

ESTABLISHING AIR POLLUTION CONTROL FINANCING FACILITY IN INDIA- ALTERNATIVES, DRIVERS AND CHALLENGES



Acknowledgement

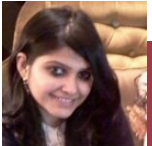
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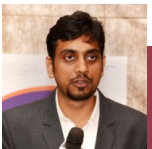


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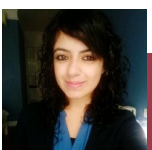
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About Intellect

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Shakti Sustainable Energy Foundation seeks to facilitate India's transition to a sustainable energy future by aiding the design and implementation of policies in the following areas: clean power, energy efficiency, sustainable urban transport, climate change mitigation and clean energy finance.

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Executive Summary

Air pollution is one of the biggest challenges in India currently. More than 75% of India's population is exposed to pollution that's higher than the recommended level set by the Government (i.e. for SO_x - 50µg/m³, NO_x - 40µg/m³, PM₁₀ - 60µg/m³, PM_{2.5} - 40µg/m³). The problem is already driving down the average life expectancy of the exposed population by ~5 years. ~12.5% of deaths in 2017 was attributed to ailments connected with adverse impacts of air pollution.

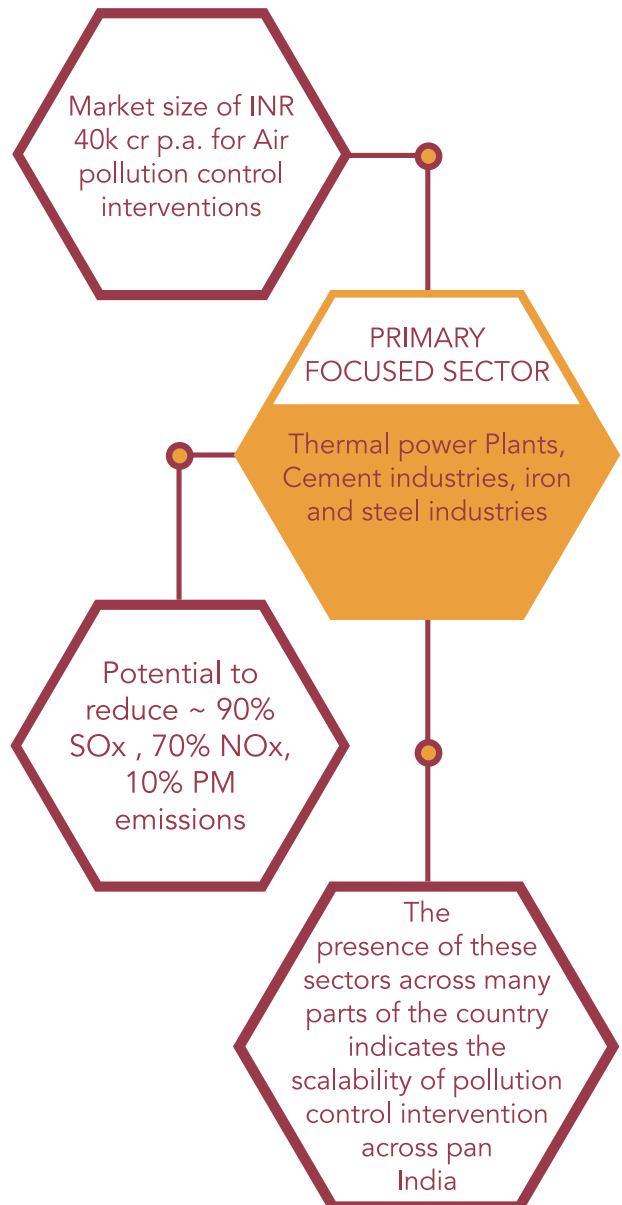
To reduce adverse impact of air pollution, the Government of India has released the National Clean Air Programme (NCAP) as a national level strategy in 2019. The objective of the program is the comprehensive mitigation actions for prevention, control and abatement of air pollution along with augmenting the air quality monitoring networks across the country and strengthening the awareness and capacity building of the relevant stakeholders. It involves a time bound national level strategy for implementation in pan India with the tentative national level target of 20%-30% reduction of PM_{2.5} and PM10 concentration by the year 2024 taking 2017 as the base year. **However, access to finance to the air pollution control technology providers is critical for the achievement of the stipulated objectives.**

Market size for financing of air pollution control technologies in India

The total capital requirement across air pollution control technologies and solution in India is estimated at about INR 7.5 trillion per annum. The distribution of this capital across major sectors is provided in the table below:

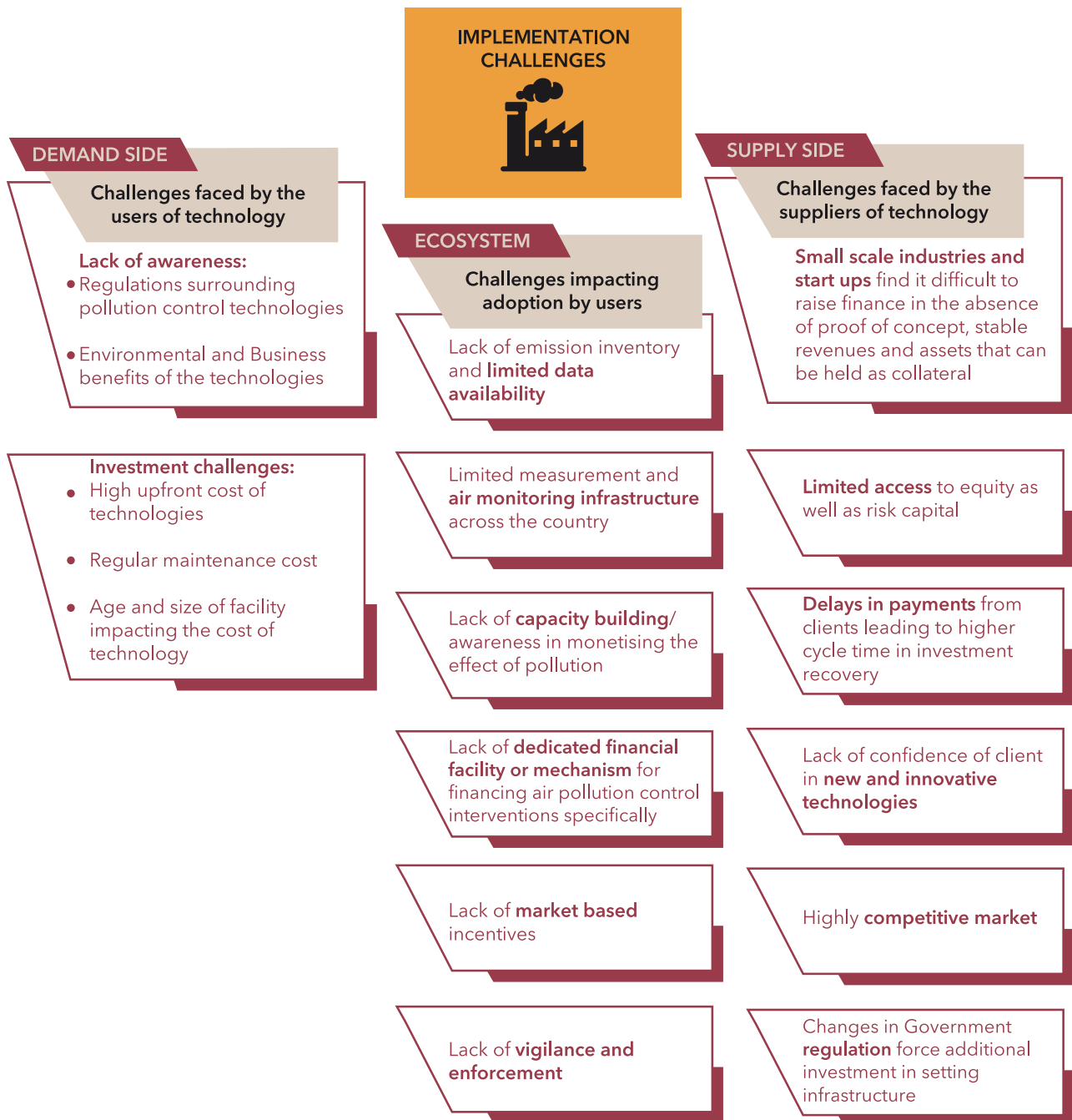
SECTOR	INVESTMENT/ANNUM (INR, CR)
Transportation	707040 ⁺
Industries	41390 ⁺
Agriculture	5600 ⁺
Waste Management	570 ⁺
Residential	200 ⁺

The sectors comprising of thermal power plants, cement industries, Iron and steel have huge potential in reducing the SO_x, NO_x, PM emission level across pan India. It would be more investment effective in incorporating Pollution control interventions in such segments and can be considered as the primary focussed segment. Investment required in this segments alone is about INR 40000 crore.



Key challenges in financing of air pollution control technologies

There are several factors that constrain the financing and thus deployment of air pollution control technologies at scale in India. These challenges constrain users and suppliers of technologies on one hand and the financiers on the other. Major challenges include lack of awareness, customer acceptance, and nascent technology that limits financing of these technologies. Specific demand and supply side challenges are highlighted below.



Existing financial institutions supporting air pollution control technologies

In India, there are debt as well as equity providers who are supporting renewable energy or energy efficiency technologies that are contributing in reducing air pollution. These include banks such as Yes Bank, IDFC, Axis Banks, others; NBFCs such as Caspian, Go Massive, others; and PE/VC funders such as Artha Ventures Anthill, Unitus ventures, Infuse Ventures, among others. Public institutions and funds such as BEE, SIDBI, SBI

Neev, NIFF, IREDA, PFC, NABARD, among others have also been actively investing in the renewable energy as well as MSME sector and have the potential to finance air pollution control interventions in their respective focus areas.

However, at present, these private as well as public financial institutions are mostly financing the clean energy segments without considering the sectors from the lens of air pollution control. Consequently, while funds are available for projects as a whole, there is little to no availability of capital for air pollution control technologies

as stand alone investments. This necessitates designing an alternative facility with innovative financing mechanism for large scale adoption of air pollution control technologies in India.

Designing of alternative financing facility for air pollution control technologies

Considering the imperative requirement of air pollution control technologies and limited financing support, Intellecap has designed a new facility to support these technologies that could help the deployment at scale and also support the Government in achieving its goals. Intellecap has followed a four step process to design the financing facility and each of them is summarized below:

Step 1: Review of global financing facilities for air pollution control technologies

Many countries/Government across the world have introduced specific mechanisms and launched financial instruments which aim to control air pollution by providing market incentives. Examples of some global financing facilities which support air pollution control technologies include (a) Programme for Result (PforR) in Jing-Jin-Ji, China (b) Pollution Control Revenue Bonds (PCRB) by California Pollution Control Financing Authority, USA, and (c) Environmental Infrastructure Support Credit Program, Philippines.

Key learnings that have emerged from the review of global facilities that support air pollution control technologies include - (1) Government is best placed to raise cheap capital essential for such facilities, (2) Result based financing has been effective and can be scaled further for air pollution control (3) Technical Assistance to financial institutions for undertaking such investments is a key pre-requisite in emerging markets.

Step 2: Considerations of factors for housing of alternate financing facility

Review of global strategies was undertaken to understand existing mechanisms, target segments, potential investors, direct/indirect benefits from Government, credit enhancement measures, government support in the form of municipal financing, etc.

Given the nature of financing required for air pollution control, three options were evaluated:

- Financing facility to be housed under an existing public financial institution
- New and dedicated financing facility managed by a public institution

- New and dedicated financing facility managed by a private institution

Option 1: Financing facility to be housed under an existing public financing institution

The financing facility under an existing public financing institution may be the most feasible option from the cost, efficiency and impact perspectives due to the following reasons:

- Government managed facilities generally **have access to low-cost funds** which is critical to driving investments in nascent and emerging areas;
- Demonstrated experience of doing both **small as well as large ticket loans**;
- Vast **experience in infrastructure financing** and can influence Government policy, which is required for mainstreaming air pollution control investments

The rate of interest on loans can be around 9.5% with a tenor of 3 to 15 years, depending on the risk profile of the company. For the purpose of collateral, lenders do consider charge on the asset(s) being financed, along with a pledge on the promoters' shares.

Option 2: New and dedicated facility managed by a public institution

The overall structure of the facility remains similar to that of the option 1 except that the facility is housed under MoEFCC, Gol, and managed by a separate special purpose vehicle (SPV) where majority share is held by the Gol.

Since most of the Government facilities are sector aligned (and air pollution technology involves application across sectors), a dedicated facility will be helpful as a more active approach in sourcing and investing.

However, setting up a new facility can be a time-consuming process, especially since it will require engagement and approvals at multiple levels with the Government.

Option 3: New and dedicated facility managed by a private institution

Private institutions have the willingness and capacity to implement financing facility, in case there is limited buy-in from the Government for setting up a dedicated financing facility. The key advantage is that such a facility can be easily and quickly implemented, but the interest rates are likely to be higher than what is feasible for a Government-owned or managed facilities. Such facilities offer higher rate of interest (>14%), and the tenors are also likely to be shorter.

Post evaluation of all the options, **leveraging an existing**

public financing facility has emerged as the most practical option. Also, even if we consider 10% of the required investments in India to be catered to by the proposed financing facility, the recommended size of the fund could be INR 3800 crore (~USD 500 million). The average ticket size could be in the range of INR 7.5 crore to INR 150 crore (USD 1mn to USD 20mn) keeping in mind the average ticket size of investments required in key air pollution control technologies across focus sectors.

Step 3: Selection of focus sectors for the financing facility

After review, we identified that **industrial and power sectors** are the main contributors to sulphur oxide (SO_x) and nitrogen oxide (NO_x) pollutants. Both of these sectors account for more than 70% share of SO_x and NO_x emissions in the country. On the other hand, residential, industrial, power, and agriculture segments are the key sources of Particulate Matter (PM) emissions. The residential sector alone contributes more than 40% of the overall PM emissions in India.

Further, 65% of SO_x and NO_x emissions in the country are attributed to the states of Uttar Pradesh, Rajasthan, Gujarat, Andhra Pradesh, Telangana, Tamil Nadu, West Bengal and Maharashtra. These states have a higher concentration of thermal power plants and industries. Further, traditional biomass and coal based cooking practised in many parts of rural India significantly contribute to the PM_{2.5} emissions.

The initial tentative areas of focus for the suggested financing facility (i.e. thermal power plants, iron and steel industries, cement industries) are accordingly aligned to the key sectors to ensure that the impact of incremental investments is maximised.

Step 4: Ensure participation of enabling ecosystem

Major stakeholders relevant to air pollution control interventions in India include Ministries and Government Bodies¹ (e.g. MoEFCC, MoP, MNRE, DHI, MoRTH, MoHUA,

NITI Aayog, CPCB, SPCB, city municipality, etc.), industry associations, technical research institutes, advisory firms, NGOs, multilateral and bilateral organizations.

Intellicap recommends a platform for a more collaborative, multi-scale, inter-state, and cross-sectoral approach through an enabling ecosystem to support a financing facility to mitigate air pollution. This requires developing necessary infrastructure (e.g. increasing the number of air monitoring stations), research and data analysis (e.g. source apportionment studies), capacity building of relevant stakeholders (implementing agencies, financial institutions, industry professionals), inclusion of market based mechanism (analogous to PAT scheme), and stricter regulations (e.g. regular pollution auditing).

Way forward

In order to operationalise the envisaged financing facility, there are three critical next steps.

- 1. Approvals:** Secure necessary approvals from Government/ministries controlling existing public financial institutions to be able to house the facility within an existing institution
- 2. Detailed Blueprints:** Assist the chosen and approved public financing institution in setting up the facility in terms of developing the operating procedures, credit policies, risk manuals, manpower requirements, KPIs, MIS dashboards, etc. after conducting deep dive assessment of existing capabilities and resources to ensure maximum synergies
- 3. Funding:** Capitalise the facility in discussions with bilateral and multilateral agencies interested in this space, as well as leveraging any public funds allocated by the government for air pollution control.

The Government of India has launched various schemes such as smart city mission, Swachh Bharat Mission, AMRUT, and HRIDAY- which are complimentary to NCAP action plans. Thus, we also recommend exploring possibilities to link different schemes so that part of the budgetary allocations for the aforementioned schemes can also be deployed through the proposed financing facility.

¹MoEFCC - Ministry of Environment Forest and Climate Change, MoP - Ministry of Power, MNRE - Ministry of New and Renewable Energy, DHI- Departments of Heavy Industries, MoRTH- Ministry of Road Transportation and Highways, MoHUA - Ministry of Housing and Urban Affairs, CPCB- Central Pollution Control Board, SPCB- State Pollution Control Board

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Conversion

1USD = 75.96 INR² (as on 23.03.2020)

Abbreviations

ADB: Asian Development Bank
AMRUT: Atal Mission for Rejuvenation and Urban Transformation
CAP: Comprehensive Action Plan
CAGR: Cumulative Average Growth Rate
C&D: Construction and Demolition
CII: Confederation of Indian Industry
CIB: Commercial International Bank
CPCB: Central Pollution Control Board
DHI: Department of Heavy Industries
DPR: Detailed Project Report
DSI: Dry Sorbent Injection
EPCA: Environment Pollution(Prevention and Control) Authority
EU: European Union
ESP: Electrostatic Precipitator
FGD: Flue Gas Desulphurisation
GRAP: Graded Response Action Plan
GDP: Gross Domestic Product
HRIDAY: National Heritage City Development and Augmentation Yojana
IFC: International Financing Corporation
IDB: Inter-American Development Bank
IREDA: Indian Renewable Energy Development Agency
JICA: Japan International Cooperation Agency
MoEFCC: Ministry of Environment Forest and Climate Change
MNRE: Ministry of New and Renewable Energy
MoP: Ministry of Power
MoRTH: Ministry of Road Transport and Highways
NBFC: Non- Banking Financing Company
NAAQS: National Ambient Air Quality Standards
NFEPWM: National Fund for Environment Protection and Water Management
NABARD: National Bank for Agriculture and Rural Development
NCEF: National Clean Energy Fund
NCAP: National Clean Air Program
NSCR: Non Selective Catalytic Reactor
NIIF: National Investment and Infrastructure Fund
PFC: Power Financing Corporation
PPP: Public Private Partnership
PM: Particulate Matter
SPCB: State Pollution Control Board
SCR: Selective catalytic Reactor
SSMS: Super Straw Management System
SIDBI: Small Industries Development Bank of India
SPV: Special Purpose Vehicle
TA: Technical Assistance
WHO: World Health Organization

1. Introduction

This report aims to support the Government and the relevant stakeholders in understanding various issues related to air pollution in India. The study captures information on the adversities of air pollution, the policy landscape stipulated for controlling air pollution in India, the various control technologies and solutions available across different sectors and subsectors along with its effectiveness, scalability, and market potential. In addition, the study captures the views and opinions of relevant stakeholders in designing an alternative financing facility in India in order to finance air pollution control technologies/ interventions.

1.1 Background

To reduce the adverse impacts of air pollution, the Government of India has released the National Clean Air Programme (NCAP) as a national level strategy in 2019. The objective of the program is to identify the comprehensive mitigation actions required for prevention, control and abatement of air pollution, along with measures needed for augmenting the air quality monitoring networks across the country and also for strengthening the awareness and capacity building paradigm of the relevant stakeholders.³ It involves a time bound national level strategy for implementation in pan India with the tentative national level target of 20%-30% reduction of PM_{2.5} and PM₁₀ concentration by the year 2024 taking 2017 as the base year. Availability of suitable finance remains one of the critical enablers to help support policy measures. NCAP, however, did not create provisions for any innovative financing to accelerate the uptake of air pollution control technologies in India. It is envisaged that without the rapid adoption of pollution control technologies by industries and relevant sectors it is difficult to achieve the targets of NCAP. SSEF has, thus, appointed Intellectap to explore the feasibility and viability of setting up an air pollution control financing facility in India and to provide recommendations on the design of such a facility covering areas such as a suitable host, scale (national or regional), means of capitalisation, areas of focus for investment etc. as well as identify partnership opportunities necessary to ensure the successful implementation of the facility.

1.2 Context

This section captures the key scope of the report for designing the financing facility to support and promote air pollution control technologies in India, to design the facility, Intellectap adopted a four-step approach comprising of (a) identifying key segments of focus for financing control interventions and mitigating air pollution, (b) evaluating existing financing facilities that support adjacent interventions either globally or in India, (c) drawing from the learnings to design a dedicated financing

facility or leverage an existing one for air pollution control interventions in India and (d) designing an enabling ecosystem for financing pollution control interventions.

The engagement had two key objectives:

- Shortlisting target segment(s) which requires financing for pollution control interventions

- Designing a financing facility for investing in those interventions

The key scope of the research includes:

- Review of major air pollution **sectors** and their impact on the environment

- Assessment of air pollution control **technologies** in respective sectors for technical feasibility, economic feasibility, market size, and potential to scale

- Analysis of key **financing barriers**, associated gaps, requirements, type of investors, and participation from other stakeholders, among others

- Understand the perspectives of stakeholders including the government (national and states), financial institutions, industry association, technical and research institutes, enterprises, among others and take their opinion on **possible interventions**

- Review of **similar facilities**, if available, in the international context

- Review of existing **facilities and infrastructure in India** which can be leveraged for financing air pollution control interventions

- Prepare a set of recommendations on the **design** and scope of such a facility as well as the road map for its implementation

- Provide recommendations for an **enabling ecosystem** that can complement the financing intervention for promoting air pollution control technologies



*Support required from shakti includes technical assistance, stakeholder engagements, policy advocacy essential to operationalize the financing facility.

³NCAP, Press Bureau Information GoI, 2019 (link)

1.3 Methodology

The study followed a three pronged approach to execute the identified scope of work. The approach comprised of a combination of desk research, individual consultation with ecosystem players, and a round table workshop with key stakeholders. We leveraged the viewpoints of stakeholders (28 experts across 5 stakeholder categories- Government, Research Institutions, Financial Institutions, Industry Associations, and Enterprises) in designing the alternative financing facility).



Secondary research was conducted to understand market size of air pollution control technologies in India along with Government plans and regulation to mitigate air pollution. It also includes collecting information on areas such as available air pollution control technologies in various sectors and subsectors, their impact potential as well as techno-economic feasibility of deploying such technologies at scale, among others.

