessment of Select Environmental Challenges in India’ highlighted that the annual cost of air pollution, specifically pollution from particulate matter (burning of fossil fuels) amounts to 3% of the GDP of the country; outdoor air pollution accounting for 1.7% and indoor air pollution for 1.3%. The report also observed that a 30% reduction in particulate emissions by 2030 would save India \$105 billion in health-related costs; a 10% reduction would save \$24 billion.

IV. KEY GOVERNMENT INITIATIVES & POLICY MEASURES TO TACKLE THE ISSUE

Amid growing concerns pertaining to rising air pollution, government of India has taken various initiatives as well as introduced policies to address the issue. In order to prevent and control air pollution, the Parliament of India enacted the Air (Prevention and Control of Pollution) Act, 1981 on 29th March 1981, which came into force on the 15th May of the same year. The Central Pollution Control Board (CPCB), a statutory organization under the Ministry of Environment & Forests (MoEF) has been entrusted with the responsibility of ensuring ambient air quality and has been conferred and assigned the power and functions to achieve the stipulated objective. Thereby, the CPCB in association with various State Pollution Control Boards (SPCBs) monitors the ambient air quality according to the National Ambient Air Quality Standards (NAAQS) with the help of 580 manual stations established in 244 cities, towns and industrial areas.

Moreover, a total of 42 questions on air pollution, its impact and efforts to check emissions and air pollution have been raised in the last 3 sessions of Parliament (24 in Lok Sabha & 18 in Rajya Sabha), which suggests increasing concern among Members of Parliament on the said issue. This section covers the significant government initiatives and policy measures over the past few years that are aimed at curbing both indoor and outdoor air pollution.

I) Steps to curb vehicular emission

With the increase in number of vehicles on Indian roads, air pollution resulting from vehicular emissions has become the main source of air pollution in the urban centres of the country. Moreover, in FY 2014, the share of diesel cars in overall car sales was 53%. According to a report released by the International Council on Clean Transportation, diesel vehicles are responsible for 56% of all PM emissions and 70% of all Nitrogen Oxides (NOx) emissions from on-road vehicles in India. Moreover, the content of sulphur in fuel makes it dirtier and lowers the efficiency of catalytic converters, which control emissions in automobiles. Therefore, several steps have been taken to mitigate the issue of vehicular emissions.

Adopting emission norms and fuel regulation standards –

Since the year 2000, India started adopting European emission and fuel regulations for all categories of vehicles. Under this plan, the Bharat Stage II emission standards were introduced initially in the four metro cities to manage the amount of air pollutants released by the internal combustion engine equipments by using cleaner fuel with low sulphur content and improved combustion engines. Accordingly, oil marketing companies were required to supply BS compliant fuel and auto manufacturers had to upgrade engines in a phased manner. Later on, the Bharat Stage fuel norms were applied to the rest of the country; as of 26th November 2011, BS – IV norms are applicable in 34 cities whereas BS –III norms are applicable in the rest of the country. However, India has been following European norms with a time lag of five years and it is in fact a decade behind developing countries such as Turkey and Brazil in



introducing cleaner-burning fuel. The SaumitraChaudhari Committee, formed to look into automobile fuel emission standards, has recommended that the government introduce the Bharat Stage – V norms across the country by 2020.

Promotion of cleaner technologies and alternate sources of energy to run vehicles:

National Mission for Electricity Mobility (NMEM) is aimed at enhancing penetration of efficient and environmentally friendly hybrid and electric vehicles; GoI earmarked 1,000 crores for the Plan in 2015 with an eye to decrease CO₂ emissions by 1.2- 1.5% in 2020.

Promotion of the cultivation, production and use of biofuels to substitute petrol and diesel in automobiles. Indicative target of 20% blending of bio-fuels such as bio-diesel and bio-ethanol by 2017 is proposed; Ethanol run bus launched in Nagpur under 'Green Bus' Project.

National Urban Transport Policy: Encouraging greater use of public transport in urban areas-

Most Indian cities are increasingly relying on motorized personal transport; in cities like Pune & Ahmedabad, motorized personal transport (in the form of cars and two-wheelers) accounts for a 48% and 44% share in the modes of transport used, respectively. With this in mind, the National Urban Transport Policy launched in 2006 by the Ministry of Urban Development (MoUD) and reviewed in 2014 seeks to prioritize the use of public transport running on cleaner fuel and technology and develop a people-centric sustainable multi-modal urban transport network, taking into consideration the unique characteristics and specific situations prevalent in cities. Therefore, various cities have either adopted or are in the process of developing public transport systems such as Mass Rapid Transit Systems (MRTS), Light Rail Transit System (LRTS) & Bus Rapid Transit Systems (BRTS); currently 14 MRTS, 8 BRTS are operational in India.