Key geographies for the pilot study were also analysed, along with the potential market size of each individual segment. Some of the key reports that were referred during the research include “Crop Residue Burning in India: Policy Challenges and Potential Solutions” by the International Journal of Environmental Research and Public Health, “Green Growth & Air Pollution in India” by TERI, “Air Pollution Emission Scenario for India” by TERI and “Investment Estimates for Industrial Air Pollution Control in India” by Sustainability Outlook.^{4 5 6 7}

Primary Research was undertaken to understand the perspectives of stakeholders and experts within each category to seek insights on different areas encompassing the study. The objectives of these interactions were three-fold (a) validate insights based on findings from secondary research and to undertake necessary estimations / extrapolations where information was not available (b) seek directional guidance on the design of the new/ alternative financing facility including key focus areas and

(c) explore possible partnership opportunities. This involved:

a. **Identification of key stakeholders:** Stakeholders were identified to ensure that we consider and understand perspective of all key stakeholder groups which includes industries (small and large scale), industry association, enterprises (technology providers), financial institutions (Multilateral agencies, DFI's, Funds, and NBFs), technical and research organizations, and Government agencies (including relevant Ministries), etc.

b. **Individual consultation with stakeholders:** Designing financing facility for air pollution control involves the effective engagement of key stakeholders ranging from capital providers, policy makers to the air pollution control technology providers. It was important to capture the views and opinions of all the relevant stakeholders into the study. Intellecap team reached out to more than 70 stakeholders out of which 28 stakeholders responded to have discussions via phone or in-person meetings.

Consultations included interviews and interactions on market size of air pollution control technologies, key challenges, opportunities and impact of such a facility, while discussing the key facts and analysis from the secondary research. A sample interview guide for the different stakeholder groups has been provided in Annexure - 10.3

c. **Stakeholder consultation workshop:** The findings from secondary research and insights from primary consultations were collated to identify key sectors contributing to air pollution in India as well as financing requirements for air pollution control technologies across those sectors. To discuss/ validate the key findings and get a buy-in from all the stakeholders a workshop was organized on 9th of October 2019 in New Delhi where experts across stakeholder groups participated. The existing landscape around pollution control technologies, challenges around data, and opportunities were highlighted in a pre-reading material shared with experts before the workshop.

The objectives of the workshop were to validate -

- The approach undertaken for an identification of the sector/ technology and the modifications required in the same in order to identify the focus areas for the financing facility;
- Learnings from existing interventions and identifying elements that could be incorporated in the proposed financing facility;
- The potential role of ecosystem players including the Government, DFIs, FIs, enterprises, and others in supporting air pollution control technologies and financing facility.

Also, the share of sectors contributing to different air pollution (PM, SO_x, NO_x) has been analysed from the secondary literature as well as through the data retrieved

⁴Crop residue burning in India: Policy challenges and potential solution, International journal of Environmental Research and Public Health (link)

⁵Green Growth & Air pollution in India , TERI (link),

⁶Air pollution Emissions Scenario for India , TERI (link),

⁷Investment Estimates for Industrial Air Pollution Control in India, Sustainability outlook (link)

⁸GAINS Model (link)

from the Green House Gas- Air Pollution Interaction and Synergies (GAINS) model⁸. The GAINS model is an open source modelling software which has the provisions to retrieve the processed emission data for each contributing sector across different states of India. The team has clustered the emission data for each sector across India in order to figure out the share of sectors across different air pollutants in India.

The amount of investments required for financing air pollution control technologies in different sectors and sub-sectors have been estimated through extensive secondary review. Certain key reports which were considered for market estimation include "Investment Estimates for Industrial Air Pollution Control in India" by Sustainability Outlook, "Automobile Production trends by SIAM", "Market Wrap" by ICICI securities etc. The Intellecrap advisory board members and other stakeholders also helped in finalizing

the approximate numbers for the financing facility.

1.4 Limitation of the study

During this study, Intellecrap identified certain limitations in executing such studies. It includes:

- Limited or no availability of pollution emission data at the PAN-India level divided by the source of pollution and relative contribution of the sector across key pollutants
- Investment requirement vary by type of technology, sector, size and layout of the polluting facility, as well as multiple other factors

Therefore, the Intellecrap team has carried out estimations on a best effort basis using the limited data that was available in the public domain.

2. Overview of air pollution landscape in India

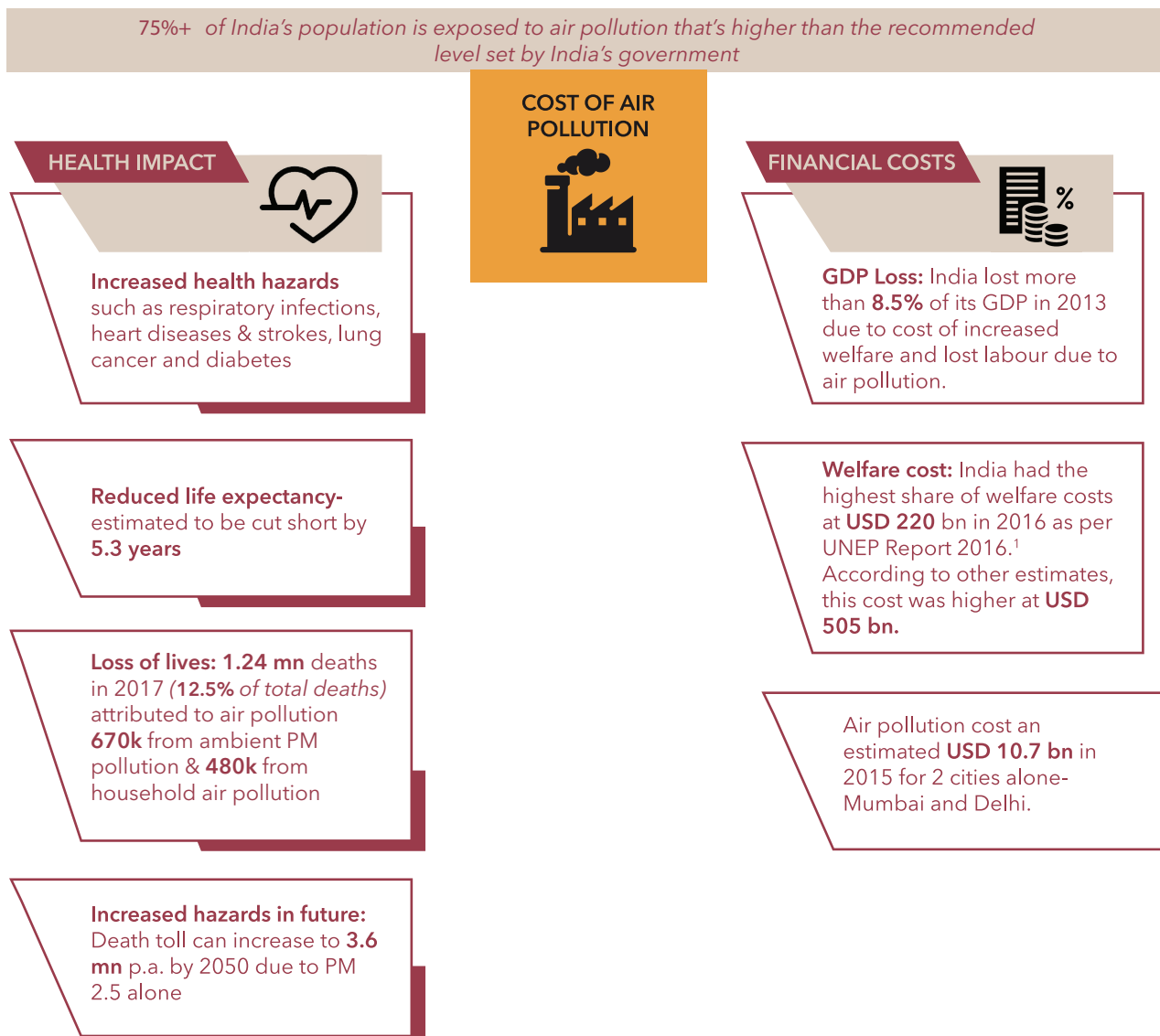
The chapter presents an overview of the challenge associated with air pollution across financial as well as non-financial parameters. It also provides an estimate of the sectoral contribution to air pollution as well as an illustration of regional concentration of key air pollutants, including reasons thereof. Furthermore, the chapter provides an overview of key policies as well as targets formulated by the Government of India to combat and mitigate the issues of air pollution in India.

2.1 External cost of air pollution: Health, Economic, Environment

India is amongst the fastest-growing economies of the world and in its effort to increase the pace further, it has been inadvertently promoting industries and other sectors which have an adverse impact on the environment. Increased industrial and vehicular emissions, crop burning, construction activities, abysmal waste management, and depleting tree cover are major contributors to dwindling air quality. Consequently, air pollution is one of the biggest challenges that India is facing today and the levels of most of the pollutants i.e. PM₁₀, PM_{2.5}, SO_x, NO_x, CO_x continue to exceed the National Ambient Air Quality Standards (NAAQS).

More than 75% of India's population is exposed to air pollution that is higher than the recommended level set by the Government (i.e. for SO_x- 50µg/m³, NO_x - 40µg/m³, PM₁₀ - 60µg/m³, PM_{2.5} - 40µg/m³). This has severe health repercussions as well as a negative financial connotation for the large segment of the population affected by the air pollution.⁹

Figure 1: Impact of air pollution on health and capital¹⁰



⁹Air pollution in India caused 1.2 millions death last year, Olivia Gold hill, 2018 (link)

¹⁰UNEP Annual Report Prof. E Somanathan, ISI, 2016

The concentration of air pollutants has severe impacts on the lives of the people. Pollution results in chronic diseases which sometimes lead to loss of lives. It has an adverse

impact especially on children and elderly people. The table below summarizes some of the ill-effects of the different pollutants in the air along with their sources of emission.

Table 1: Source of air pollutants & their impact on health

POLLUTANTS	KEY SOURCES OF POLLUTANT	KEY IMPACT ON HEALTH
Nitrogen (NOx)	Combustion process (heating, power generation, and vehicles)	Bronchitis in asthmatic children and reduces the lung function growth.
PM _{2.5} , PM ₁₀	Vehicles, household fuel combustion, construction activities, industrial activities, road re-suspension	Cardiovascular and respiratory diseases, lung cancer, acute lower respiratory infections, and chronic obstructive pulmonary disease.
Sulphur oxide (SOx)	Burning of sulphur present in the fossil fuels in relation to domestic, power plants, transportation industry	Respiratory/breathing issues, lung functioning, also aggravate asthma and chronic bronchitis.

2.2 Key factors contributing to air pollution in India

The air quality in India has been continuously degrading since the past 10 years.¹¹ The emission levels in urban cities especially the PM levels have increased drastically over the years with the increase in economic activities, in automobile usage and migration of population from rural to urban cities, among others. Broadly, there are various factors which have contributed to the growing challenge of air pollution. Some of these factors are:

- **Increasing urbanization:** Over the past few decades,

urbanization has been growing at a rapid pace and in 2018 the urban population had constituted 33% of the total population in India¹²

- **Increase in energy demand:** This is stemming from rising industrialisation as well as lifestyle changes associated with increasing income levels. A large portion of this increasing energy demand is being met through highly polluting thermal sources

- **Increase in ownership of private vehicles:** Registered vehicles in India have experienced an annual growth rate of 10% and stood at 210 mn in 2015¹³ especially a rapid growth of private vehicles in the country

Table 2: Growth of key factors contributing to air pollution in India

DESCRIPTION	CAGR(%)	TIME DURATION
Growth of urban population in India	1.1	1958-2018
Growth in motor vehicle registration	10.04	2001-2015
Growth in GDP per capita	7.1	2005-2016
Growth in annual electricity consumption	5.8	2006-2016

¹¹Air pollution trend in India past 10 years, IJARIT, 2017(link)

¹²World-Bank (2019) (link)

¹³Ministry of Statistics and Programme Implementation, G. (n.d.). MOTOR VEHICLES - Statistical Year Book India 2017. (G ol, Producer)(Link),

2.3 Sectorial contribution to air pollution

There are four key pollutants- SO_x, NO_x, PM_{2.5}, and PM₁₀ which adversely impacts the air quality and hence, has become the focus of this engagement. The team extensively analysed the source of these pollutants across various sectors and sub-sectors using secondary as well as primary research. While there are isolated studies that focus on sector wise contribution in selected pockets of

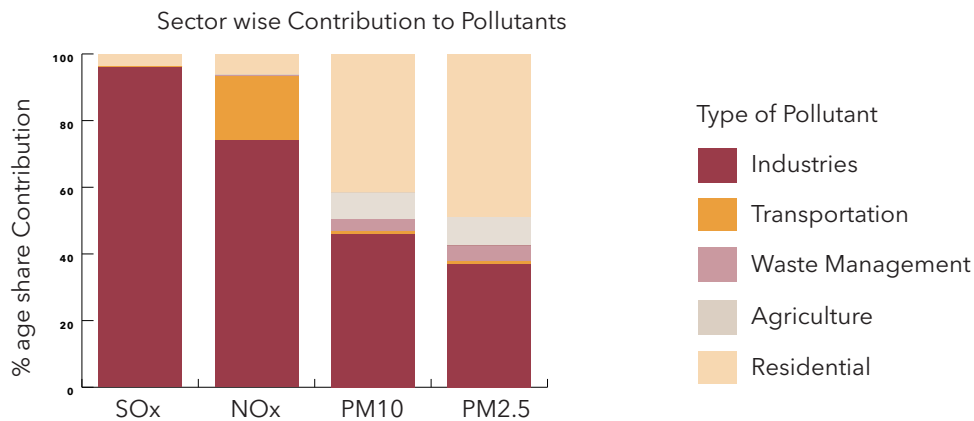
the country, there is very little national level data on air pollution. In addition, there is some variation and inconsistency in data from alternate sources due to the adoption of different methodologies as well as different time periods of estimation.

The sector-wise share of various pollutants across India is captured in the table below. The term "Industries" also includes thermal power plants.

Table 3: Percentage pollutant share across sectors ¹⁴

SECTOR	POLLUTANT SHARE (%)			
	SO _x	NO _x	PM ₁₀	PM _{2.5}
Industries	96.1%	74.1%	46.1%	37.1%
Transportation	0.2 %	19.5%	0.7%	0.8%
Waste Management	0.0%	0.2%	3.7%	4.7%
Agriculture	0.2%	0.2%	8.0%	8.6%
Residential	3.6%	6.1%	41.5%	48.8%

Figure 2: Sector wise pollutant share



However, there are some noticeable variations in pollutant data across sectors as per TERI classification vis-à-vis the GAINS model.

a. SO_x contributions:

The major contributor of SO_x is the industrial and power sector. This is clearly visible from the classifications of both the GAINS model as well as from the studies of TERI.

This is primarily due to the use of different modelling process, mathematical equations and year of simulation. The variations are highlighted below.

However, there are certain variations in the percentage contribution of SO_x across sectors within the classification carried out by TERI¹⁵ reports and GAINS model¹⁴.

¹⁴GAINS Model(link)

¹⁵Green Growth and air pollution in India , TERI, 2015(link)

Figure 3: GAINS Classification of SOx contribution

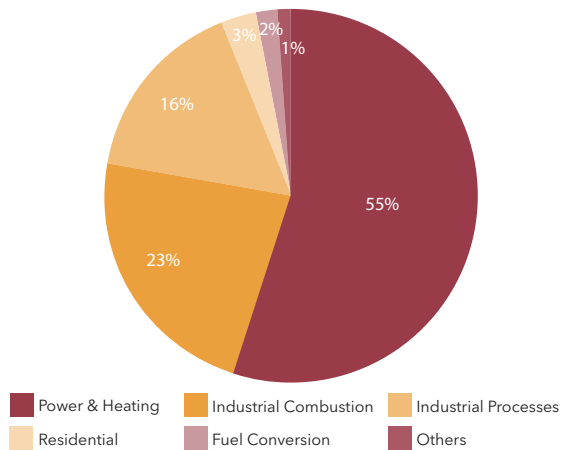
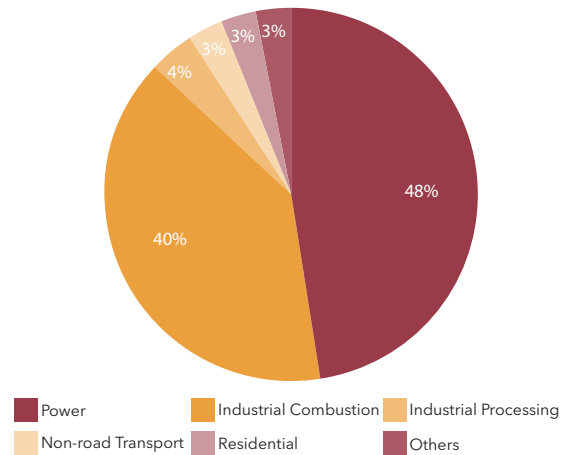


Figure 4: TERI Classification of SOx contribution



b.NOx contributions:

The major contributors of NOx are the power sector, road transportation and also the industrial segment.

Together, these segments contribute approximately **70%** to overall NOx emissions in the country.

Figure 5: TERI Classification of NOx contribution

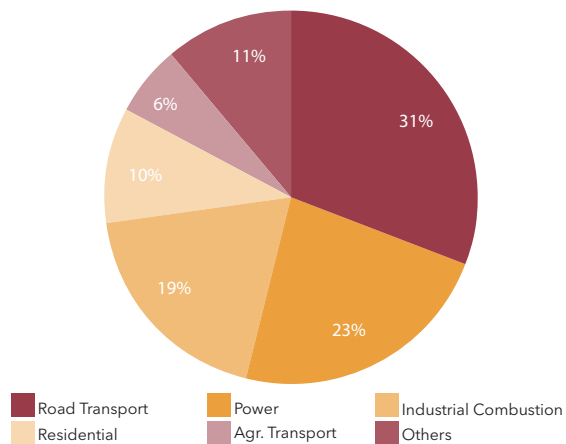
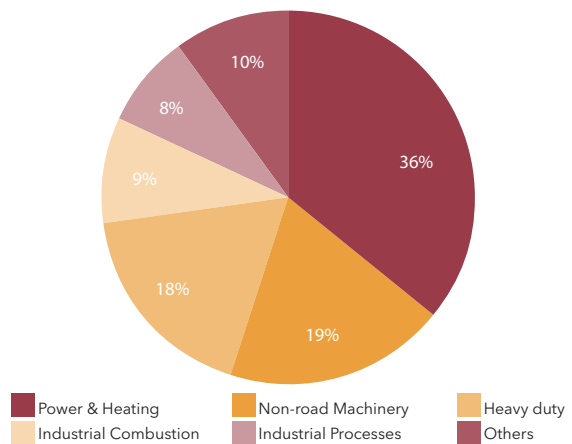


Figure 6: GAINS Classification of NOx contribution



c.PM2.5 Contribution:

The major contributor of PM2.5 is the residential and industrial segment.

Open burning of the agriculture residue also contributes significantly to the PM2.5 pollution.

Figure 7: TERI Classification of PM2.5 contribution

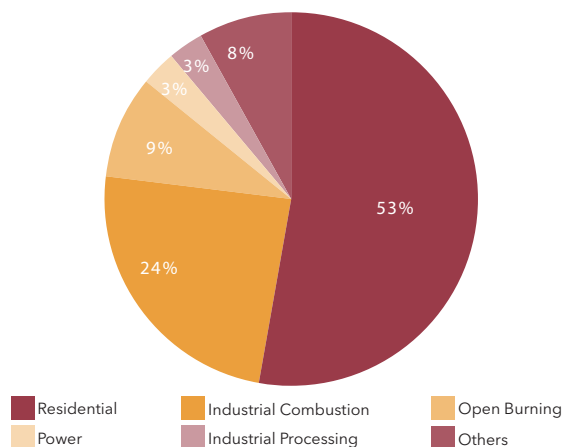
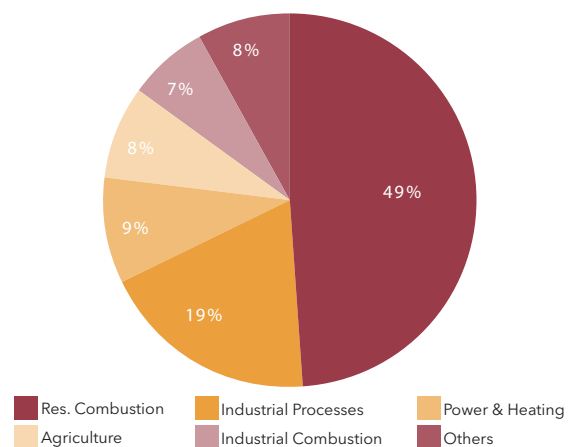


Figure 8: GAINS Classification of PM2.5 contribution



d.PM10 Contribution:

The major contributor of PM10 is the residential, industrial and power sector.

Open burning of agriculture residue also contributes to PM10 emissions to some extent.