II) Reducing the dependence on biomass burning in rural households

Biomass – fuel wood, agricultural residue and animal waste – is among the most prevalent sources of energy in India, with almost 87% of rural households and 26% of urban households dependent on biomass for cooking. These fuels are burned in outdated cook stoves as a result of which they emit harmful pollutants, contributing to indoor air pollution in rural areas. The Government of India has focused on the importance of clean and efficient cook stoves in order to reduce emissions as well as the health hazards associated with inhalation of these emissions.

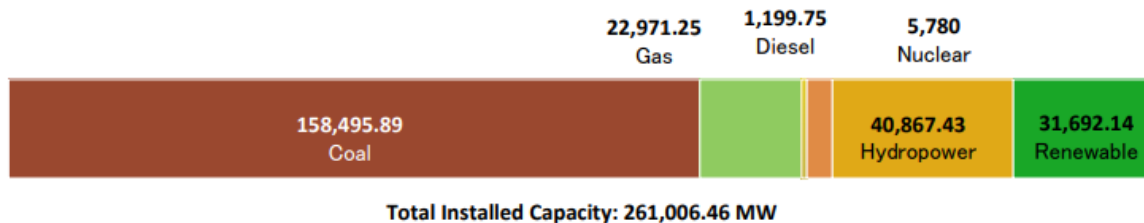
National Biomass Cookstoves Programme: improved cookstoves to reduce indoor air pollution-

The National Biomass Cookstoves Programme (NBCP) was launched by the Ministry of New and Renewable Energy to promote the use of improved cookstoves, which would result in reduced emissions and offer cleaner cooking energy solutions. As part of this programme, the government undertook wide consultations with NGOs, entrepreneurs and industries in the country with the objective of identifying ways and means for the development and deployment of improved biomass cook stoves across a large number of community undertakings and individual households.

Based on further discussions and deliberations, the government initiated the National Biomass Cookstove Initiative to design, develop an efficient and cost-effective device and assess the status of improved chulhas. Under this initiative, pilot scale demonstrative projects were undertaken to test for the efficiency of community-size cook stoves in Mid-day meal schemes in government schools in states of AP, Chhattisgarh, UP, Maharashtra, MP and Haryana and individual biomass cook stoves in J&K, Bihar, Karnataka, UP and Jharkhand. The results of the projects indicated substantial reduction in emissions and fuel consumption Accordingly, the UnnatChulhaAbhiyan has been launched to expand the deployment of the improved cook-stoves across the country. Rs.131 crores have been allocated for promotion of improved cookstoves and solar cookers in the Union Budget 2015-16.



III) Renewable Energy – the new area of focus to reduce dependency on coal



India is extremely rich in renewable energy (RE) sources, such as wind, solar and small hydro, however, green energy accounts for only 12.14% of India’s total installed power capacity. According to the India Renewable Energy Status Report 2014, the total renewable energy potential from various sources in India is 2,49,188 Mw which implies that only 12.71% of the potential has been achieved. Moreover, wind energy constitutes almost 65% of the total renewable energy generated in the country. It is imperative that the country alters its existing energy mix and reduce its reliance on coal and shift to greener modes of energy. The Electricity Act, 2003 proposed mandatory Renewable Purchase Specifications (RPS) for all states in order to increase the uptake of electricity from renewable energy sources. 26 State Electricity Regulatory Commission (SERC) specified the mandatory purchase obligation for purchase of fixed percentage of energy generated from RE sources.

It is in line with this idea that the government has set an ambitious target to achieve 175,000 MW of green energy by 2022 including one lakh MW of solar power, 60,000 MW of wind energy, 10,000 MW of biomass and 5000 MW of small hydro projects. Accordingly, several incentives and policy initiatives at the Central and State levels have been put in place both for grid connected and off-grid renewable energy

Solar Power: to become a crucial component of India’s power portfolio-

The Jawaharlal Nehru National Solar Mission (JNNSM), part of the missions launched as part of the National Action Plan on Climate Change seeks to tap the immense potential of solar power as a future energy source in the country. As part of the mission, it is envisaged that the installed capacity of solar power – both solar thermal and solar photovoltaic - should be ramped up to 20 GW by 2022 in three phases; in order to achieve the same, an enabling policy framework for manufacturing solar components and setting up power plants should be created. Furthermore, off-grid applications are to be promoted and steps taken to bring tariff to grid parity level. This mission has been largely successful and the current government has revised the target to 100 GW by 2022. Currently, the second phase of the Solar Mission is underway and the total installed capacity of solar power stands at 3,382.78 MW (as on 28.02.2015).