Figure 9: TERI Classification of PM10 contribution

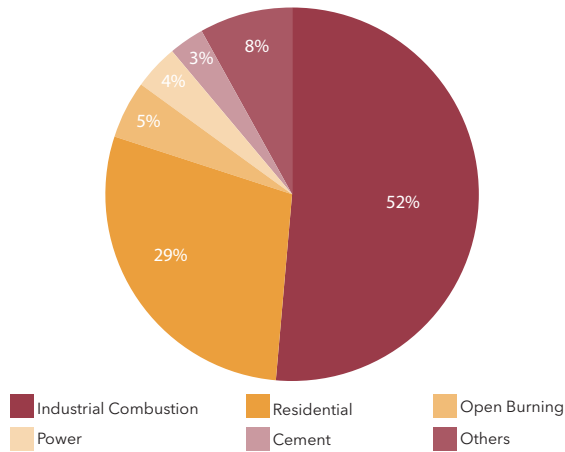
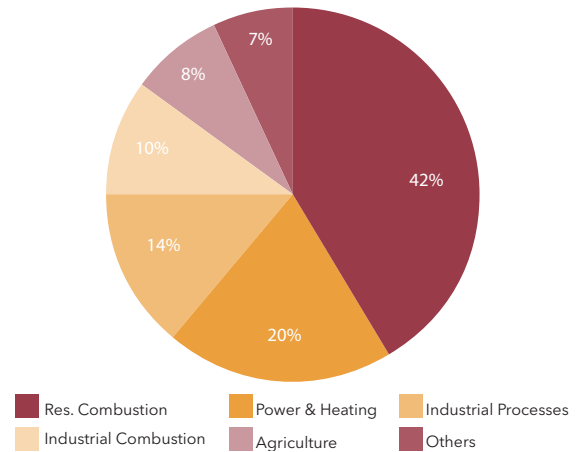


Figure 10: GAINS Classification of PM10 contribution



2.4 Region wise concentration of air pollution

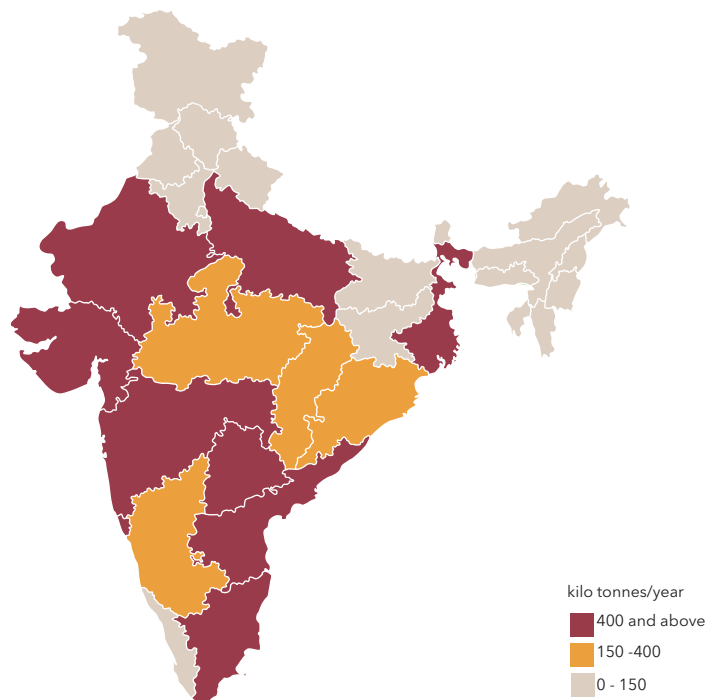
a. SO_x contribution:

The states of UP, Rajasthan, Gujarat, Andhra Pradesh, Telangana, Tamil Nadu, West Bengal and Maharashtra contribute to 65% of SO_x emissions in the country. This can

This section gives an overview of the state wise contribution to various types of pollutants in India.¹⁶

likely be attributed to the higher penetration of thermal power plants in these states. Figure 11 provides a graphical representation of the incidence of SO_x levels by state.

Figure 11: Region wise SO_x concentration¹⁶



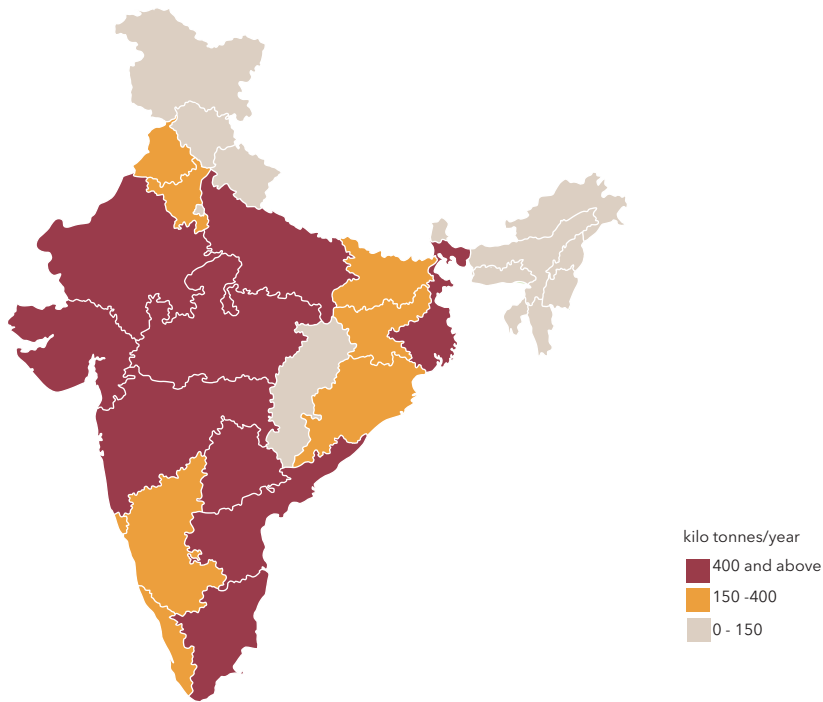
b. NO_x contribution:

It is observed that 65% of NO_x emissions in the country come from the states of Uttar Pradesh, Rajasthan, Gujarat, Andhra Pradesh, Telangana, Tamil Nadu, West Bengal,

Maharashtra, Madhya Pradesh and Odisha. This is clearly visible in the Figure 12

¹⁶GAINS Model(link)

Figure 12: Region wise NOx concentration¹⁶



These states have the highest penetration of thermal power plants as well as other industries (large scale and SMEs) and large number of transportation vehicles

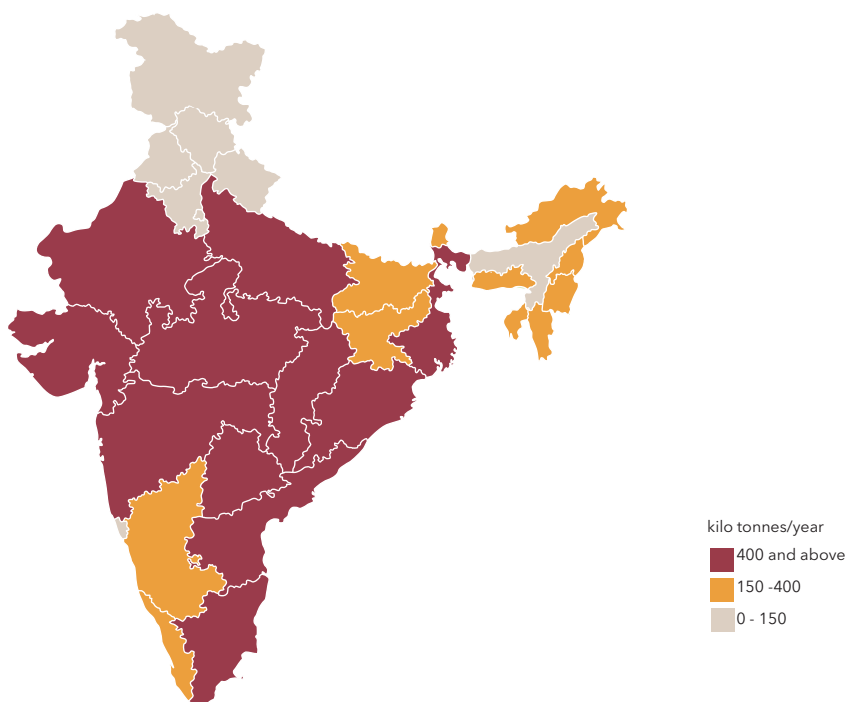
which are likely to be the cause behind higher NOx emission levels.

c. PM10 contribution:

Thermal power plants, as well as industries such as brick and cement, are the major contributor of PM10 across the 10 states in India. The Indo-Gangetic plain with a high concentration of brick kilns as well as states with high

industrial activity and residential population are worst affected due to the presence of PM10 in the air. This is reflected in Figure 13

Figure 13: Region wise PM10 concentration¹⁶

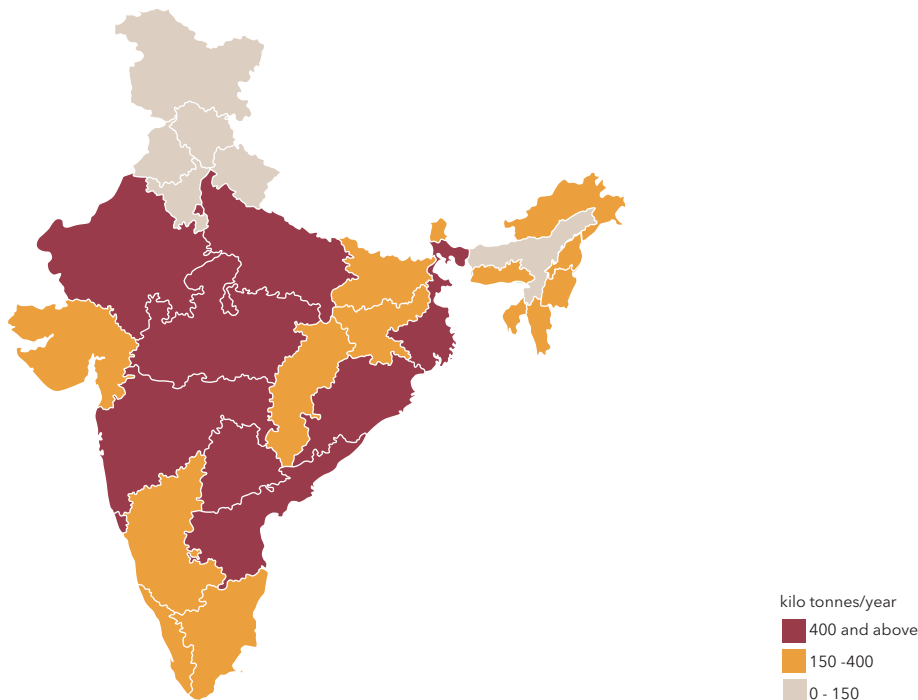


d. PM2.5 contribution:

The traditional cooking practised in many rural parts of India significantly contributes to the PM2.5 emission. In addition to that, the open burning of municipal waste and agriculture residues are also the major sources of PM2.5 emission in some parts of India. The high concentration of

industries along with the non-efficient cooking methods and burning of waste, all at the same location affects the PM2.5 level significantly. On an average 7 states of India contribute to more than 58% of PM2.5 level in the country. This is clearly visible from the Figure 14.

Figure 14: Region wise PM2.5 concentration¹⁶



2.5 Policy landscape: Institutional framework, Government targets and action plans

The **Ministry of Environment, Forest and Climate Change (MoEFCC)** is the nodal agency in the administrative structure of Government of India for planning, promotion, coordination, and monitoring the implementation of policies and programme relevant to Environment and Forest.

The **Central Pollution Control Board (CPCB)** is a statutory organization under MoEFCC and was established in the year 1974 to control industrial air and water pollution. It is tasked with the responsibility to improve the quality of air and to prevent, control and abate air pollution in the country. The CPCB jointly works with its counterparts in every state i.e. the **State Pollution Control Board**

(**SPCB**) to implement the legislations relating to the prevention and control of environment pollution.

For a union territory like Delhi, CPCB has delegated its power and functions to the **Delhi Pollution Control Committee (DPCC)**, under Section 4(4) of Water Act & Section 6 of Air Act. DPCC is an autonomous regulatory body which was setup in the year 1991. It advises the Delhi Government on any matter concerning prevention and control of water and air pollution and on the improvement of the quality of air. Similarly, the **Environment Pollution Control Authority (EPCA)** was constituted to protect and improve the quality of the environment and control environment pollution in the National Capital Region.

Various laws and guidelines have been introduced in India to address the problem of air pollution in industries and other areas, as highlighted in Table 4:

Table 4: Important laws and guidelines for air pollution control in India¹⁷

YEAR	LAW/ GUIDELINE	KEY ACTIONS/ ACTIVITIES
1984	National Air Quality Monitoring Programme (NAMP)	<ul style="list-style-type: none"> ● Central Government provides funds through CPCB for National Air Quality Monitoring Programme to various State Pollution Control Boards (SPCBs) and Pollution Control Committees (PCCs). This programme intends to provide knowledge and understandings necessary for developing preventive and corrective actions
1986	Environment (Protection) Act (Created as a response to Bhopal Gas Tragedy)	<ul style="list-style-type: none"> ● Highlights the responsibility of the Indian Central government to control the sources and effects of pollution and restrict the setting up of any industrial facility on environmental grounds
1987	The Air (Prevention and Control of Pollution) Act 1981, Amendment, 1987	<ul style="list-style-type: none"> ● Addresses the issue of deterioration in air quality. ● Prescribes the various functions of the Central Pollution Control Board (CPCB) at the apex level and State Pollution Control Board (SPCB) at the state level. (For instance, advising the central Government on matters concerning the improvement of air quality, and the prevention, control or abatement of air pollution).
1994	National Ambient Air Quality Standards (NAAQS)	<ul style="list-style-type: none"> ● Provide guidelines for standards. For example, emission standards were revised in 2009 to include additional pollutants. Additionally, standards for residential areas were extended to industrial areas as well.
1995	National Environmental Tribunal Act	<ul style="list-style-type: none"> ● Provides guidelines for setting up environment courts in the country, replacing the National Environmental Appellate Authority (NEAA) in the settling of environment and public health related conflicts. ● Enabled creation of the National Green Tribunal (NGT) post amendment in 2010 which is responsible for effective and expeditious disposal of cases relating to environmental protection and conservation of forests and natural resources.
2015	Environment (Protection) Amendment Rule	<ul style="list-style-type: none"> ● Enables guideline for permissible emission of pollutants. Targets 60% - 80% reduction in particulate matter (PM), sulphur oxide (SO_x), nitrogen oxides (NO_x), mercury emission and freshwater withdrawal. ● For example, MoEFCC in December 2015 notified changes related and relevant to thermal power plants under the Environment (Protection) Amendment Rule, 2015.
2017	Graded Response Action Plan (GRAP)	<ul style="list-style-type: none"> ● The Government has notified a GRAP to implement measures in reducing air pollution in Delhi and NCR region. ● For Example, Ministry of Environment, Forests & Climate Change (MoEFCC) prepared an action plan for implementation under different Air Quality Index (AQI) categories namely, Moderate & Poor, Very Poor and Severe as per the National Air Quality Index.
2017	Comprehensive Action Plan (CAP)	<ul style="list-style-type: none"> ● Aims to meet the ambient air quality standards in the National Capital Territory of Delhi and National capital Region, including states of Haryana, Rajasthan and Uttar Pradesh. Plans are drafted by Environment Pollution (Prevention and Control) Authority (EPCA) ● Issue guidelines to take stringent actions on all sources of pollution to meet clean air targets in a time bound manner. ● Promote a regional approach for a common air shed with the consideration that local pollution control needs to be supported by regional action.
2019	National Clean Air Programme (NCAP)	<ul style="list-style-type: none"> ● Set guidelines and long-term plans for 122 cities. ● National level target of 20%-30% reduction of PM_{2.5} and PM₁₀ concentration by the year 2024 taking 2017 as the base year. ● Issues guidelines on National Action Plan on Climate Change as part of the NCAP.

¹⁷Green Growth and Air, 2015, The Energy and Resources Institute Pollution in India (Link), Rewind 2018: State of the air India breathes, 2019, Down To Earth (Link)

2.5.1 Key targets and action plan of the Government

Some of the key targets set and action plans taken by the Government of India, across various sectors and sub-sectors, are tabulated below:

Table 5: Government targets and action plans for air pollution across different sectors

SECTOR	GOVERNEMENT TARGET	ACTION PLANS
Thermal Power Plants	Reduction in carbon, NO _x , SO _x and SPM emission	Coal power plants to adopt super critical technology with efficient boilers.
	Reduction in SO _x emission and meet new norms (below 100 mg/Nm ³) by year 2022 (revised)	Installation of Flue Gas Desulphurization (FGD) in all thermal power plants by year 2022. ¹⁸
	Reduction in NO _x emission and meet new norms (below 100 mg/Nm ³) by Dec 2017	Use of Selective catalytic reduction(SCR) and selective non catalytic reduction (SNCR)
	Reduction in SPM emission and meet new norms (below 30 mg/Nm ³) by Dec 2017	Renovation and Modernizing of Electrostatic Precipitators in all existing power plants
Industries	Reduction in GHG and SPM emissions	Compliance of Energy Efficiency targets through application of Performance Achieve & Trade (PAT).
	Reduction in SPM emission by 75% in Brick industries	Mandatory installation of Zig zag or vertical shaft kilns for brick industries by May 2018.
	Reduction in GHG and SPM emissions	Ban of coke and furnace oil in industry in NCR districts to reduce carbon and SPM emission.
	Reduction in NO _x , SO _x emission from polluting industries	New stringent emission standards for SO ₂ and NO _x for five industries (ceramics, foundries, glass foundries, lime kilns, reheating furnaces)
Automobiles	Reduction in NO _x (68%) and SPM emissions (75%)	Enforcement of BS-VI norms for new road vehicles by Apr 2020
	Reduction in NO _x and SPM emissions	Applicability of Fame scheme I: incentives for increasing the adoption of electric vehicle and removal of infrastructure barriers
Others (Waste and Agri Residue Management)	Reduction in SPM emissions in Indian cities	Ban on open burning of waste (trash) and strict follow of solid waste management rules 2016
	Reduction in SPM emissions	Ban of crop residue burning specially near NCR zones
	Reduction in SPM emissions	Advisory issued to power plant units to use 5%-10% biomass pellets primarily made of agri residue along with coal in year 2017

The CPCB has classified over 17 industry categories as highly polluting industries¹⁹ including distillery, sugar, fertiliser, pharmaceuticals (basic), dyes, pesticides,

cement, thermal power plants, steel, petrochemicals, and tyres, among others. These sectors are subject to strict standards and are also considered as red alert industries.

¹⁸CEEW, 2019, Pathways to achieve National Ambient Air quality standards (NAAQS) in India (link),

¹⁹Inventorization of 17 category/GPI/Red category industries, CPCB (link)

Figure 15: Highly polluting industries in India



In case of power plants, India's **Ministry of Power** issued guidelines for certain goals to reduce emission of various pollutants across 650 power plants of India which together constitute 196 Giga Watt (GW) of the installed capacity. Some of the goals include:

- Reduce SO_x: Installation of Flue Gas Desulfurization (FGD) units in 414 plants by 2022
- Reduce PM-2.5: Installations and up-gradation to Electrostatic Precipitator to achieve particulate matter (PM) norms

- Reduce NO_x: Installation of pre-combustion modifications in a boiler, installation of low NO_x burners, etc

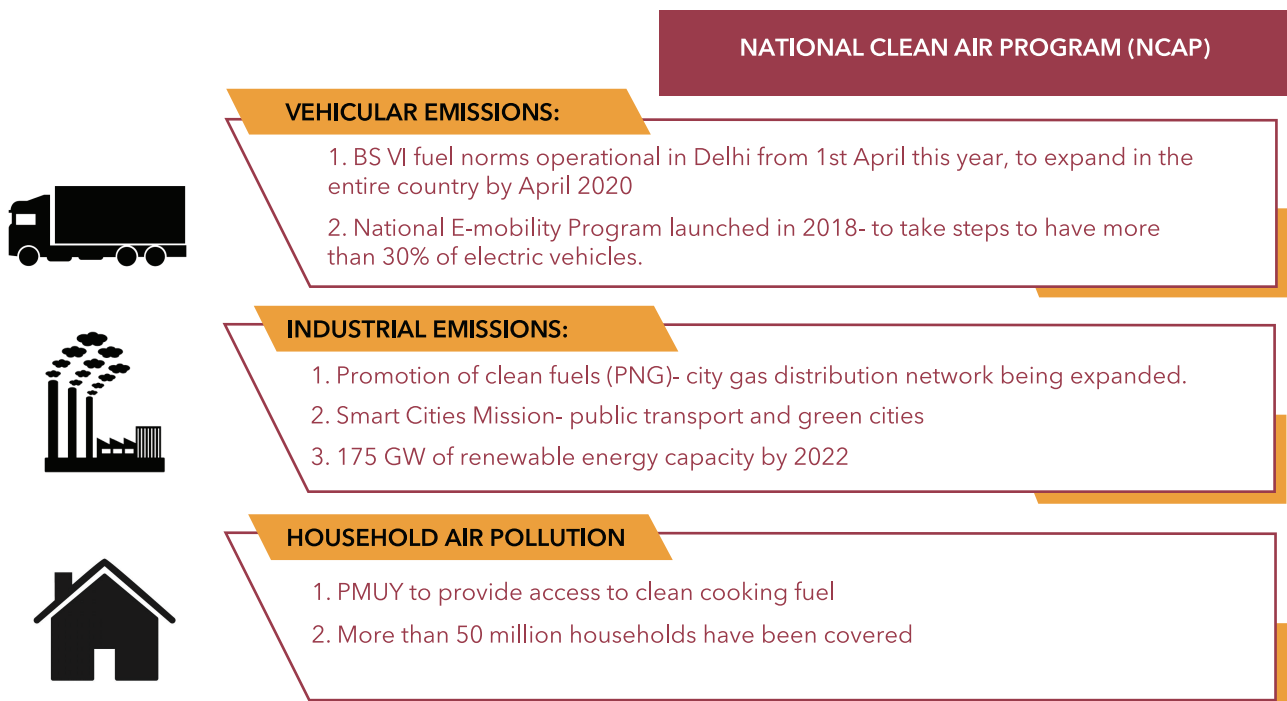
The legislations by GoI provide significant opportunities for air pollution control technologies in the country and the consequent need for financing in order to de-bottleneck the implementation process. Overall, 160 GW of thermal power capacity is required to have FGD systems by 2021. Some of these thermal power plants are mentioned in annexure 10.4.

2.5.2 Key initiatives by Government of India

GoI has formulated a **National Clean Air Programme (NCAP)** for 122 cities, especially a long-term strategy to achieve desired results. The plan is a national level target of 20%-30% reduction of PM_{2.5} and PM₁₀ concentration by the year 2024 taking 2017 as the base year.

The plan includes initiatives taken under the **National Action Plan on Climate Change** which aims to create over 3 billion tonnes of CO₂ equivalent of additional tree and forest cover. The plan also envisages having 40% of installed electricity generation capacity from renewable sources (sun, wind, hydro, others) and reducing the emissions intensity of the GDP by 33% to 35% by 2030.²⁰

Figure 16: Overview of initiatives taken under National Clean Air Programme²¹



²⁰Management of Air Pollution in Delhi NCR and National Clean Air Program, 2018, GOI (Link)

²¹Management of Air Pollution in Delhi NCR and National Clean Air Program, 2018, GOI (Link)

²²Rewind 2018: State of the air India breathes, 2019, Down To Earth (Link)

Some of the key initiatives taken by the Centre and various State Governments to control air pollution and promote relevant technologies have been summarised in the table below:

Table 6: Examples of Central and State initiatives to reduce air pollution and promote air pollution technologies²²

STATE	INITIATIVES TO CURB AIR POLLUTION
Centre	India's new vehicle scrap policy has been given 'in-principle' approval to remove 20-year-old commercial vehicles from April 1, 2020.
23 States	The National Green Tribunal (NGT) on October 2, 2018 directed 23 states and Union territories, including Delhi and Chandigarh, to prepare action plans within two months to bring the air quality standard within the prescribed limit.
Delhi	Union Environment Ministry banned import of pet coke for purpose of trading in Delhi and its neighbouring states. It had also notified DOs and DON'Ts for the sale and use of pet coke in cement plant and other industries.
Delhi	The central government cleared schemes worth INR 1,200 crore to help check air pollution in the national capital.
Punjab	Punjab Cabinet agreed to revise the terms and conditions of the Paddy Straw Challenge Fund in 2018 to find a viable technological solution to combat the menace of paddy straw burning.
ELECTRIC -VEHICLES	
	The State Government has approved Uttarakhand's electric vehicle manufacturing and battery charging infrastructure promotion policy to reduce the state's vehicular pollution
	Telangana Government has introduced 40 electric buses in association with State Road Transport Corporation in Hyderabad.
	Kerala's electric vehicle draft policy, which is a part of NITI Aayog's document, aims to reduce the number of vehicles on the roads with the introduction of modern shared transport systems like air-conditioned e-bus and e-autorickshaws.

2.5.3 Penalties imposed by CPCB

The CPCB in recent past has issued notification to various sectors for non-compliance of the pollution control norms. The errant firms are mostly part of sectors like waste

management, steel industries, oil refineries, automotive industries, construction companies etc.

The following table provides information on the non-compliance letters issued by CPCB in the recent past

²²Central Pollution Control Board, 2019 (link)

Table 7: Details of Penalty imposed by CPCB²³

SI NO	DATE OF ISSUE (DD.MM.YYYY)	ORGANIZATION	SECTOR	CORE ISSUES	PENALTY IF ANY
1	18.06.2019	South Delhi Municipal Corporation (SDMC)	Waste Management	<ul style="list-style-type: none"> • Non-segregation of municipal solid waste and plastic waste and dumping on open lands • Open burning of MSW and plastics. 	1crore + 12% interest from 17.04.2019
2	18.06.2019	East Delhi Municipal Corporation (SDMC)	Waste Management	<ul style="list-style-type: none"> • Non-segregation of municipal solid waste and plastic waste and dumping on open lands • Open burning of MSW and plastics. 	1crore + 12% interest from 17.04.2019
3	18.06.2019	North Delhi Municipal Corporation (SDMC)	Waste Management	<ul style="list-style-type: none"> • Non-segregation of municipal solid waste and plastic waste and dumping on open lands • Open burning of MSW and plastics. 	1crore + 12% interest from 17.04.2019
4	27.08.2018	Bilaspur Sponge Iron India Pvt Ltd	Iron and Steel	<ul style="list-style-type: none"> • Improvements required in emission quality and fugitive emission control system 	Closure of the Factory
5	13.02.2018	Brick Kiln Industries through Collector	Brick kiln industries	<ul style="list-style-type: none"> • No operation of Brick Kilns without Adoption of Zig Zag technology by 30.06.2018 	Closure of the Factory
6	27.02.2018	M/s AMI Steel & Power Co	Steel and Power	<ul style="list-style-type: none"> • Non installation of online emission and effluent monitoring system 	Closure of the Factory
7	06.03.2018	M/s Reliance Industries Pvt Ltd	Oil refinery	<ul style="list-style-type: none"> • Non installation of dynamic emission limit 	Environmental Compensation
8	06.03.2018	M/s ONGC Tatipahaka Refinery	Oil refinery	<ul style="list-style-type: none"> • Non installation of dynamic emission limit 	Environmental Compensation
9	06.03.2018	M/s HPCL Visakha Refinery	Oil refinery	<ul style="list-style-type: none"> • Non installation of dynamic emission limit 	Environmental Compensation
10	06.03.2018	M/s HPCL Mahul	Oil refinery	<ul style="list-style-type: none"> • Non installation of dynamic emission limit 	Environmental Compensation
11	06.03.2018	M/s BPCL Mumbai Refinery	Oil refinery	<ul style="list-style-type: none"> • Non installation of dynamic emission limit 	Environmental Compensation
12	04.12.2018	NBCC, Shapoorji Pallonji Group, ITPO, L&T	Construction companies	<ul style="list-style-type: none"> • Fined for violating air pollution control norms 	3.5 lacs
13	15.01.2019	Volkswagen	Automobiles	<ul style="list-style-type: none"> • High NOx emission by VW cars in Delhi (435 MT annually) 	171 crores

3. Assessment of air pollution control technology

This chapter aims to capture the information on the existing and emerging technologies to control air pollution in various sectors and sub-sectors across India. The information on assessment criteria, sector wise recommendations, and final shortlisted technologies are

captured in this section.

3.1 Criteria for assessment of air pollution control technologies

The criteria used for assessing the effectiveness of different air pollution control technologies include technical and implementation feasibility, economic feasibility, impact potential, market potential, and its possibility to scale across different locations in India. The description of the criteria is mentioned in the table below:

Table 8: Assessment criteria for selecting and shortlisting air pollution control technologies

CRITERIA	DESCRIPTION
Technical and Implementation Feasibility	Applicability of the technology in various sectors/segments.
	The ease of introducing intervention in various sectors/sub-sectors.
	Design and performance characteristics of the particular control system.
	Aesthetic considerations.
	The requirement of ancillary facilities, utilities, space, etc. to implement the intervention.
Economic Feasibility	Cost implication of the technology (Capex and Opex)
	Benefits of the technology in comparison to the existing set up
Impact potential	The efficiency of the technology
	The overall reduction in the emission of the pollutant
Geographical applicability	Applicability of the technology in specific geography/locations in India.
	Potential of scaling the intervention to other locations.

3.2 Sector-wise air pollution control technology assessment

The air pollution control technologies in different sector and sub-sectors namely industries (including thermal

power plants), transportation, waste management, agriculture and residential have been assessed as per afore-mentioned criteria. The results/outcomes of our evaluation across the sectors are highlighted below:

a. Industries and thermal power plants

The industrial segment has the maximum share of contribution towards pollution. The major pollutants contributed by this segment are SO_x (with an overall share

of 96%), NO_x (74%), PM_{2.5} (37%) and PM₁₀ (46%). The matrix below details the availability of control technology in this sector and the respective assessments on key attributes.

Table 9: Assessment of air pollution control technologies for industries and thermal power plants

TECHNOLOGY	POLLUTANT BEING TACKLED	TECHNICAL AND IMPLEMENTATION FEASIBILITY	ECONOMIC FEASIBILITY	IMPACT POTENTIAL	GEOGRAPHICAL APPLICABILITY
FGD (Flue Gas Desulphuriser)	<ul style="list-style-type: none"> SOx 	<ul style="list-style-type: none"> Application in multiple segments such as thermal power, steel, cement, chemical industries ~ 72 GW of thermal plant capacity is not in a position to install FGD due to non-availability of space 	<ul style="list-style-type: none"> FGD requires a sizable upfront capital investment but has relatively low operating costs. One unit of FGD can cost around INR50 Lacs per MW 	<ul style="list-style-type: none"> The efficiency of technology is more than 90%. Overall, 70-80% reduction in SOx emission 	Majority of the installation will be in the state of Maharashtra, Uttar Pradesh, Chhattisgarh, West Bengal and Andhra Pradesh
DSI (Dry Sorbent Injection)	<ul style="list-style-type: none"> SOx 	<ul style="list-style-type: none"> Applicable in both large and small segments such as real estate, telecom, other industries etc Easy to retrofit and does not consume much energy 	<ul style="list-style-type: none"> Low upfront investment and significant operational expenditure More cost-effective than FGD at stations that burn low-sulphur coal 	<ul style="list-style-type: none"> The efficiency of technology is 60% to 90%. Overall, 50% to 70% reduction in SOx emission 	Scalable to pan India
Particulate Matter Capturing Technology	<ul style="list-style-type: none"> PM10 PM2.5 	<ul style="list-style-type: none"> Applicable in both large and small segments such as real estate, telecom, other industries etc Easy to retrofit and does not consume much energy 	<ul style="list-style-type: none"> Cost to retrofit diesel gen sets is ~10% of DG cost It has an expected life of only 7 - 15 years. 	<ul style="list-style-type: none"> The efficiency of technology is 70% to 90%. Overall, 30% to 40% reduction in PM10 emission and 20% to 30% reduction in PM2.5 emission. 	Scalable to pan India
Electrostatic precipitator	<ul style="list-style-type: none"> PM10 PM2.5 	<ul style="list-style-type: none"> Applicable in power plants, cement, metal, other manufacturing Require large space for set up 	<ul style="list-style-type: none"> High upgradation cost - ~INR 5- 15 Lakh per MW 	<ul style="list-style-type: none"> The efficiency of technology is 99%. Overall, 40-50% reduction in PM10 emission and 25%-30% reduction in PM2.5 emission 	Scalable to pan India
Zig Zag Kiln Technology	<ul style="list-style-type: none"> PM10 PM2.5 	<ul style="list-style-type: none"> Applicable in manufacturing of bricks. Zigzag firing pattern is easily suitable in the existing system and 	<ul style="list-style-type: none"> Retrofitting requires INR 10 - 25 Lakhs 	<ul style="list-style-type: none"> The efficiency of technology is 75%. Overall, 2-3% reduction in PM10 emission and 1%-2% reduction in PM2.5 emission 	Scalable to pan India

		<ul style="list-style-type: none"> requires only process change with minimal structural changes Requires over 4 - 6 acres of land Operation is seasonal in nature 			
Coal Beneficiation Technology	<ul style="list-style-type: none"> SOx PM10 	<ul style="list-style-type: none"> Applicable in power plants Setting up of Washeries has not favoured the private sector and public sector is also reluctant to partner 	<ul style="list-style-type: none"> Cost of setting up a washery is ~INR 380 crore Economic benefits of washing coal, while documented in theory, have not been realised in practice 	<ul style="list-style-type: none"> Overall, 30% reduction in PM10, 25% reduction in SOx and 6.5% reduction in CO2. 	Scalable to pan India
Low NOx Burner (LNB)	<ul style="list-style-type: none"> NOx 	<ul style="list-style-type: none"> Applicable across industries including automobiles. Already in use by few plants in India 	<ul style="list-style-type: none"> Cost of installation is ~ INR 5 lakh per MW. 	<ul style="list-style-type: none"> The efficiency of the technology is 50%. Overall, 20%-25% reduction in NOx emission. 	Scalable to pan India

High
 Medium
 Low

b. Transportation Sector

In large metropolitan cities like Delhi and Mumbai, vehicular pollution is a major concern as it is growing significantly over the years. The major pollutant contributed by the vehicles is NOx (overall share of 20% in NOx emission). In order to mitigate the issues, the Government has been taking certain actions like shifting from

BS-IV to BS-VI norm vehicles, introducing electric vehicles, installing charging infrastructure at scale in big cities & smart cities, developing public transport infrastructure, etc.

Some of the existing and emerging pollution control technologies in this sector are tabulated below:

Table 10: Pollution Control technology for transportation sector

TECHNOLOGY	POLLUTANT BEING TACKLED	TECHNICAL AND IMPLEMENTATION FEASIBILITY	ECONOMIC FEASIBILITY	IMPACT POTENTIAL	GEOGRAPHICAL APPLICABILITY
Electric Vehicles	<ul style="list-style-type: none"> SOx NOx PM 	<ul style="list-style-type: none"> Inadequate charging infrastructure leading to less uptake of electric vehicles Space is one of the constraints for installing charging stations 	<ul style="list-style-type: none"> Cost of setting up a public charging station is ~ 30 lacs with an opex of ~ 9 lacs Electric vehicles are 1.5 - 3 times costlier than the fossil fuel vehicles 	<ul style="list-style-type: none"> The efficiency of technology varies with the type of pollutants as per the following: <ul style="list-style-type: none"> - SOx - 45% - NOx - 81% - PM - 36% Overall, 1%, 0.2%, 16% reduction in SOx, PM, NOx emission respectively. 	Scalable to pan India

Diesel Particulate Filters	<ul style="list-style-type: none"> PM10 PM2.5 	<ul style="list-style-type: none"> Installation is mandatory under the BS-VI norms It requires cleaning every 1000 hours of vehicle operation 	<ul style="list-style-type: none"> High Labour intensive Can cost up to INR 14000 	<ul style="list-style-type: none"> The efficiency of technology is 85% to 95% Overall, 1% reduction in PM emission. 	Scalable to pan India. At initial phase, the BS -VI norms is enforced in Delhi from April 2020
Fabric Filters	<ul style="list-style-type: none"> PM10 PM2.5 	<ul style="list-style-type: none"> Applicable in multi segments such as transportation, power generation, chemical industry, pharmaceutical, food & beverages and steel mills Fabric bags tends to damage at extreme temperature 	<ul style="list-style-type: none"> Cost of filters range from 25 lacs to 5 crores 	<ul style="list-style-type: none"> The efficiency of technology is 90%-95% Overall, 2% reduction in PM10 & PM2.5 emission 	Scalable to pan India
Mechanical Road Sweeping Machine	<ul style="list-style-type: none"> PM10 PM2.5 	<ul style="list-style-type: none"> Considered effective than the manual brooms The device can be easily attached to a motor vehicle The mechanical road sweepers are already being operated by the Delhi Municipal Corporations 	<ul style="list-style-type: none"> Case studies show that Pune Municipal Corporation is expected to save INR 3 crore per year by shifting from manual sweeping to mechanical sweepers 	<ul style="list-style-type: none"> Overall, 1-2% reduction in PM10 emission and 1%-2% reduction in PM2.5 emission 	Scalable to pan India

High Medium Low

c. Waste management sector

Waste management is one of the prime areas contributing to air pollution with the emission of pollutants like particulate matter arising from municipal solid waste, household organic waste etc.

This segment has an overall share of 4% towards particulate matter emission. Examples of technologies that can be deployed in this space are given below.

Table 11: Pollution Control technology for waste management sector

TECHNOLOGY	POLLUTANT BEING TACKLED	TECHNICAL AND IMPLEMENTATION FEASIBILITY	ECONOMIC FEASIBILITY	IMPACT POTENTIAL	GEOGRAPHICAL APPLICABILITY
Anaerobic Digester	<ul style="list-style-type: none"> NOx PM 	<ul style="list-style-type: none"> The raw materials are available in large quantum. However, proper waste segregation is essential for higher efficiency in the complete system 	<ul style="list-style-type: none"> Cost of setting up a unit is Rs 0.25 crore per tonne of waste utilised The operational and maintenance expenses are generally 2%-7% of 	<ul style="list-style-type: none"> The efficiency of technology is ~ 48% Overall, 0.1% reduction in NOx emission and 4% reduction in PM emission 	It has high potential of utilization in class A and class B cities and scalable to pan India

		<ul style="list-style-type: none"> • Technology is available in various sizes to cater to the quantum of waste and conversion to energy 	the capital cost		
Scrubber wet and dry	<ul style="list-style-type: none"> • PM10 • PM2.5 	<ul style="list-style-type: none"> • Applicable in boilers, incinerators, automotive, wastewater treatment plants, shipping and other industries • Compact and can be retrofitted easily • Wet scrubbing is most versatile and cost effective • Scrubbers suffer from high levels of corrosion and produce slurry waste streams • Scrubbers are very multidisciplinary, with the ability to remove solids, mists, and gases simultaneously while also providing cooling. • Capable of handling explosive and flammable gases safely 	<ul style="list-style-type: none"> • Majority demand is expected from the shipping industry, where cumulative cost of retrofitting a scrubber including shipyard space, engineering works and downtime, would be around INR 30-35 Lacs per vessel 	<ul style="list-style-type: none"> • The efficiency of technology is 90%-95% • Overall, 3% reduction in PM10 emission and 6% reduction in PM2.5 emission 	Scalable to pan India

High Medium Low

d. Agriculture Sector

Outdoor burning of crop residue is a common practice in India. Although, not a dominant source of air pollution throughout the year, post-monsoon fires contribute significantly to regional air pollution- especially in land bound cities such as Delhi.

23 million tonnes of paddy straw is burnt in Punjab, Haryana and Uttar Pradesh, which increases carbon dioxide levels and GHG in the air by 70% and carbon monoxide and nitrogen dioxide levels by 7% and 0.2%, respectively. In addition, this segment also contributes to PM emission with an overall share of about 8%. Traditional

methods of managing paddy straw burning issue include using bio-char, pellets/ briquettes for thermal power plants etc.²⁴

The Government, however, is now promoting the use of in-situ agricultural machineries for management of crop residue, considered more effective than traditional methods. Examples of such technologies include Super Straw Management System (Super SMS) to be attached with Combine Harvester, Happy Seeder, Paddy Straw Chopper/Shredder/Mulcher, Shrub Master/ Cutter cum spreader, Rotary Slasher, Rotavator etc.²⁵

²⁴National Clean Air Programme, 2019, GOI (Link)

²⁵Promotion of Agricultural Mechanization for In-Situ management of crop residue, 2018, GOI (Link)

Table 12: Pollution Control technology for Agriculture sector

TECHNOLOGY	POLLUTANT BEING TACKLED	TECHNICAL AND IMPLEMENTATION FEASIBILITY	ECONOMIC FEASIBILITY	IMPACT POTENTIAL	GEOGRAPHICAL APPLICABILITY
Super Straw Management System (SSMS)	<ul style="list-style-type: none"> • PM_{2.5} • PM₁₀ 	<ul style="list-style-type: none"> • The normal combine harvester leaves behind 10-12 inches long stubble. With the use of SSMS and the combine harvester, paddy straw can be cut till 4-5 inches from the ground • Farmers have been given subsidies in some states 	<ul style="list-style-type: none"> • The combine harvester costs ~18lacs and addition of SSMS increases the cost by 1.2 lacs 	<ul style="list-style-type: none"> • The technology reduces the PM emission 	The rice-wheat cropping system is predominant in the states of Delhi, Haryana, Punjab and Uttar Pradesh and are potential usage of the SSMS technology
Happy Seeder	<ul style="list-style-type: none"> • PM₁₀ • PM_{2.5} 	<ul style="list-style-type: none"> • The market penetration of the technology is low • Shortage of machines during the peak period leads to long waiting time and compels farmer to carry out the stubble burning practise • Subsidies from the Government is available for the farmers to purchase • Enhances the nutrient value by 10%-15% 	<ul style="list-style-type: none"> • The cost of technology is ~ 1.3 lacs and associated with capital subsidy 	<ul style="list-style-type: none"> • The efficiency of technology is 80%. • Overall 1%-2% reduction in PM emission 	The rice-wheat cropping system is predominant in the states of Delhi, Haryana, Punjab and Uttar Pradesh and are the potential usage of the Happy Seeder technology
Biomass Pellet	<ul style="list-style-type: none"> • SO_x • NO_x • PM 	<ul style="list-style-type: none"> • In 2017, Central Electricity Authority (CEA) had issued an advisory to public and private generating units to use 5-10 per cent biomass pellets primarily made of agro residues along with coal • The high transportation cost of compressed paddy stubble necessitates the power plants to be 	<ul style="list-style-type: none"> • The Feed in Tariff for such agri utilization plants is Rs 7/- per unit which is double the unit price of complete coal-based power plant. Off takers of power has issues in purchasing power at such higher cost 	<ul style="list-style-type: none"> • The biomass pellet blended with coal at a ratio of 5:95 has the capacity to reduce SO_x by 17% and NO_x by 5% in the thermal power plants • The use of biomass pellet prevents burning of stubble and thereby reducing PM emission 	Scalable to pan India, preferably closer to the thermal power plants

		<p>in the vicinity</p> <ul style="list-style-type: none"> • Agri residues are seasonal in nature which delays the investment recoveries (paybacks) in palletization & briquetting plants 		<ul style="list-style-type: none"> • Overall, 4-5% reduction in SO_x, 1-1.5% reduction in NO_x and 1% reduction in PM emission 	
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High Medium Low

e. Residential Sector

Residential sector also accounts for air pollution due to improper household waste disposal, cooking by burning fossil fuels, etc. The major pollutants contributed by this segment are the PM10 and PM2.5 with an overall share

of 41% and 49% respectively. Some of the existing technologies which assist in mitigating pollution are tabulated below:

Table 13: Pollution control technology for residential sector

TECHNOLOGY	POLLUTANT BEING TACKLED	TECHNICAL AND IMPLEMENTATION FEASIBILITY	ECONOMIC FEASIBILITY	IMPACT POTENTIAL	GEOGRAPHICAL APPLICABILITY
Air Purifier	<ul style="list-style-type: none"> • PM_{2.5} • PM₁₀ 	<ul style="list-style-type: none"> • Plug & play and easy to deploy in-house 	<ul style="list-style-type: none"> • Pricing to eventual customer can vary from INR 10,000 to 90,000 	<ul style="list-style-type: none"> • The efficiency of technology is ~ 50% to 90% • Overall 20%-25% reduction in PM₁₀ emission and 25%-45% reduction in PM_{2.5} emission 	Scalable to PAN India
Clean cooking stoves, LPG	<ul style="list-style-type: none"> • PM10 • PM2.5 	<ul style="list-style-type: none"> • Ujjwala Yojana Scheme was launched in 2016 to promote clean cooking by providing poor women with free LPG connections and has reached 8.3 crore households in 715 districts in India • Solar thermal cooker is an emerging clean cooking technology and is easy to implement • Tier-III and Tier-IV clean cooking stoves are available with higher efficiency and lower emissions 	<ul style="list-style-type: none"> • The cost of clean cooking stoves varies from INR 5000 to INR 15000 	<ul style="list-style-type: none"> • The efficiency of technology is in the range of 40% to 50% 	Scalable to PAN India

High Medium Low


3.3 Overall assessment of the control technologies

In the outcome of this section, the team has tried to present the analysis of the effectiveness of the control technologies based on the criteria's defined earlier and feedback received by the stakeholders during individual

consultation and a group brain storming workshop.

a. Thermal Power Plants and industries


Industries and thermal power plants contribute highest in terms of share. Hence the overall impact of incorporating control interventions in this sector is "high".