Role of states in promoting renewable energy:

States are expected to play a pivotal role in promotion of RE by establishing a policy and regulatory framework that incentivizes generation and purchase of RE. Certain states have taken the lead in attracting sizeable investments in the RE space by unveiling policies providing tax exemptions such as reduced VAT on RE components, adopting preferential tariffs for purchase of power from RE sources and initiatives for production of RE that connects to the grid as well as off-grid applications. Moreover, most of the progress in the RE space has been state-driven till date with states like Gujarat, Tamil Nadu, Rajasthan and Madhya Pradesh focusing extensively on diversifying their energy mix; almost 38% of TN’s total installed power capacity comes from RE.

The success of initiatives such as Gandhinagar Solar Photovoltaic Rooftop Programme - to establish and generate Solar Power by setting up grid interactive rooftop Solar Photovoltaic systems in Gandhinagar in order to make it a solar city – have encouraged other states and cities to encourage public participation in generation and utilization of green energy sources.

Move from carbon subsidization to carbon taxation:

Cess on coal has been doubled to Rs. 200 per tonne from Rs. 100 per tonne, which will boost renewable energy financing. India is among the few countries in the world to have introduced such a tax. The cess is collected as National Clean Energy Fund and is disbursed for renewable energy-based initiatives and power projects.



IV) National 'Air Quality Index' to enable common man to understand Air Quality:

Announced in October 2014 by the Ministry of Environment, Forests and Climate Change, the National Air Quality Index (AQI) is a measurement index consisting of 8 parameters, which would disseminate information in a simple and effective manner to the common man as characterized by its slogan "One Color, One Number and One Description". This data would be available for 10 cities in the first phase after the launch and would be disseminated in a real-time manner to enhance public awareness. Under the AQI scheme, the levels of the 8 pollutants are categorized as Good, Satisfactory, Moderately Polluted, Poor, Very Poor and Severe based on the ambient concentration, conformity to National Ambient Air Quality Standards and likely health impact. It is planned that this air quality index would be extended to 20 state capitals and 46 million plus cities over the next couple of years. This was launched by the Prime Minister on the 6th April, 2015.

V. CONCLUSION

Air Pollution is a complicated issue and negatively impacts the health of citizens as well as the economy of the country. Both indoor and outdoor air pollution have emerged as one of the leading causes of deaths in India and while recent reports highlight the worsening outdoor air pollution in urban centres, indoor air pollution due to biomass burning and inefficient 'chulhas' is also an area of concern. The Government of India and the state governments have recognized the adverse effect of air pollution and there is increased seriousness about addressing the air quality issue among all the stakeholders. Furthermore, recent efforts such as the launch of National Air Quality Index point to the need for enhancing public awareness on the quality of air they are breathing. A shift towards renewable energy is part of the plan to reduce dependency on fossil fuels as well as provide clean energy to households, which are currently using kerosene for lighting purposes. It is important that a comprehensive, integrated and long-term plan of action, involving coordination between different ministries and departments, is drawn to address the issue, reduce air pollution and ensure that citizens breathe clean air.

REFERENCES

1. Dr.Arif Khan, 2019,Quantify impact on water Environment by Using Fuzzy set Theory INTERNATIONAL JOURNAL OF CIVIL STRUCTURAL ENVIRONMENTAL AND INFRASTRUCTURE ENGINEERING RESEARCH DEVELOPMENT (VOLUME 9,ISSUE PP-1-11,AUG 2019)
2. Dr Arif Khan Bai V Raman ReinierBouwnmeester and S Mohan 2017 INTERNATIONAL JOURNAL of Civil Structural ,Environmentl and infrastructure Engineering Reseach Department Volume 7.issue 4;pp-15-20,august 2017
3. Dr.Arif Khan, 2017,INTERNATIONAL JOURNAL of innovative Research in Science Engineering Volume 6,Issue 7,pp-13258-13263, july 2017
4. Dr Arif Khan VenkateshUddameri 2017, International Journal of Engineering Research and Application Volume 7,Issue 6.(Part II),pp-01-06,June 2017
5. Dr Arif Khan 2017 To fuzzy Logic Approach Quantify Water Pollution,International Journal of Engineering Science and Computing Volume 5,Issue 5,pp-12227-12233,May 2017
6. SnehalBhaskarThamke , Dr.Arif Khan, 2021, Constructed Wetlands – Natural Treatment of Wastewater, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 10, Issue 06 (June 2021)
7. Narendra SukhdevraoNaik , Dr.Arif Khan, 2020, E-Waste Management with respect to Indian Scenario, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 09, Issue 11 (November 2020)
8. MdShahjadaAlam , Dr.Arif Khan, 2020, To minimize Vehicular Emissions of Nagpur, India, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 09, Issue 11 (November 2020)
9. MdShahjadaAlam, Dr.Arif Khan,2020, The Impact Study of Vehicular Pollution On Environment, International Journal for Science and Advance Research In Technology (IJSART) Volume 6 Issue 12 –DECEMBER 2020.
10. ChandramaniBhimraoPatil , Dr.Arif Khan, 2020, Sustainable Solid Waste Management; Case study of Nagpur, India, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 09, Issue 11 (November 2020)