Sector : Thermal Power Plant and Industries					
Type of Pollutant	Share of Pollutant	Air Pollution Control Technology	Intellectap Analysis		
			Technical Feasibility	Cost Feasibility	Impact Potential
SOx	96%	Flue gas desulphurization, Dry sorbent injection, Coal washeries	MEDIUM	HIGH	HIGH
NOx	74%	Low NOx burners, Over fire air system, selective catalytic reduction	MEDIUM	MEDIUM	HIGH
PM ₁₀	46%	Particulate matter capturing technology, Electrostatic precipitation, Zig Zag kiln technology, washeries	MEDIUM	HIGH	MEDIUM
PM _{2.5}	37%		MEDIUM	HIGH	MEDIUM
Overall Analysis  HIGH					

b. Transportation Sector

The contribution of the transportation sector to air pollution at apollutant level is not very high pan India.


requirements are high for long terms solutions such as electric vehicles. Hence the overall analysis by the team for the control interventions in this sector is "low".

Sector : Transportation					
Type of Pollutant	Share of Pollutant	Air Pollution Control Technology	Intellectap Analysis		
			Technical Feasibility	Cost Feasibility	Impact Potential
SOx	0.2%	Electric Vehicle	MEDIUM	MEDIUM	LOW
NOx	19.5%	Electric Vehicle, BS VI Norms	MEDIUM	MEDIUM	HIGH
PM ₁₀	0.7%	Electric Vehicle, BS VI Norms, Diesel Particular Filters, Fabric Filter	HIGH	LOW	LOW
PM _{2.5}	0.8%		HIGH	LOW	LOW
Overall  LOW					

c. Waste Management Sector

The contribution of waste management sector to air pollution across different pollutants is low. However, the cost of control interventions is also low which means that


the economic feasibility of such interventions is high. Further-more, some of the possible control technologies have high technical feasibility. Considering these factors, the overall feasibility is "Medium"

Sector : Waste Management					
Type of Pollutant	Share of Pollutant	Air Pollution Control Technology	Intellectap Analysis		
			Technical Feasibility	Cost Feasibility	Impact Potential
SO _x	0.1%	Anaerobic digester	MEDIUM	HIGH	LOW
NO _x	0.2%	Anaerobic digester	MEDIUM	HIGH	LOW
PM ₁₀	3.7%	Anaerobic digester, Scrubber wet and dry	HIGH	HIGH	LOW
PM _{2.5}	4.7%		HIGH	HIGH	LOW
Overall		 MEDIUM			

d. Residential Sector

The contribution of the residential segment to the PM levels in the air is significant. A substantial reduction can be achieved through focus on clean cooking alternatives for low income populations. While the cost of such


intervention is not high in absolute terms, the cost burden to a low-income consumer can sometimes be high, which is why the economic feasibility of such intervention is rated as medium. Further-more, some of the possible control technologies have high technical feasibility. Considering the above notion, the overall feasibility is "Medium".

Sector : Residential					
Type of Pollutant	Share of Pollutant	Air Pollution Control Technology	Intellectap Analysis		
			Technical Feasibility	Cost Feasibility	Impact Potential
SO _x	3.6%	Clean cooking Stoves , LPG	HIGH	MEDIUM	MEDIUM
NO _x	6.1%		HIGH	MEDIUM	MEDIUM
PM ₁₀	41.5%	Anaerobic digester, Scrubber wet and dry	HIGH	MEDIUM	MEDIUM
PM _{2.5}	48.9%		HIGH	MEDIUM	MEDIUM
Overall		 MEDIUM			

e. Agriculture Sector

The contribution of the agriculture sector to air pollution levels is low. The cost of control intervention varies from low to medium for different air pollutants coming from

this sector. The economic feasibility of control interventions is accordingly assessed as medium. Technical feasibility of the control technologies is also medium. Considering all these factors, the overall feasibility is "Medium".

Sector : Agriculture					
Type of Pollutant	Share of Pollutant	Air Pollution Control Technology	Intellectap Analysis		
			Technical Feasibility	Cost Feasibility	Impact Potential
SO _x	0.2%	Biomass Pellet	MEDIUM	LOW	LOW
NO _x	0.2%	SSMS, Biomass pellet	MEDIUM	LOW	LOW
PM ₁₀	8.0%	Anaerobic digester, Scrubber wet and dry	MEDIUM	MEDIUM	MEDIUM
PM _{2.5}	8.6%		MEDIUM	MEDIUM	MEDIUM
Overall		MEDIUM			

support air pollution control technologies along with the financing mechanism associated with such facilities.

4. Financing landscape

This chapter highlights the overall market size and investment potential for air pollution control technologies in India. In addition, it also captures an overview of public and private financial institutions which can manage suggested air pollution control financing facility, by extending their existing focus in the areas of renewable energy and energy efficiency, among others. This section also highlights the existing global facilities which

4.1 Investment potential of air pollution control technologies

The investment potential for air pollution control technologies is huge and it's increasing not just in India but across the globe. Recent estimates/study by Acumen Research and Consulting have highlighted that the global market size for air pollution control technologies in the industrial segment will be USD 99 billion by the year 2026 (with an average growth rate of 5.1% YoY).²⁶

Intelcap also estimated annual investment required for air pollution control across different sectors and sub-sectors as highlighted in the table below.

Table 14: Investment required for reducing air pollution across industries (sub-sector wise)

SECTOR	SUB SECTOR	MAJOR POLLUTANT	INVESTMENT REQUIRED PER ANNUM (INR, CR)
INDUSTRIES	Thermal Power	PM, SO _x , NO _x	29,050
	Iron and Steel	SO _x	8,442
	Textile	PM	1,645
	Cement	PM	1,540
	Aluminum	PM	147
	Chlor-Alkali	PM	126
	Pulp and Paper	PM	91
	Petrochemical	NO _x	91
	Steel Re-rolling	PM	84
	Foundry	PM	70
	Fertilizer	PM, NO _x	63
	Petroleum	PM	31
	Forging and Casting	PM	9
	Ceramic	PM	2
Total Financing Requirement			41391*

²⁶ Investment estimates for Industrial air pollution control in India, 2019 (link)

Table 15: Investment required for reducing air pollution across waste management, transportation, and other sectors

Sector	Sub Sector	Major Pollutant	Investment required per annum(INR Cr)
WASTE MANAGEMENT	Waste Processing	PM	210
	Waste to Energy (Incineration)	PM, SO _x , NO _x	364
	Total Financing Requirement		574+
TRANSPORTATION	BS IV to BS VI transition	PM, SO _x , NO _x	2,40,135
	Investment potential in EV and infrastructure	PM, SO _x , NO _x	4,66,900
	Total Financing Requirement		7,07,035+
AGRICULTURE	Agri waste to Solid fuel	PM, SO _x , NO _x	5,600
	Waste to Energy (Incineration)		
	Total Financing Requirement		5,600+
RESIDENTIAL	Air purifiers	PM	80
	Clean cooking stoves	PM	120
	Total Financing Requirement		200+

It is evident (from the above) that the requirement of capital is high in the transportation and industrial sectors (including thermal power plants), amongst all major air pollution contributing sectors. Also, the overall magnitude of required investment is also high (in the range of INR 7.5 trillion) across all air pollution contributing sectors.

Thus, there is a need for a systemic intervention to facilitate the flow of funds in these sectors. We thus explored the strength and initiatives of Indian financial institutions as well global case studies to design a unique financing facility that could support air pollution control technologies in India.

4.2 Profile of financial institutions in India

There are several public and private institutions that are providing infrastructure and clean energy finance to support air pollution control technologies (though often indirectly) in India. The institutions are categorized as public sector banks (State Bank of India, Punjab National Bank, others), private sector banks (Yes Bank, RBL Bank, others), and non-banking financing companies (NBFCs) such as Caspian, Kinara Capital, Intellegrow, among others. Key characteristics of these institutions, supported

instruments and a brief profile are included in this chapter.

4.2.1 Private sector financial institutions

Financial institutions in the private sector provide capital to enterprises as well as consumers (e.g., industries) in the field of renewable energy, energy efficiency (including climate friendly investments), and other high impact areas that support in reducing air pollution. Information on some of these organizations along with their key offerings in the sector is captured below:

Table 16: Information on private sector financial Institutions in India

ORGANIZATION	TOTAL CORPUS	INSTRUMENT	KEY INFORMATION
Yes Bank	Yes Bank Over USD 260m [INR 1976 Crore] (Green Bond, 2015,2016)	Debt	Portfolio: Renewable energy and energy efficiency technologies along with climate friendly investments
Axis Bank	USD 500 mn. [INR 3800 Crore](Green Bonds, 2016)	Debt	Portfolio: Sustainable sectors such as renewable and clean energy, low carbon transport, and effective waste management
Caspian	USD 50 mn [INR 380 Crore](2018)	Debt & Equity	Portfolio: Food and Agriculture, financial inclusion, healthcare, clean energy & energy efficiency etc. Ticket size: USD 147K - 2.2 mn (debt), USD 147K - 735K (equity)
Artha Ventures, Anthill, Unitus Ventures	Artha-USD 30mn[INR 228 Crore](2018) Anthill - NA Unitus - USD 50 mn[INR 380 Crore] (2018)	Equity	Portfolio: Start-ups with innovative technologies as part of YES Bank's accelerator programme
Go Massive	USD 150 mn. [INR 1140 Crore](2018)	Equity	Portfolio: Pollution reduction & other sectors aligned with UN SDGs
IDFC	USD 15 mn [INR 100 Crore] (Parampara Early Stage Opportunities Fund, 2017)	Equity	Portfolio: Investments in companies across sectors to promote technology, intellectual property and innovation Ticket size: USD 100K - 1 mn
Infuse Ventures	USD 25 mn. [INR 190 Crore] (Infuse Fund, 2013), USD 100 mn [INR 760 Crore](Bharat Fund, 2017)	Equity	Portfolio: : Provides early stage venture capital fund and ecosystem focussed on sustainability and clean energy sector in India Ticket size: USD 150K - 1.5 mn (Infuse fund), USD 1 mn - 4 mn (Bharat Fund)

4.2.2 Public sector financial institutions

Financial institutions in the public sector play a pivotal role in financing green infrastructure projects and related investments across sectors in India. Like private institutions, these sectors also cater to investments required for projects in areas such as renewable energy, energy efficiency, thermal power plants, agriculture, etc.

These institutions typically may not finance air pollution

control technologies or interventions in a dedicated manner but provide investments for projects which support in reducing air pollution. For example, PFC finances thermal power projects in India which cover financing of large boilers or ESPs (which is responsible for air pollution) as part of the overall project cost.

Information on some of these organizations along with their key offerings in the sector is captured below:

Table 17: Information on public sector financial institutions in India

ORGANIZATION	TOTAL CORPUS	INSTRUMENT	KEY INFORMATION
Bureau of Energy Efficiency (BEE)	NA	Guarantee Fund	Portfolio: Guarantees 50% of loan amount or INR 10 crore per projects, whichever is less to participating FIs to ease its credit risk involved in providing loans for Energy Efficiency (EE)
India Renewable Energy Development Agency Limited (IREDA)	USD 3.5 billion [INR 26600 Crore] (2018)	Debt	Portfolio: Enterprise and bank financing for projects related to Renewable energy including solar, wind, biomass, waste management and Energy efficiency. Ticket size: INR 50 Lakh +
Power Finance Corporation Limited	USD 400 million [INR 3040 Crore]	Debt	Portfolio: Renewable energy firms and energy efficiency firms including electric vehicles
SIDBI	USD 31.2 mn [INR 237 Crore] (Maharashtra State Social Venture Fund, 2015)	Equity	Portfolio: Renewable and non-conventional energy enterprises among other sectors
SBI Neev	USD 110 million [INR 836 Crore]	Equity	Portfolio: Infrastructure sub sectors including renewable energy, agriculture supply chain, etc. Ticket size: USD 5 - 10 mn
National Investment & Infrastructure Fund (NIIF)	USD 3 billion [INR 22800 Crore]	Equity	<ul style="list-style-type: none"> • Master Fund is an infrastructure fund primarily investing in operating assets in core infrastructure sectors • Fund of Funds invests across infrastructure services and allied sectors including energy • Strategic Fund is aimed at growth and development stage investments in projects/ companies

4.3 Global financing facilities and mechanisms for air pollution

Governments across the world are recognising the economic importance of reducing air pollution and are moving beyond enacting regulations to introducing financial interventions that can channelize the required funds for pollution reduction measures.

A number of multilateral development banks (MDBs) also provide financial support for economic and social development activities to developing countries. In addition to equity, they offer financing especially long term loans at interest rates below market rates (soft loans) and grants which are mostly used for technical assistance, advisory services and project preparations.

Information on initiatives of some of these MDBs is highlighted below:

- World Bank provides funding for three innovative efforts

that aim to reduce Green House Gas(GHGs) across the world. These are the Prototype Carbon Fund (PCF), the Bio Carbon Fund, and the Community Development Carbon Fund (CDCF), information on which are provided below²⁷:

FUNDS	DESCRIPTION
Prototype Carbon Fund (PCF)	<ul style="list-style-type: none"> • Promote and support Public-Private Partnership projects to pioneer a market for innovative projects that target GHG emission reduction. • Support projects that demonstrate the methodology of lowering the compliance cost in relation to Kyoto protocol, and also promote sustainable development by mobilizing new and green resources for bank clients.
Bio carbon Fund (BCF)	<ul style="list-style-type: none"> • Multilateral fund supported by donor agencies and governments of developed nations and managed by the World Bank. • Promotes the reduction of GHG emissions from the land sector, by reducing deforestation and forest degradation in developing countries and by promoting sustainable agricultural practices, smarter land use planning, policies and practices.
Community Development Carbon Fund (CDCF)	<ul style="list-style-type: none"> • Support projects that resonate with three global themes: reduce poverty, mitigate climate change, and promote corporate social responsibility (CSR). • Extends the benefit of carbon finance to the low-income countries by purchasing the Clean Development Mechanism (CDM) compliant emission reductions (ERs)

- **International Finance Corporation (IFC)** is one of the largest sources of debt and equity financing for private sector projects in the developing world including finance for air pollution control technologies and projects. It has proposed the issuance of an innovative bond namely "Breathe Better Bond" whose proceeds would be used to fund the infrastructure projects that reduce both air pollution and GHG emission²⁹. The bonds are envisaged to be issued by a city, state or special purpose vehicle in order to raise finance for interventions to reduce air pollution especially GHG emissions. The bond feature allows the issuer to reduce the cost of financing by entering the results-based payment agreement with the donor, philanthropic institutions, development finance institution, etc. The investment type includes debt, equity, investment stage grant and preparation stage grants.

- **African Development Bank Group (AfDB)** and the **Asian Development Bank (ADB)** are the two largest bilateral organizations that provide financing for developmental goals on concessional terms in the form of debt and equity investments for economic and social advancements to its member countries. ADB also offers credit guarantees, partial risk guarantees and commercial co-financing facilities for air pollution control initiatives/projects.

- The **InterAmerican Development Bank Group's (IDB Group) Multilateral Investment Fund (MIF)** is an USD 1.3

bn grant and investment facility with a general mandate to provide the investment for private sector growth in Latin America and the Caribbean. Special emphasis is provided to the development of small enterprises that have USD 3 million to USD 5 million in sales and fewer than 100 employees.

In addition to development finance agencies, there are many public and private institutions that offer innovative financing to enterprises that provide air pollution control technologies. For instance, China Industrial Bank (CIB) in cooperation with IFC created China's first Green Credit product in 2006. By the end of 2012, the Assets Under Management (AUM) for green finances by CIB amounted to INR (USD 11 billion). This resulted into the energy savings equivalent to 256 million tonnes of coal per year. It also resulted in annual emission reductions - equivalent to SO_x and NO_x reduction by 44,000 tonnes and 6,900 tonnes respectively.

Similarly, Bank of China issued **China Green Covered Bonds** in November 2016 where 12% of the proceeds was dedicated to pollution prevention and control projects.²⁹ Other examples include the Clean tech Fund, E&Co, Eco-Enterprises Fund, Latin American Clean Energy Services Fund (also referred to as the ESCO Fund), and North America Environmental Fund which are private funds supported by MIF in various capacities.³⁰

²⁷ Ibid.

²⁸ Breathe better bond initiative, The Lab, 2019 (link)

²⁹ Greening China's Financial System, 2015, IISD (Link)

³⁰ Ibid.

The following table illustrates some of the other facilities technologies for air pollution control that offer finance for development initiatives and

Table 18: Global financing facilities for air pollution control technologies

INSTITUTION/ GLOBAL FACILITY	INSTRUMENT	PUBLIC/ PRIVATE	COUN- TRY	KEY SUMMARY
European Investment Bank	Sustainability Awareness Bonds	Public	Works with 28 European Union (EU) member states	Portfolio: The institution devotes over 25% of its financing each year to climate change mitigation and adaptation activities. Issued over EUR 23 billion climate awareness bonds till December 2018 projects.
Japan Environment Corporation	Long-term loans at lower-than market interest rates	Public	Japan	Portfolio: Provide loans for industries to support air pollution control technologies. In addition to loan, it also offers basic infrastructure for industrial development and technical assistance and guidance to industries.
KfW	Fixed Income Green Bonds	Public	Germany	The target volume of the portfolio was EUR 2 billion in May 2017
Developmental Bank of Philippines	Environmental Infrastructure Support Credit Program (EISCP)	Public	Philippines	Portfolio: The institution provides concessional credit scheme which encourage companies to invest in pollution control technologies and activities. The loans were provided to sugar industries, food processing industries, steel industries and power industries to adopt air pollution control technologies.
Oxley Holdings limited	Green Bonds and Loans	Private	Singapore	Portfolio: Finances and re-finances the green projects in line with the SDG goals of the UN. Defined the framework for tracking, allocating and managing the green projects effectively.
Renewi Green Finance Framework	Green Bonds and Loans	Private	Europe, North America, and based in the UK	Portfolio: Aligns green finance framework with the Green Bond Principles 2017 administered by International Capital Market association (ICMA) and the green loan principles administered by loan market association & Asia-Pacific loan market association. <ul style="list-style-type: none"> • With such framework it has assisted in reducing emission levels of hydro-carbon by 70%, NOx by 80%, particulates by 50%
National Fund for Environmental Protection and Water Management	Loans and grants on preferential terms	Public	Poland	Portfolio: The NFEPWM charges fines and penalties to the polluting sectors and provides loans and grants to the beneficiaries & investors for financing the pollution control technologies

The Lebanon Environmental pollution abatement project financed by Italian Cooperation (AICS)	Concessional loans	Public	Lebanon	<p>Portfolio: Assist borrowers in reducing industrial pollution and strengthening of the monitoring and enforcement capabilities of Ministry of Environment.</p> <ul style="list-style-type: none"> Concessional loans assist enterprises to reduce air emission, control effluent discharges, and minimize industrial waste generation as per national environmental standard norms in a cost-effective manner
Clean Technology Fund	Blended finance including mix of grants, concessional loans and guarantees	Public	12 countries including UK, US, Japan, Germany among others	<p>Portfolio: Multi donor trust fund channelled through a SPV created in the partnership of the AfDB, ADB, EBRD, IDB, and WBG</p> <ul style="list-style-type: none"> Promotes scale-up financing for demonstration, deployment, and transfer of low-carbon technologies with significant potential for long-term reduction of GHG emissions. Offers blended finance with interest rates between 2% and 10% for a tenure of 20 to 40 years

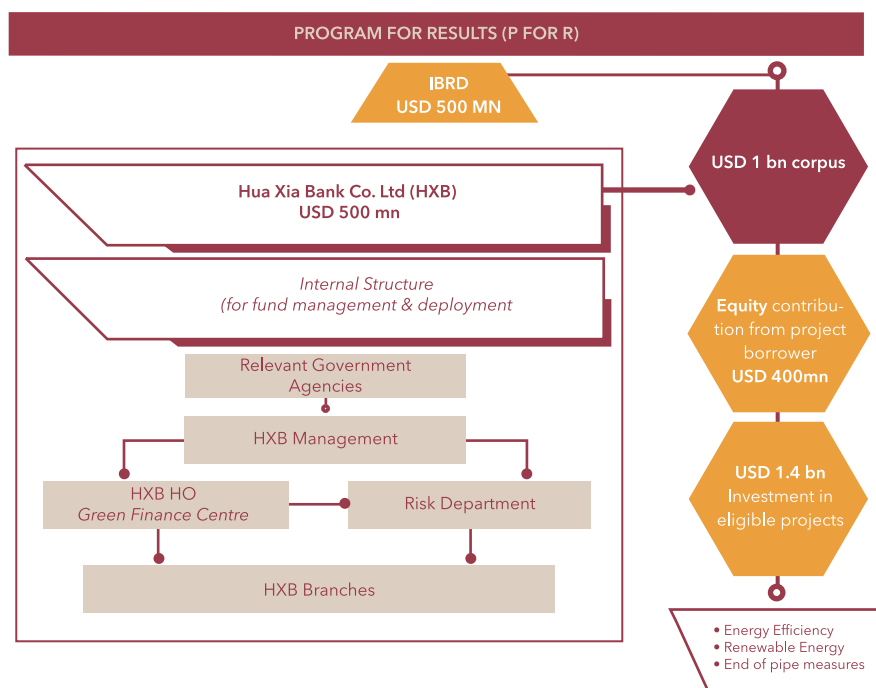
4.3.1 Case studies on financing mechanism of some of the global facilities

A. Case Study: Programme for Results (PforR) by World Bank in Jing-Jin-Ji (JJJ), China³¹

China has experienced a rapid growth in its economy over the past few years and as a result its energy consumption has also increased multi-fold. This has resulted in China becoming one of the biggest emitter of pollution, and many of its cities have been featured as the world’s most polluted cities. The emission levels of PM, NOx, and SOx, had substantially exceeded the national standards by 80%, 70%, and 50% respectively. Thus, controlling of air

pollution became the highest priority of the Government of China. World Bank in its commitment to support the Government of China has initiated an innovative project called Programme for Result (PforR); a result based financing program/mechanism for reducing air pollution.

The PforR leveraged the strength of an existing financing institution (HXB) to create and manage a corpus of USD 1 billion. It has also mobilized the project borrowers to invest their equity contribution of about USD 400 million which has resulted in an overall corpus of facility at USD 1.4 billion. The overall fund was then utilized to finance projects in the field of energy efficiency, renewable energy and end of pipe measures.



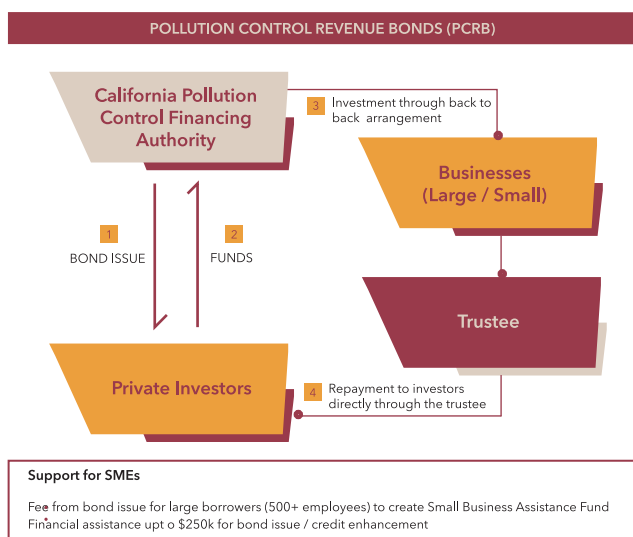
³¹ Innovative Financing Scheme for Air pollution Control, World Bank 2019 (link)

B. Case study - Pollution Control Revenue Bonds in California³²

The California Pollution Control Financing Authority initiated pollution control revenue bonds to finance projects which help to abate, control, prevent, or eliminate any form of pollution related to the earth, water, air, etc. The bonds are subscribed by the private investors and the funds raised are utilized in financing the pollution control projects adopted by large scale and small scale industries.

The loan beneficiaries repay the loan to the investors directly through the trustee.

The financing authority charges certain operational fees for the issuance of bonds applicable to large borrowers (defined as organizations having employee strength of more than 500). Such fees is partly utilised in the sustainability of the facility and partly deposited in the small business assistance fund. Small Business Assistance Fund is utilized in financing the small entities (SMEs) and also to waive off their fees related to bond issuance or credit enhancement.



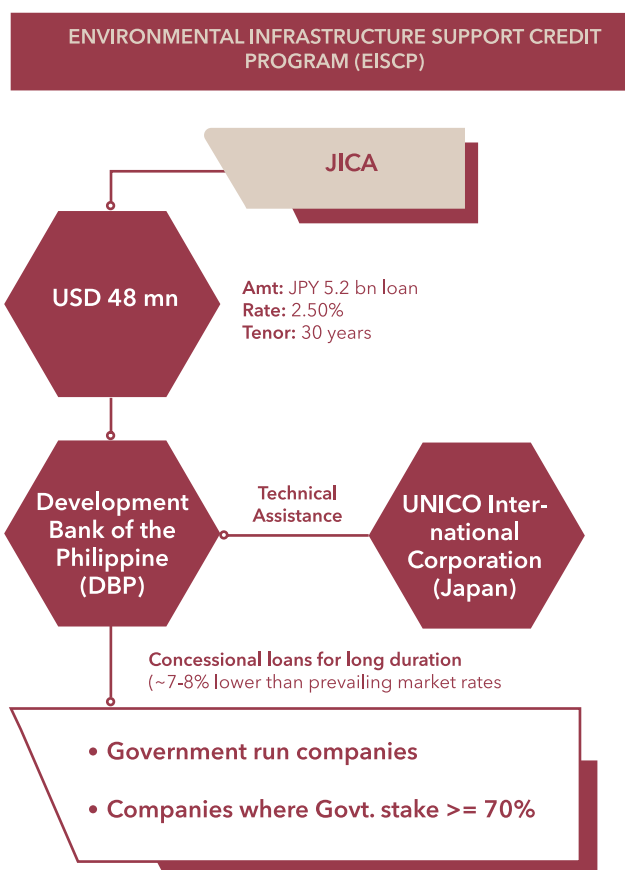
C. Case study - Environmental Infrastructure Support Credit Program, Philippines³³

The quality of air and water has degraded significantly in Philippines, especially in the Metropolitan Manila areas due to the growing population and increase in economic activities. It was estimated that approximately 40% of the total pollution is emitted from industries in the region. As a result, industries needed to adopt pollution control interventions on an urgent basis.

Development Bank of Philippines (DBP) thus initiated a program to support industries in the efficient disposal of gas emissions, wastewater, solid waste, along with efficient management of production processes. DBP provides credit to industries as environmental investment, to ensure improvements in quality of environment near the industries and the efficient use of resources.

The programme managed by the DBP is funded by the Japan International Cooperation Agency (JICA) at a cheaper cost (2.5% interest rate) over 30 years. There is also a provision of technical assistance to the bank to manage the loan disbursement process which was provided by the UNICO International Corporation (Japan).

It was observed that 11 out of the 13 companies that received concession loan from DBP were able to reduce their emission levels significantly due to installation of pollution control technologies. Also, the majority of the local residents near the industries stated that they experienced an improvement in the air quality post adoption of measures by industries due to funding support.



³²California Pollution Control Financing Authority, 2019 (link)

³³Environmental Infrastructure Support Credit Program, Philippines (link)

An overall summary of the above mentioned interventions across policy, ecosystem, and financing intervention is highlighted in the table below:

Table 19: Summary of 3 key global financing facilities

FINANCING FACILITY	POLICY INTERVENTION	ECOSYSTEM INTERVENTION	FINANCING INTERVENTION
<p>World Bank - Innovative Financing for Air Pollution Control in Jing-Jin-Ji (JJJ) Project</p>	<ul style="list-style-type: none"> Adopting Program for Result instrument with the provision of incentives on result-based emission reduction targets in the areas of - Renewable Energy, Energy Efficiency and End of Pipe measures 	<ul style="list-style-type: none"> Encouraging the local and developmental banks to deploy innovative financial products. Setting up internal green lending procedures for loan originating, risk assessment and appraisal for HXB institution. Facilitating the lending options to MSME units. 	<ul style="list-style-type: none"> Scaling up green financing and leveraging the IBRD Funds. Implementing innovative financing product which includes: <ul style="list-style-type: none"> A. Project based lending where loan is collateralised by cash flow from energy cost savings and revenue from RE generation. B. Securitization of project assets. C. Aggregation of small-scale projects to increase loan size. D. Issuance of Green bonds
<p>California Pollution Control Financing Authority</p>	<ul style="list-style-type: none"> Tax exempted Pollution Control Revenue Bonds (PCRB) issued by State and local Government with lower interest costs 	<ul style="list-style-type: none"> Small Business Assistance Programme Small business Assistance fund is created from the fee received by issuance of bonds to large borrowers (500+ employees). The fund is utilized to support financing to small units and also waive off any fees related to costs of bond issuance or credit enhancement applicable to such small entities 	<p>Models for structuring PCRB:</p> <ul style="list-style-type: none"> Balance sheet Financing: With strong balance sheet, no requirement for collateral security and possibility for 100% project cost financing. Letter of Credit: For third party credit enhancement-useful mainly for small and start up business enterprises. Project financing: Pledging the project assets and revenues as sole security for bonds; The maximum interest rate on bond is 12% with a repayment period of maximum 50 years
<p>Environmental Infrastructure Support Credit Programme , Philippines</p>		<ul style="list-style-type: none"> Collaboration with industry bodies to stimulate need for environmental investment within SMEs. Capacity building of staffs of the companies 	<p>Financing offered: 80% of project cost Interest rate: 11% (fixed) Tenor: 3-15 years (max 5 year moratorium) <ul style="list-style-type: none"> Preferential terms required for SMEs (8.6% of funds allocated to SME's) </p>

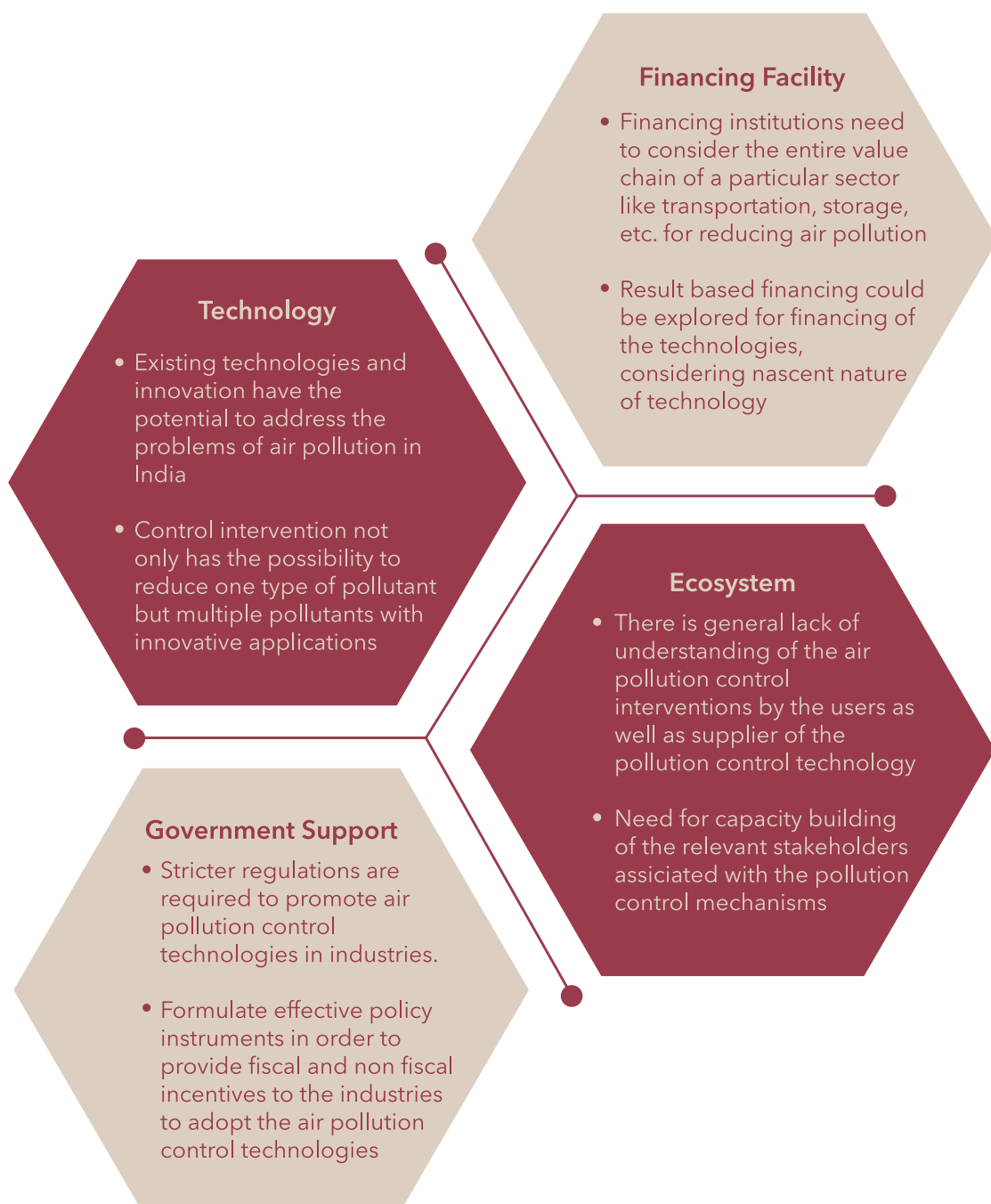
5. Key findings:

Intellect reached out to more than 70 stakeholders for consultation and inputs. About 28 consultations were done over phone as well as in-person meetings. Furthermore, an advisory committee was constituted, and a workshop was organized on 9th of October 2019 in New Delhi where experts across stakeholder groups were invited to validate the findings of study.

5.1 Perspective of enterprises

- Financing the working capital requirements for air pollution control technology suppliers is a challenge; banks do not lend easily to new innovations without a proof of concept and proven revenues
- Regulations need to evolve and be more stringent to increase the rate of adoption of air pollution control technologies by different sectors and sub sectors

In brief, the enterprises have highlighted the important features of technology, financing facilities, government support and ecosystem requirements for scaling up the air pollution control technologies in India.



5.2 Perspective of consumers - industry and industry associations

- Effective utilization of biomass waste to generate power can be effective in reducing air pollution. However, the cost of generation of power from biomass is high. Hence, necessary measures and incentive structures are required to make the power generated from such resources price-wise competitive and viable.

- There is a lack of granular data on the share of different sources across pollutant levels and the impact of air pollution on the environment. Appropriate structure to measure and monitor air pollution levels across its constituent sources is key to monitor progress on the mitigation measures

- It is difficult to quantify the actual impact of various pollution control technologies due to the following reasons:

A. Many sectors are interconnected. The intervention of technology can have an impact on multiple sectors

B. Technology may control a specific pollutant but may not ensure control of other major pollutants from the same source

C. The impact of the control technology would vary from place to place, with variations in the pollution concentration over the different geographical locations

- Sectors are interconnected and hence focusing on the negative impact created by specific pollutants might be a good idea. Accordingly, the necessary interventions can be adopted to reduce the respective pollutant

- Enabling ecosystem like capacity building of industry professionals with regards to the technical know-how of air pollution control technologies can play a very important role in a greater adoption of air pollution control technologies. In addition, the formulation of conducive policies and regulatory framework by the Government can support in scaling up the adoption of pollution control interventions

5.3 Perspective of financial institutions

- There is no "one size fits all" solution to air pollution. Different geographies require different interventions

- Focusing on the outcome is a better way to look at the situation rather than evaluating the technology alone

- Air pollution control interventions/ technologies have not been able to attract significant investment in the past

- Financial intermediaries with requisite expertise as well as focus are needed to promote uptake of air pollution control interventions

- FIs focussing on financing energy efficiency projects can

extend lending to other air pollution control interventions as well

- The facility should be designed keeping non-linear shifts in mind. For instance, the potential role of nuclear energy should be an important consideration while identifying focus area of control pollution control intervention

- Institutions like 'Go Massive' are open to investing in a Pollution Service Company which can further invest money in various air pollution control interventions provided such investments make economic sense

- Grants based facility may not be a good idea as the quantum of funds required for addressing the issue cannot be met through grant alone

- Debt may not be a viable proposition for a new technology / idea

5.4 Perspective of technical and research

- The focus of the financing facility should be on financing broader solution-oriented interventions rather than on individual technologies

- It is essential to look at areas where the Government is not financing and at sectors which need heavy capital expenditure

- Capacity building of relevant stakeholders associated with the implementation of air pollution control measures is essential; in order to achieve the time bound targets as formulated in the NCAP plan. It is necessary to build up human resources with appropriate technical expertise and establish air quality measurement sensors on ground in order to mitigate air pollution

- Impact on health should also be considered while prioritising focus areas in financing control interventions

- Availability of data is a challenge. Investments are needed to ensure effective monitoring of data as no intervention can be effectively designed without reliable information

- Investments are required in 2 key areas- (a) for the deployment of technologies that are viable and have a proven track record, and (b) supporting those that are relatively new or in the development stage

- Investment amount in air pollution control interventions should cover knowledge generation costs along with the technology cost as well. For example, in the case of waste management facilities, merely establishing the waste management technology will not serve the purpose, unless it is being promptly sensitised among the citizens about the importance of the interventions. This will encourage the citizens to discharge their individual responsibilities in executing proper waste segregation at source

- Pollutant offenders should be penalised, and the money should be further invested in pollution control interventions

5.5 Perspective of Government agencies

- No specific sectors have been prioritised for air pollution control interventions so far

- NCAP budget of INR 300 crore has been allocated for facilitating, implementing and monitoring pollution control activities at a national and regional scale. The Gol in its recent union budget has allocated INR 4600 crore for the financial year 2020-21 to combat air pollution in India ³⁴

- Key areas which can be considered for financing include waste management, public transportation, industries; in addition, the focus should also be on educating the industry professionals through capacity building programme about the quantum of air pollution being released, their effects and the possible mitigating actions essential to control the pollution level within the standard limits and regulations

- Possibility of leveraging existing financing facilities like PFC, IREDA, SIDBI etc. should be explored to expedite air pollution control financing

- The secondary research information and the stakeholder consultation inputs formed the basis of preparing a roadmap for financing air pollution control interventions

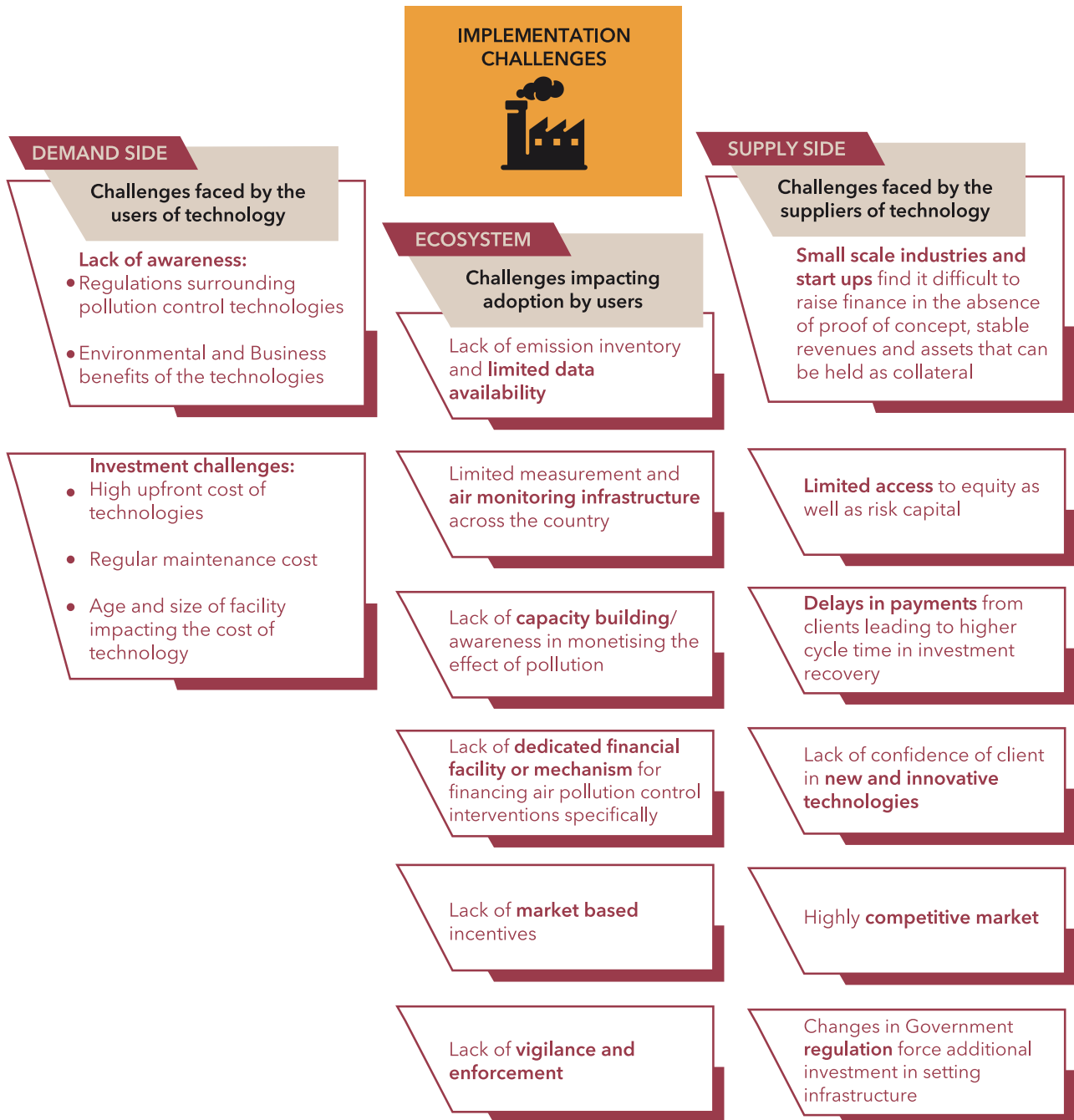


Image source: <https://www.teriin.org/project/developing-strategies-control-air-pollution-india-and-its-cities>

³⁴Union Budget 2020-21 promises Rs 4,400 cr for clean air; how, where and how soon?, Down to Earthz

6. Key challenges in financing and large-scale adoption of air pollution control technologies

There are several factors that constraint the deployment of air pollution control technologies at a large scale in India. The factors are related to the challenges faced by the user of the control technologies, suppliers of the control technologies and the eco system challenges impacting the adoption of the technologies. A snapshot of these challenges is highlighted below. Subsequently challenges across the stakeholders are captured in this section.



6.1 Demand side challenges

This section captures challenges faced by enterprises and consumers who need to adopt interventions to mitigate

air pollution. There are three major challenges that are faced by these stakeholders (a) lack of awareness, (b) huge capital requirement for deploying air pollution control interventions, and (c) long payment cycle.

6.1.1 Lack of awareness

Consumers typically industries have limited information on key pollutants and emission levels to effectively identify and deploy the right pollution control technologies. Small scale industries are many times not even aware of regulations surrounding control of air pollution. Additionally, many enterprises do not recognize air pollution as a development issue or understand the gravity of the problem, and consequently do not integrate their development policies to include initiatives for reduction of air pollution.

For instance, MSMEs continue to rely on outdated technologies due to their limited awareness of energy efficiency measures. Incorporation and adoption of energy efficient technologies can not only improve their profitability but also result in a substantial reduction in their air pollution emission levels.

6.1.2 High cost of investment

Cost of retrofitting existing technologies or deploying new technologies altogether for pollution control is currently high. This acts as a deterrent in most cases, especially when there is no economic benefit to be derived from such investment or when stakeholders fail to perceive its value.

Even in case where organisations decide to make such investments, mobilization of funds becomes an issue.³⁵ Not many banks or financial institutions currently offer loans for such interventions unless it is a part of a larger requirement. Hence, access to low cost credit for investment in requisite technology is also a key challenge.

6.1.3 Long payment cycle

Technology suppliers face significant delays in receiving payment from clients. This leads to the longer working capital cycle and also increases their cost of capital.

6.2 Supply Side Challenges

6.2.1 Limited provision of credit to start-ups for innovative technologies

Financial institutions do not provide credit in absence of proof of concept, stable revenues, and sizable collateral. The institutions are often reluctant to shift from the traditional asset-based financing to future cash-flow-based financing. Access to equity capital is also limited and costly and hence not suitable for meeting short term working capital needs.