11. Annepu, R.K., 2012. Sustainable Solid Waste Management in India (Mastersthesis). Earth Engineering Center, Columbia University, New York, USA.
12. Balakrishnan, K., Ganguli, B., Ghosh, S., Sambandam, S., Roy, S., Chatterjee, A., 2013. A spatially disaggregated time-series analysis of the short-term effects of particulate matter exposure on mortality in Chennai, India. *Air Qual. Atmos. Health* 6, 111e121.
13. Balakrishnan, K., Ramaswamy, P., Sambandam, S., Thangavel, G., Ghosh, S., Johnson, P., Mukhopadhyay, K., Venugopal, V., Thanasekaraan, V., 2011.
14. Air pollution from household solid fuel combustion in India: an overview of exposure and health related information to inform health research priorities. *Glob. Health Action* 4. Barter, P.A., 2012.
15. Off-street parking policy surprises in Asian cities. *Cities* 29, 23e31. Beig, G., Chate, D.M., Ghude, S.D., Mahajan, A., Srinivas, R., Ali, K., Sahu, S., Parkhi, N., Surendran, D., Trimbake, H., 2013. Quantifying the effect of air quality control measures during the 2010 Commonwealth Games at Delhi, India. *Atmos. Environ.* 80, 455e463. CEA, 2012. All India Electricity Statistics e General Review 2012.
16. Central Electricity Authority, Ministry of Power, Government of India, New Delhi, India. Census-India, 2012. Census of India, 2011.
17. The Government of India, New Delhi, India. Chakrabarty, R.K., Pervez, S., Chow, J.C., Watson, J.G., Dewangan, S., Robles, J., Tian, G., 2013. Funeral pyres in South Asia: brown carbon aerosol emissions and climate impacts. *Environ. Sci. Technol. Lett.* 1, 44e48. Chithra, V.S., Shiva Nagendra, S.M., 2013.
19. Chemical and morphological characteristics of indoor and outdoor particulate matter in an urban environment. *Atmos. Environ.* 77, 579e587. Clark, M.L., Peel, J.L., Balakrishnan, K., Breyse, P.N., Chillrud, S.N., Naeher, L.P., Rodes, C.E., Vette, A.F., Balbus, J.M., 2013.
20. Health and household air pollution from solid fuel use: the need for improved exposure assessment. *Environ. Health Perspect.* 121 (10), 1120e1128. CPCB, 2009.
21. Comprehensive Environmental Assessment of Industrial Clusters. Central Pollution Control Board, the Government of India, New Delhi, India.
22. CPCB, 2010. Air Quality Monitoring, Emission Inventory and Source Apportionment Study for Indian Cities. Central Pollution Control Board, the Government of India, New Delhi, India. Cropper, M.L., Simon, N.B., Alberini, A., Arora, S., Sharma, P., 1997.
23. The health benefits of air pollution control in Delhi. *Am. J. Agric. Econ.* 79, 1625e1629. CSE, 2012. Parking Policy: Getting the Principles Right, Policy Brief. Center for Science and Environment, New Delhi, India.
24. Deka, P., Hoque, R.R., 2014. Incremental effect of festive biomass burning on wintertime PM10 in Brahmaputra Valley of Northeast India.
25. *Atmos. Res.* 143, 380e391. Dholakia, H.H., Purohit, P., Rao, S., Garg, A., 2013. Impact of current policies on future air quality and health outcomes in Delhi, India.



**Impact Factor:
7.569**



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details