6.2.2 Lack of continuous revenue stream for new and innovative technologies

Innovative technology providers often struggle to show continuous revenue as they could not convince clients about the reliability and effectiveness of the technology. Unless the technologies are proven on the ground through pilot projects or certified by the government, financial institutions often refrain from investing in the technology.

6.2.3 High competition for established technologies

The manufacturers and suppliers of established technologies have to face severe market competition while supplying their technology to various sectors. The reasons includes non availability of raw materials at competitive cost, lack of bulk demands preventing them from taking the benefits of economy of scale and others.

6.2.4 Lack of Government regulations and support

Government regulations on air pollution and control interventions are still evolving in India and keep changing frequently. This necessitates additional investments in setting up infrastructure for manufacturing new and updated technology interventions. As such, it entails a significant financial risk for technology suppliers. For example, the BSIV emission norms vehicles were introduced in India in the year 2017. However, the enforcement of BS-VI emissions norms for the automotive vehicles from April 2020 across the country and bypassing the BS-V emission norms necessarily entails huge financial investments on R&D and manufacturing set-up. This also involves financial risk of the uncertainty in the sale of the remaining BS-IV norm vehicles already in stock with the companies.

6.3 Ecosystem challenges

An enabling ecosystem that not only reinforces the criticality of making air pollution control interventions, but also facilitates such investments is extremely crucial for scaling such interventions. Following ecosystem level challenges have been the key impediments to the growth of air pollution control investments;

6.3.1 Lack of emission inventory and limited data availability

Source apportionment studies are a direct means to understand the changing contribution of various polluting sources. They also provide critical information relating to change in air quality management plans as per the incremental growth of the cities.

The prioritization of the mitigating actions to improve air quality accordingly requires reliable information on the contribution of various sources to air pollution. Some source apportionment studies have been carried out by the World Bank and TERI in coordination with CPCB but these studies are limited in coverage as they cover large cities only. For other regions, data is available only from modelling tools which have their own limitation in terms of model assumptions, data conversion and analysis.

There are more than 53 cities in India with a population of over a million where the air quality has been deteriorating continuously, and hence source apportionment studies are essential. Lack of such studies is a major

³⁵ Measures to Control Air Pollution in Urban Centres of India: Policy and Institutional framework, 2018, The Energy and Resource Institute (Link)

challenge in designing suitable interventions and taking decisive actions for mitigating air pollution in India.

6.3.2 Limited measurement and monitoring infrastructure

The air quality monitoring network in India is not adequate to provide required information on contribution of different sources to air pollution. There are about 703 manual monitoring stations in India catering to 307 cities. Further, there are only 134 continuous ambient air quality monitoring stations (CAAQMS) installed in 71 cities. These numbers are quite meagre considering the scale of the nation.

It is important to note that rural areas also contribute to pollution through PM emissions from open burning etc. There are more than 605 Indian cities which have a population of over 50,000, necessitating the installing of an estimated 3300 monitoring stations to cover all such areas.

6.3.3 Gaps in vigilance and enforcement

CPCB has set standards for permissible emission of different pollutants for different categories of industries. However, these limits are not effectively enforced by concerned officials due to various reasons such as lack of time and capacity. Further, there is very limited third-party audit of the emission levels from various industries.

6.3.4 Lack of market-based incentives

The adoption of air pollution control interventions imposes a cost burden on the stakeholders in the respective sectors and segments. The investments carry limited or nil financial returns. Hence, certain market-based mechanisms such as financial gains through the trading of emission reduction certificates are required to incentivise adoption.

The absence of such a market mechanism in India implies that adoption rates will be driven solely by fear of stringent action from the regulators, which is also

absent due to enforcement gaps as described previously.

While the Emission Trading Scheme (ETS) has been started in India on a pilot basis, it is currently limited to only 3 states- Gujarat, Maharashtra and Tamil Nadu.

6.3.5 Lack of dedicated financing facility or mechanism

Unlike in the case of renewable energy or energy efficiency, there is a lack of suitable financing scheme / facility to promote the adoption of pollution control interventions in India. The absence of such scheme / modality has created a signaling effect and pushed air pollution control action plans and policies to low priority area for most stakeholders, besides impacting offtake from willing adopters as they are unable to mobilize the required funds for investment.

6.3.6 Limited public-private partnership models

There are limited public-private partnership models in specific sectors contributing to air pollution control interventions. This poses a significant implementation challenge in India. For example, waste-to-energy options (with proper pollution controls) need to be explored on the public-private partnership model for an effective implementation and its viability.³⁶

6.3.7 Limited awareness of the need for control interventions

The level of awareness among citizens in the country on issues pertaining to air pollution is very limited in India. Hence, the need for targets and policies to achieve desired outcomes in a time bound manner is often not appreciated. Unless victims understand the core issues and its impact, any intervention such as effective vigilance by implementation authorities is unlikely to be sustainable.

Simultaneously, there is also a lack of awareness amongst the implementing agencies on areas such as the latest technologies, their applicability and suitability, etc.

³⁶Creating an enabling environment for public private partnership in waste to energy projects, ADB , 2018 (link)

7. Enabling ecosystem for financing air pollution control technologies

An enabling ecosystem is imperative for the uptake of the air pollution control technology in India on a larger scale. Given the systemic challenges described

previously, it is critical to develop the required ecosystem for air pollution control interventions to scale. A few key suggestions and a road-map for executing the same in the Indian context have been presented below, basis learnings from similar interventions in other areas;

7.1 Key stakeholders

There are 6 key stakeholder groups that need to be mobilized or partnered with for financing of air pollution control technologies ecosystem. A brief snapshot of these stakeholders, as well as their high-level roles are mentioned below.



7.2 Existing roles and responsibilities of ecosystem players

The table below captures more specific details on assigned

roles and responsibilities of the various implementing agencies and relevant Ministries as laid out in the National Clean Air Programme (NCAP). It clearly underscores the importance of inter-ministerial coordination as well as between Government bodies to achieve the set targets.

SR NO.	SEGMENTS	LIST OF ACTION POINTS	CITY SPECIFIC	IMPLEMENTING AGENCY
	Air monitoring	Web based system for AQI monitoring	No	CPCB
		Adequate manpower for strengthening, monitoring and inspection	Yes	CPCB
		Enhance installation of manual monitoring stations from 703 stations to 1500 stations	Yes	CPCB, SPCB's
		Identification of alternative technology for real time monitoring	Yes	CPCB, SPCB's
		Setting up 100 monitoring stations in the rural areas	Yes	CPCB, SPCB's
		Augment the number of monitoring stations for PM2.5	Yes	CPCB, SPCB's
		Satellite based measurements	Yes	CPCB, SPCB's, ISRO
		Adopt 3rd party audits for polluting industries	Yes	MoEFCC , CPCB
	Planning	Preliminary city action plans to be formulated for 102 non-attainment cities	Yes	CPCB, SPCB's
		City Level review committee in districts	Yes	DM
		Involvement of technical institutions for implementation of plans	Yes	MoEFCC
		Formulation of a comprehensive transboundary plan	No	MoEFCC
		Formulate plan for use of Smart Cities framework to launch NCAP in the 43 smart cities falling in the list of 122 non-attainment cities	Yes	MoHUA
	Research Studies	Evaluate socio-economic feasibility for implementation of ex situ options like production of Prali-char, bio char, pellets, briquettes, bio cng, bio ethanol	No	MoEFCC
		Innovative end of pipe control technologies	Yes	MoEFCC , CPCB
		Source apportionment studies extended to all 122 non-attainment cities	Yes	MoEFCC , CPCB
	Capacity Building	Carry out capacity building initiatives for Krishi Vigyan Kendra	No	MoA
		Promotion of Clean technology	Yes	MoEFCC
		Capacity building of stake holders	Yes	CPCB

	Financing Facility	Specific allocation for creating a venture capital fund	No	MoP, DHI
	Green drives	Plantation initiatives at pollution hot/spot in cities/towns being managed by CAMPA fund	Yes	MoEFCC
		Greening and landscaping of major arterial roads and national highways	Yes	Municipal Corporation
	Industries	Explore possibility of fly ash utilization	No	MoEFCC
		Stringent compliance by Thermal power plants	No	MoP
		Phasing out older power plants	Yes	MoP
		Improved power reliability in urban areas to eliminate the DG set operations	Yes	MoP
		Elimination of DG sets from industries	No	MoP, Discoms
		Expansion of Renewable Power	Yes	MoP/MNRE
		Optimal utilisation of existing power plants and prioritising the clean fuel power production	No	MoP/MoPNG
		Stricter enforcement of standards in large industries through continuous monitoring	No	SPCB, CPCB
	Transportation	Formulate national, state , city action plan for e mobility	Yes	MoP, DHI, MoEFCC
		Rapid augmentation of charging infrastructure	Yes	MoP, DHI
		Central Government fleet older than 15 years to shift to E-Vehicles	No	MoP, DHI
		Govt run public transport, private buses and 3 wheelers to convert to EV's	Yes	MoP, DHI
		Transition of 2 wheeler to E-mobility	Yes	MoP, DHI
		Invest in R&D for BESS	No	MoP, DHI
		Scaling up CNG in 2 wheeler	Yes	MoPNG
		Scaling up of R&D on use of Hydrogen as transport fuel	Yes	MoPNG
		Extend PMUY in 122 cities, towns, and associated village areas	Yes	MoPNG
		Stringent implementation of BS-VI norms	Yes	MoRTH
		City action plans to review the extension of MRT in cities/towns	Yes	MoRTH
		Strict inspection and maintenance system for vehicles	Yes	MoRTH
		Stringent implementation of PUC Certificate	Yes	MoRTH
	Fleet modernization and retro fitment programme for vehicles	Yes	MoRTH	

		Wall to wall paving of roads	Yes	Municipal Corporation
		STP water sprinkling along roads twice before peak hours	Yes	Municipal Corporation
		Reduce emission by congestion management	No	MoRTH
	Waste Management	Disposal of collected dust from mechanical sweeping	Yes	CPCB
		Promote technologies to convert waste/plastic to use them as fuel under National Biofuel Policy	Yes	MNRE
		Transform the centralized waste disposal infrastructure to a sustainable decentralized system in 122 cities	Yes	MoHUA
		Introducing mechanical sweepers in cities	Yes	Municipal Corporation
		Stringent control of dust from construction activities using enclosures etc	Yes	Municipal Corporation
		Source Segregation of waste into dry and wet	Yes	Municipal Corporation
		Capacity building of municipalities and RWA	Yes	Municipal Corporation
		Formulation of city specific plan for integrated solid waste management strategy, including targeting waste prevention, recycling, composting, energy recovery, treatment, and disposal	Yes	Municipal Corporation
		Stringent implementation of integrated waste management plan in cities	Yes	Municipal Corporation
		Waste reduction Schemes such as composting, bio methanation, RDF plants etc	Yes	Municipal Corporation
		Construction of a decentralized composting plant, bio methanisation plant and C&D waste plant	Yes	Municipal Corporation
		Deployment of fixed compactor and doing away with dhalaos	Yes	Municipal Corporation
		Stringent implementation and monitoring for extended producer responsibility for e-waste and plastic waste	Yes	Municipal Corporation
	Agriculture	Implement plan for management of agricultural emission	No	MoEFCC , CPCB
		Enhanced LPG Penetration, agricultural burning control and management	No	Municipal Corporation

It is not possible for the Government alone to cope up with the responsibility of the pollution control in India. It needs to be carried out through collective support of

relevant stakeholders. The table below describes the key roles and responsibilities of such stakeholders in relation to pollution control interventions.

Table 20: Roles and responsibilities of key stakeholders

STAKE HOLDER	ROLES AND RESPONSIBILITIES
NGOs / CSOs (SSEF, TERI, CSE, Awaaz Foundation etc.)	<ul style="list-style-type: none"> • NGO plays a vital role in conservation of natural resources and environmental protection • Supports the Government in bridging the gaps by conducting research to facilitate policy development, building institutional capacities and creating awareness among the citizens regarding air pollution control measures and affects
Industry associations (FICCI, CII, SIAM, ASSOCHAM, PCIA etc)	<ul style="list-style-type: none"> • Represents and articulates the views and concerns of industries and business entities in India • Engages extensively with the policy makers and the civil society and have significant influence over the formulation of policies/regulations concerning the industrial pollution • Educates and build the capacities of the industries in adopting pollution control interventions through networking platform and consensus building within and across the sectors
Technical Research Institutions (ARAI, IIT's, NIT's, BAARC, CSIR, JNU etc)	<ul style="list-style-type: none"> • Carries out research and development on pollution control technology and solutions • Prepares road map and schemes for pollution abatement in cities and states of India
Advisory Research institutions (Intellectap, CSTEP, CEEW etc)	<ul style="list-style-type: none"> • Investigates market size and investment strategies for financing air pollution control interventions • Provides advisory support in designing alternative financing facilities and enabling ecosystems for implementation of air pollution control interventions at scale
Bilateral / Multilateral development organizations (World Bank, IFC, UNIDO, GIZ etc)	<ul style="list-style-type: none"> • Provide financing support in the form of interest subsidy, line of credit, technical assistance grants, etc to accelerate the uptake of air pollution control technologies and solutions

7.3 Envisaged responsibilities of key ecosystem players

7.3.1 Regular monitoring of air pollution levels

The existing air monitoring system needs to be improved not only in terms of quantity but also in terms of quality. Understanding the flow dynamics of pollutants at a regional level becomes important to take appropriate action and this requires setting up of additional monitoring stations in urban as well as rural areas. For e.g., burning of agriculture waste in the northern

states of Punjab, Haryana, and Uttar Pradesh not only affects the pollution concentration in those states but also has a severe effect on adjoining cities like Delhi.

Similarly, there is need to increase the installation of continuous ambient air quality monitoring stations (CAAQMS) in India which can capture air pollution dynamics on a real time basis and assist in taking decisive actions by the relevant stakeholders.

In order to set up the required monitoring infrastructure, the envisaged roles and responsibilities of different stakeholders are summarised in the following table:

STAKE HOLDER	ROLES AND RESPONSIBILITIES
MoEFCC	<ul style="list-style-type: none"> • Grants: Provide funding in form of grant allocation to states for purchase and installation of manual air monitoring stations as well as continuous ambient air quality monitoring stations • Feedback: Take regular feedback from CPCB and SPCBs regarding the progress of installation
CPCB and SPCB	<ul style="list-style-type: none"> • Installation: Overall responsibility for installation of the air monitoring stations at city level • Feedback: Regular monitoring of the installed units and feedback on their operation
NGOs / NPOs (SSEF)	<ul style="list-style-type: none"> • Software: Provide support in soft-ware and network management of the monitoring stations along with cloud spacing
Municipality	<ul style="list-style-type: none"> • Taxes: Levy additional taxes/cess from the citizens to maintain and operate the installed monitoring stations on an ongoing basis
Industries	<ul style="list-style-type: none"> • Responsible for installing the air pollution monitoring sensors and stations inside the industries and connect to the server of CPCB for real time monitoring • Provides funding for installation of air monitoring stations through CSR and CER funds
DFIs (World Bank, ADB, etc.)	<ul style="list-style-type: none"> • Subsidy: Provide capital subsidy / soft loans for installation of air quality monitoring stations

7.3.2 Commissioning of source apportionment studies

As mentioned in the previous section, source apportionment studies are essential to identify the various sources contributing to air pollution. Such studies help in improving air quality management plans as per the growth patterns of a city / region. It is important to carry out such studies on a regular basis across all cities with a population of more than a million. The funding for such studies can come from corporates through the CSR and CER activity route. Premier research institutes in India such as IITs, NITs, etc can be specially identified to conduct such studies under the supervision of MoEFCC and CPCB.

It is also envisaged that air modelling studies and analytics need to be carried out for understanding the current and future air quality. There is presently no database on emissions at the national or regional level.³⁰ In this context, national scale inventories developed by TERI for current and future years based on energy and emission models³⁷ can be further refined for developing a national level database on emissions. A brief snapshot of the indicative roles and responsibilities for conducting source apportionment studies is presented here:

³⁷Sharma and Kumar 2016

STAKE HOLDER	ROLES AND RESPONSIBILITIES
MoEFCC and CPCB/ SPCB	<ul style="list-style-type: none"> Supervise source apportionment studies
Research institutes	<ul style="list-style-type: none"> Conduct these studies and maintain a database of pollutant emission on regional and national scale in the Government portal Government Research Institutes like IIT's and NIT's can be mandated to manage and maintain the emission inventory. Such inventory may be shared in the public domain to facilitate various research activities in India
Industries	<ul style="list-style-type: none"> Provide funding for the studies through their CER and CSR funds

7.3.3 Capacity building initiatives for Government organizations

Lack of skilled and adequate manpower and infrastructure in CPCB and SPCB has been one of the major bottle necks in the air pollution control interventions. Hence, there is a strong need for building the capacity of these boards

in areas such as technology and data management.

Regular training and workshop on latest technologies and lessons from a global context should be imparted to relevant stakeholders. In this context, the envisaged roles and responsibilities of relevant stakeholders are described below:

STAKE HOLDER	ROLES AND RESPONSIBILITIES
Government Bodies	<ul style="list-style-type: none"> Funding capacity building of implementing agencies Trainings of CPCB and SPCB officials on technology advancements such as web-based monitoring systems and data management
NGOs	<ul style="list-style-type: none"> Supports in strengthening the institutional capacities through workshops, demonstrations, training programme and knowledge exchange programme through national and international engagements Disseminate information to the general public for better awareness on Government plans and targets for mitigating air pollution
Industries	<ul style="list-style-type: none"> Build capacity of in-house staff in terms of efficient process management and updated technology know how to reduce the air pollutant emission For example, the Environment Monitoring Group in NTPC Ltd etc ensures in meeting the standard environmental norms through regular meetings, workshops, training programs of the professionals associated with the power plant operational activities

Financial institutions

- **Training** relevant staff on evaluating funding proposals for air pollution control investments through necessary information on investment outlays and effectiveness of alternate technologies in each sector / segment

7.3.4 Implement and support market based mechanism

Market-based mechanisms such as the emission trading scheme play a vital role in encouraging industries and other sectors in adopting pollution control interventions promptly. The Emission Trading Scheme (ETS) is being currently implemented in three states namely Maharashtra, Gujarat and Tamil Nadu on a pilot basis. It is analogous

to the PAT scheme of Energy Efficiency. Accordingly, a cap on emissions can be assigned for a region and allocated to each of the contributing industrial units in the region. The flue-gas stacks can be continuously monitored, and overachieving performers can trade emission credits with those who find it difficult to achieve those targets.

In order to accomplish the same, the envisaged roles and responsibilities of the relevant stakeholders are mentioned below:

STAKE HOLDER	ROLES AND RESPONSIBILITIES
MoEFCC	<ul style="list-style-type: none"> • Prepare policy document for the ETS scheme • Institute an emission control division under its umbrella to administer the scheme. The setup may be similar to BEE under MoP in connection with the PAT Scheme
Bureau of Emission Control (BEC) (hypothetical name for the envisaged body recommended to be set up)	<ul style="list-style-type: none"> • Act as the central nodal agency for the scheme • Provide certification courses related to environmental audit • Provide emission trading certificates to the designated units
CPCB	<ul style="list-style-type: none"> • Act as the central regulator to identify designated consumers across the country in coordination with SPCBs
State Pollution Control Board (SPCB)	<ul style="list-style-type: none"> • Act as state regulator and also adjudicator to resolve any issues
Empaneled Accredited Environment Auditors	<ul style="list-style-type: none"> • Verify the baseline emission levels; report actual achievement against set targets
CPCB, SPCB, Regional MoEFCC	<ul style="list-style-type: none"> • Act as trading regulator and facilitates the Registry procedure of the industries in the trading scheme
Power exchange- IEX, NCDC	<ul style="list-style-type: none"> • Operate and maintain the trading platform at a national level

Overview of Emission Trading mechanism



7.3.5 Vigilance and enforcement

In order to enforce the pollution standards norms effectively, there is a stronger need to carry out pollution audit of industries regularly. Such audits can be carried out

by third parties and strengthened by involving institutes of the highest reputation and capacity through accreditation. They can also recommend measures for continuous improvement.

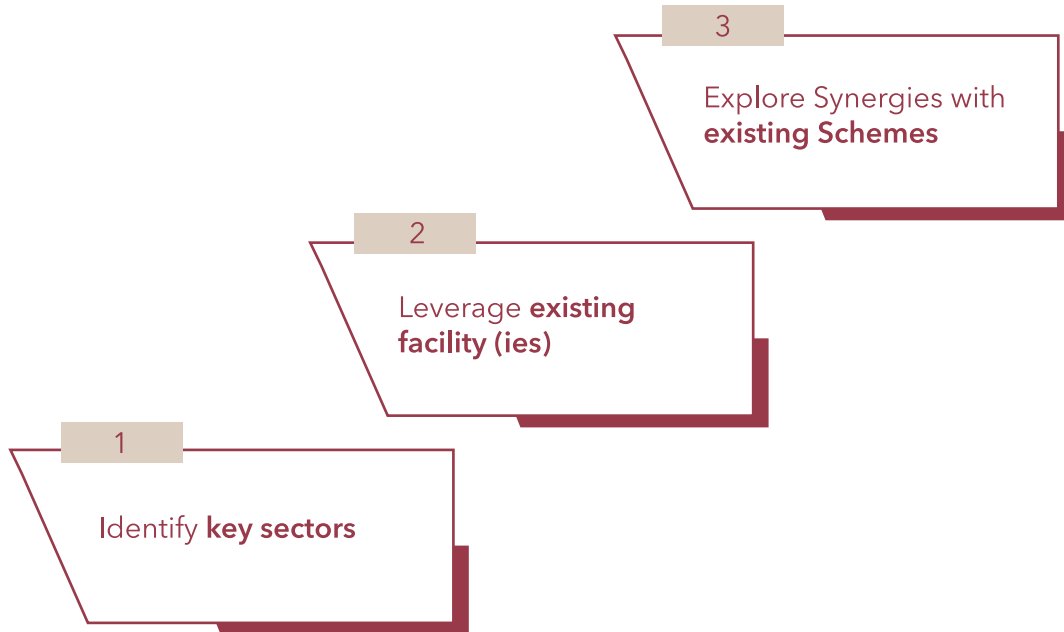
8. Roadmap for air pollution control financing in India

There were three key considerations while developing an effective roadmap for financing of

air pollution control solutions in India. These are:

- Understand key sectors that need focus based on the potential impact on overall pollution levels;
- Leverage existing financing facilities to finance air pollution control interventions;
- Explore interlinkages between Government Schemes and infrastructures such as Swachh Bharat Mission, Smart City Financing, Municipal Financing etc.

Figure 19: Schematic road map for air pollution control financing



8.1 Identification of key sectors

A tentative matrix of priority sectors which contribute most to air pollution has been designed initially. This can serve as areas of primary focus for the financing facility. Our

research demonstrates that 3 industrial segments- Thermal power, Iron and Steel, and Cement contribute nearly 96% of SOX, 71% of NOX, and ~10% of PM emissions.³⁸ Accordingly, these segments should constitute primary areas of focus for the facility initially.

Table 21: Primary focus sectors for air pollution control financing

SECTOR	SUB SECTORS	CONTRIBUTION TO POLLUTANTS	REASON WHY TO FOCUS	KEY CONCERNS
Industrial	<ul style="list-style-type: none"> • Thermal power • Iron and Steel • Cement 	<ul style="list-style-type: none"> • SOX: 96% • NOX: 71% • PM10:13% • PM2.5: 9.62% 	<ul style="list-style-type: none"> • Significant majority of SOx and NOx emissions come from these industries • These entities have stronger balance sheets due to which they are likely to be in a better position to absorb the investment; increased investor comfort implies quicker implementation • Pan India presence of thermal power plants, cement industries and iron & steel units implies that pollution control intervention in these sectors can impact many parts of India and not be limited to certain specific locations 	<p>There is a necessity to incorporate an upper limit to the ticket size in order to restrict the financing of only fewer large entities. Financing few segments and few firms within those segments may increase the portfolio concentration risk especially when some of these segments are highly cyclical</p>

³⁸ Air Pollutant Emission Scenario in India , TERI z ; Gains Software Analysis

It is pertinent to mention that the above industries namely thermal power plants, iron and steel, cement industries are also the focal point of attention under the PAT Scheme implemented by the Bureau of Energy Efficiency (BEE) for the cycles I, II, III and IV. However, the PAT scheme focuses on energy consumption of such energy intensive industries and does not directly target the air pollutant emissions by such industries. Hence, the PAT scheme should be implemented in conjunction with the implementation of other direct

air pollution control interventions for maximum effect. Such control interventions would essentially require innovative financing instruments and mechanisms for implementation at scale.

Secondary Focus: The financing facility can also look at the below segments on case to case basis while these may not be the primary areas of focus. They comprise of the industrial sector (mainly the red category industries) and the agriculture sector.

Table 22: Secondary focussed Sectors for air pollution control financing

SECTOR	SUB SECTORS	CONTRIBUTION TO POLLUTANTS	REASON WHY TO FOCUS	KEY CONCERNS
Industrial (large scale and MSME)	<ul style="list-style-type: none"> Aluminium Sugar Fermentation Sulphuric acid Petro chemical Petroleum Refinery Tanneries Fertilizer Zinc smelter Dye Pesticides Basic drugs Pulp & Paper Copper Smelter 	Significant contribution to PM10 & PM2.5 emissions	<ul style="list-style-type: none"> Some of these are red category industries and are closely monitored by the Pollution Control Board. They contribute to pollution levels significantly in a localized area often attracting agitation and strikes Various penalties have been imposed on these industries by CPCB for non-compliance of pollution norms; they need financing support for compliance Investments make economic sense as they can avoid loss due to strikes and external fringes and pollution control norms Financing a larger pool of industries may decrease the portfolio risk 	<p>MSME Sectors:</p> <ul style="list-style-type: none"> Some of the entities in these sub-sectors are smaller and may lack strong balance sheet, collateral, and / or ability to absorb a commercial debt. Significant subvention may be required to finance this segment Cost of acquiring and servicing entities will be high due to large no. of small beneficiaries and varying attributes of each sub-sector <p>Large Scale Industries:</p> <ul style="list-style-type: none"> These sectors are not as concentrated, so sourcing of leads for financing and servicing will likely be more costly. Concise data stating the share of air pollutants by such specific industries is not available. Anecdotal data suggests that the overall contribution of such sectors towards air pollution is not as high, so the overall impact will be lower.
Agriculture	<ul style="list-style-type: none"> Agriwaste 	<ul style="list-style-type: none"> PM10: 8.0% PM2.5: 8.6% 	<ul style="list-style-type: none"> Creates positive impact on dual sectors i.e. prevention of agri waste burning and reducing the emission from thermal power plants by blending of waste with the coal and burning in boilers The impact potential seems less on pan India basis, but has a significant seasonal impact in and around localized areas like Delhi 	<ul style="list-style-type: none"> Limited impact in reducing the overall pollution levels on a pan India scale

The below sectors and segments can be looked at from a future perspective but will not be a part of focus initially.

Table 23: Sectors of future focus for air pollution control financing

SECTOR	SUB SECTORS	CONTRIBUTION TO POLLUTANTS	REASON WHY TO FOCUS
Transportation	Automobiles	<ul style="list-style-type: none"> • NOx: 19.5% 	<ul style="list-style-type: none"> • Consumer financing required for increased cost of vehicle due to BS IV to BS VI migration is already available • EV Infra investments can be looked at subsequently when the ecosystem is more conducive
Waste Management	MSW	<ul style="list-style-type: none"> • PM10: 3.7% • PM2.5: 4.7% 	<ul style="list-style-type: none"> • Small ticket size investment • Limited incremental impact
Residential	Clean cooking	<ul style="list-style-type: none"> • PM10: 41.5% • PM2.5: 48.9% 	<ul style="list-style-type: none"> • Small ticket investment (consumer financing); banks and NBFCs best placed to intervene

8.2 Leveraging an existing facility

With air pollution control interventions being considered as a part of existing sectors and facilities, there seems a limited agreement on creating a new financing facility. Hence, leveraging an existing facility has emerged as the most practical option. It is also pertinent to mention that MoEFCC during stakeholder consultation stated that

leveraging an existing financing facility is a good option and should be explored in detail.

Air pollution control technologies/ solutions are already being financed by some of the suggested financing institutions when they form part of the overall project cost. Some examples are as follows:

Table 24: Information on financing facilities to be leveraged for financing air pollution control technology

SECTOR	FINANCIAL INSTITUTIONS
Thermal power plants, Renewable Energy, Energy storage, E-mobility, waste heat recovery, waste management, Energy efficiency	Power Financing Corporation (PFC)
Renewable Energy, Waste to heat, Biomass energy, Biofuels integration	India Renewable Energy Development Agency (IREDA)
Agriculture and Agri waste management	National Bank for Agriculture and Rural Development (NABARD)
MSME projects including Energy efficiency, Emission control technology	Small Industries Development Bank of India (SIDBI)

Discussions were held with some of the above financial institutions in order to explore the possibility of leveraging their existing facility for air pollution control financing. IREDA and PFC have conveyed their in-principle agreement to the idea of housing such a facility within their construct provided necessary clearances and approvals are secured from respective ministries.

8.2.1 Discussion with PFC

PFC is a company registered under erstwhile companies Act 1956 incorporated on 16th July 1986. It is under the administrative control of the Ministry of Power and was conferred the title of Navratna CPSE in June 2007. It is a registered non-banking finance company (NBFC) with the RBI. PFC is the nodal agency for the implementation of programs such as Independent Transmission Projects (ITP), Restructured Accelerated Power Development Reforms

Programme (R-APDRP) Integrated Power Development Scheme (IPDS) and Ultra-Mega Power Projects (UMPP). PFC works closely with the Govt of India, State Governments, power sector utilities, other power sector intermediaries and private sector clients for the implementation of policies and procedural reforms in the power sector.

PFC finances pollution control technologies such as financing Renovation and Modification (R&M) of ESP in thermal power plants (one of the pollution control interventions). However, the interest rate for financing air pollution control technology is the same as that for financing other equipment.

In order to incentivise industries to adopt air pollution control technology/ solutions through interventions such as capital subsidy, interest subvention, partial risk guarantee, etc., through PFC, the following steps will be involved:

STEPS	DESCRIPTION
STEP 1	The estimated investments required by the power plants in installing various pollution control technologies such as FGD's, NSCR, ESP's etc. may be ratified or endorsed by the Central Electricity Authority (CEA)
STEP 2	Proposal with the conceptual framework* and estimated investment details of air pollution control may be submitted to MoEFCC
STEP 3	Assist and support MoEFCC in coordinating with Ministry of Power (MoP) for approval of the proposal
STEP 4	Post sanction/approval of the proposal, MoP would issue guidelines and specific mandate to PFC
STEP 5	-With the mandate PFC would finance the air pollution control interventions as per guideline and relevant scheme charted by MoP

**The framework may be composed of the types of stakeholders involved; their roles and responsibilities, the financial offerings including key financial terms and conditions, targeted industries if any, etc*

8.2.2 Discussion with IREDA

IREDA is a 100% Government of India owned organization under the administrative control of the Ministry of New and Renewable Energy (MNRE)³⁹ and established in the year 1987. It's a public financial institution (PFI) under section 2(72) of the Companies Act, 2013 and is registered as a non-banking financial company (NBFC) with the Reserve Bank of India. It has more than 30 years of experience in financing renewable energy projects.

It has been conferred with the Mini Ratna status in June 2015 by the Dept. of Public Enterprises. Bankers to IREDA include Bank of India, CANARA Bank, HDFC Bank, Yes Bank, Union Bank and Indus Bank Limited.

IREDA has played a strategic role in the Govt's initiatives for the promotion and development of the RE sector in India. It has been involved in devising and implementing various policies and structural and procedural reforms in RE sector in India. The RE projects for

³⁹IREDA (link)

It has been conferred with the Mini Ratna status in June 2015 by the Dept. of Public Enterprises. Bankers to IREDA include Bank of India, CANARA Bank, HDFC Bank, Yes Bank, Union Bank and Indus Bank Limited.

IREDA has played a strategic role in the Gol's initiatives for the promotion and development of the RE sector in India. It has been involved in devising and implementing various policies and structural and procedural reforms in RE sector in India. The RE projects for biomass (up to 10 MW) and small hydro (up to 5 MW) has been refinanced by IREDA through the funds received from National Clean Energy Fund ("NCEF") under the IREDA-NCEF refinancing

scheme. IREDA has also been involved in various Golschemes including the Wind GBI Scheme, the Solar GBI Scheme and the Solar Water Heating System Capital Subsidy Scheme.

IREDA is financing renewable energy including waste to energy and energy efficiency projects which are applicable in large scale industries and MSME units. Hence, they have a large base of beneficiaries across various sectors and sub sectors. At present capacity, IREDA is not mandated to finance the air pollution control technologies and solution across such sectors and subsectors but-zting IREDA to cater to air pollution control financing is mentioned below:

STEPS	DESCRIPTION
STEP 1	Proposal with the conceptual framework*, relevant information and estimated investment details of air pollution control may be submitted to MoEFCC
STEP 2	Assist and support MoEFCC in coordinating with Ministry of New and Renewable Energy (MNRE) for approval of the proposal
STEP 3	After in-principle sanction/approval from MNRE, the guidelines are sent to RBI for confirmation.
STEP 4	After final approval from MNRE and RBI, the IREDA would be mandated to finance the air pollution control technologies.

*The framework may be composed of the types of stakeholders involved; their roles and responsibilities, the financial offerings including key financial terms and conditions, targeted industries if any, etc

The above discussions clearly indicate that there is a high possibility to leverage an existing financing facility, but it needs collaborative multi-sector and multi-state coordination between central ministries, state governments and government agencies.

8.3 Linking/converging with existing schemes

The Government of India has launched various schemes such as Smart City Mission, Swachh Bharat Mission, etc in order to make urban and rural areas sustainable in terms of environment and pollution control. There is significant potential to leverage these alternative schemes which have elements bearing significant impact on air pollution.

Some of these schemes and potential areas of synergy are mentioned here for ready reference.

8.3.1 Smart City Mission

The smart city mission is an innovative programme launched by the Union Ministry of Housing and Urban

Affairs with the target to establish 100 such cities across the country. The mission is being executed in collaboration with the state government and local urban bodies of respective cities. It aims to reduce traffic congestion, mitigate air pollution and boost the local economy in terms of the sustainable environment.⁴⁰

Considering that some of the NCAP action plans match with features of smart city mission, it is essential to find out ways of funding common projects through budget allocated for smart city financing. The augmentation of air monitoring stations and network management, proper waste management as envisaged in the NCAP could be carried out by utilising the smart city funds. Similarly, strengthening of the public transportation system and constructing pathways for pedestrians and cyclists as envisaged in the smart city mission plan can be also discussed in the NCAP plan for pollution control.

8.3.2 Swachh Bharat Mission

The Swachh Bharat Mission⁴¹ aims to clean up the streets, roads and infrastructure of urban and rural areas in India.

⁴⁰Smart and Sustainable Cities of the Future, key initiatives under smart city mission, Govt of India; Deloitte (2019) (link)

⁴¹Swachh Bharat Mission Urban (link)

The mission for example illustrates the implementation of integrated solid waste management systems (one of the action plan mentioned in NCAP under the waste management segment). This clearly indicates that the Swachh Bharat mission can be possibly leveraged as a source of funding for implementing some of the common action plans mentioned in NCAP.

8.3.3 Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

AMRUT⁴² (Atal Mission for Rejuvenation and Urban Transformation) aims at building the capacity of the relevant stakeholders, reform implementation water supply, sewerage and septage management, storm-water drainage, urban transport and development of green spaces and parks. It is opined that the action plans under NCAP like institutional capacity building, promotion of green drives, proper waste management have similar features to the attributes mentioned in the AMRUT Scheme. Hence, it is prudent to link the schemes - AMRUT and NCAP together and utilise the funds collectively for better outcomes on air pollution control. There can be a possible collaboration between the Ministry of Housing and Urban Affairs (implementing AMRUT scheme) and the Ministry of Environment Forests and Climate Change (implementing NCAP plan) to achieve some of the common goals in mitigating air pollution.

8.3.4 National Heritage City Development and Augmentation Yojana (HRIDAY)

Similarly, the HRIDAY⁴³ (National Heritage City Development and Augmentation Yojana) scheme aims to provide proper water supply, proper sanitation, proper waste

management, improved public transportation systems, proper road facilities etc. to make the cities sustainable and citizen-friendly. The scheme is being implemented in 13 identified cities namely Ajmer, Amaravati, Amritsar, Badami, Dwarka, Gaya, Kanchipuram, Mathura, Puri, Varanasi, Velankanni, Vellore and Warangal. It is observed that out of the 13 identified cities under HRIDAY scheme, 3 of them namely Amritsar, Gaya, Varanasi are listed under NCAP plan. The possible linkage between the Ministry of Housing and Urban Affairs (implementing the AMRUT scheme) and the Ministry of Environment Forests and Climate Change (implementing the NCAP plan) can be explored to achieve the common action plans such as proper waste management and improved public transportation system pertaining to the mitigation of air pollution in the cities.

8.3.5 Municipal Corporation

Municipal Corporations in the respective cities and towns are entrusted with funds to ensure a sustainable environment for citizens in terms of proper waste management, proper roads and sanitation etc. Such features are also mentioned under NCAP and hence it would be sensible to link some of the action plans of the NCAP with municipalities and utilise the municipality finance to achieve some of the outcomes under the NCAP effectively.

Citizens can be charged a minimal amount under property tax for developmental activities such as maintenance of air monitoring stations, waste management, maintenance of public parks etc in relation to pollution control interventions in the cities.

Specific features of existing schemes which can be possibly linked with the NCAP plan are summarised below:

Table 25: Summary of Existing Schemes in relation to NCAP plan

SCHEMES	FEATURES (IN RELATION TO AIR POLLUTION CONTROL)
Smart City Mission	<ul style="list-style-type: none"> • Installation of air monitoring stations • Strengthening the public transportation system • Proper municipal solid waste management • Introduction of E-mobility in cities with charging infrastructure installation
Swachh Bharat Mission	<ul style="list-style-type: none"> • Integrated Solid Waste Management including C&D, E-waste, hazardous waste
AMRUT	<ul style="list-style-type: none"> • Proper sewerage and septage management • Development of green spaces and parks • Improvements in the public transportation

⁴²AMRUT, Ministry of Housing and Urban Affairs (link)

⁴³HRIDAY, Ministry of Housing and Urban Affairs (link)



8.4 Design of proposed alternative financing facility

8.4.1 Key considerations for designing the facility

The team tried to analyse the operating model and key parameters of various financing facilities in India as well as globally. Accordingly, three alternative facility designs have been identified for the purpose of air pollution control interventions. In proposing the design, we have considered multiple factors as illustrated below:

Table 26: Design features for a financing facility

DESIGN PARAMETERS	DESIGN CONSIDERATION	REMARKS
Target Segment	<ul style="list-style-type: none"> • Primary targets can be the industries which can be easily aggregated and can impact efficiency of the pollution control intervention 	It is easier to implement and achieve impact at scale due to fewer buy-ins required where the concentration of industries is high
Host	<ul style="list-style-type: none"> • Government versus private financial institutions • Setting up new facility versus leveraging the existing facilities 	<p>Government managed facility seems to be better option on account of the following:</p> <ul style="list-style-type: none"> • It has ability to raise large amounts of capital • It has ability to influence the policy • It has also the ability to do small as well as large ticket loans
Investor	<ul style="list-style-type: none"> • Domestic versus International investors • Co-opt the value chain player (e.g. cement supplier and DLF) • Insurance companies providing investments at reduced interest rates • Ministry of Health and Family Welfare provides budgetary allocation 	<ul style="list-style-type: none"> • Insurance companies have the incentive to invest as they find it difficult to resort to residency based premium pricing <p><i>(they are unable to increase premiums where pollution levels are higher and consequently the health risk is higher)</i></p> <ul style="list-style-type: none"> • Ministry of Health and Family also has an incentive to invest since it incurs health care expenditure across hospitals due to ill impacts of air pollution
Repayment Frequency	<ul style="list-style-type: none"> • Moratorium • Balloon Repayment 	<ul style="list-style-type: none"> • May have to be determined / customized on case to case basis

Indirect benefits from Govt of India to enhance viability	<ul style="list-style-type: none"> • Accelerated Depreciation • Tax free Investment • Govt procurement policy 	<ul style="list-style-type: none"> • Government's tender based procurement policy can mandate minimum pollution control standards to be maintained by the suppliers. Learnings can be drawn from similar interventions tried in areas such as carbon disclosure projects. For e.g. during procurement, IndusInd bank prefers vendors that demonstrate climate mitigation measures • Buy-in on the concept may be time-consuming
Credit enhancement	<ul style="list-style-type: none"> • Tripartite arrangement between bank (financier), Government (buyer) and enterprise (supplier) can be established 	<ul style="list-style-type: none"> • The buy in of the concept may be time consuming
Municipal Financing	<ul style="list-style-type: none"> • Availability of resources • Ability to raise low cost debts • Human resource essential to manage the facility 	<ul style="list-style-type: none"> • The balance sheets are negative or stretched in most of the municipal corporation

After considering the pros and cons of the various options and basis discussions with the internal advisory board and some key external stakeholders, we have narrowed down to 3 key options as presented below:

8.4.2 Option 1: Housed in an existing Government facility

There are three main reasons why housing air pollution control financing facility within an existing government-owned or managed facility may be the most feasible option from a cost, efficiency, and impact perspective:

- Government managed facilities have access to low-cost funds which is critical to driving investments in areas that are not necessarily revenue accretive.
- Existing Government facilities like IREDA have the ability to do small as well as large ticket loans.
- Government-owned facilities such as PFC, IREDA have vast experience of infrastructure financing involving the appraisal of long tenor loans across industries especially in the thermal sector which is one of the key air pollution sectors.

Table 27: Lay out of suggested new financing facility housed under Government institutions

SR NO.	DESIGN ELEMENTS	DETAILS	EXPLANATION
1	Model	Direct financing	<ul style="list-style-type: none"> • Refinancing will increase cost • Recommended hosts are already financing the enterprises directly
2	Scope	<ul style="list-style-type: none"> • Only financing in stage - I • Financing + TA in stage -II 	<ul style="list-style-type: none"> • Focus segments comprise of large companies with significant market share • TA is more relevant for MSMEs which can be targeted subsequently
3	Objective	Reduction in SOx / NOx / PM	<ul style="list-style-type: none"> • Focus on outcome (ends) rather than technologies (means)

4	Focus areas / target segments / projects	<ul style="list-style-type: none"> • Thermal • Iron & Steel • Cement 	<ul style="list-style-type: none"> • Most polluting segments- investments can have max impact on achieving target reduction • These are highly concentrated industries • These industries are managed by large players with strong balance sheets to absorb debt
5	Nature of financing support	Debt	<ul style="list-style-type: none"> • Since investment reqd. is above USD 5000 mn per year, Grant funding is not going to be scalable • Equity capital has higher cost connotations; hence, it is not suitable for low to non-revenue accretive projects / investments
6	Size of fund / intervention	USD 500mn	<ul style="list-style-type: none"> • Considering 10% of the investment required in the target segments which can be catered by the facility in initial years
7	Key Financing terms	Ticket size: USD 1 mn to USD 20mn	<ul style="list-style-type: none"> • The upper and lower limits of ticket size have been fixed to accommodate large number of entities for financing leading to investment efficiency in pollution control interventions • The interest rates and tenor are in line with existing practice at IREDA and nature of requirement in the sectors of focus
8		Interest Rate: 9.5% onwards	
9		Tenor: 3 years - 15 years	
10		Collateral: Primary charge on the asset being financed	
11		Pledge: Pledge on promoter shares may be required	
12	Legal Structure	NBFC	<ul style="list-style-type: none"> • Existing structure of IREDA / PFC
13	Technical collaboration, if any	NA	<ul style="list-style-type: none"> • Existing structure of IREDA / PFC
14	Capitalization Plan for the facility	Domestic and foreign funds which includes Green and Masala Bonds	<ul style="list-style-type: none"> • In line with existing sources of capital in case of IREDA / PFC

8.4.3 Option 2: Dedicated facility managed by Government

While government owned and managed facilities bring

advantages as mentioned in Option 1 above, creating a dedicated facility for air pollution control interventions, instead of housing it in an existing government owned/ managed facility, has a couple of additional advantages as well as some concerns.

KEY ADVANTAGES

- Most of the Government facilities are sector-specific. However, air pollution is not a new sector but cuts across sectors like thermal and industrial which are the dominant contributors to SO_x and NO_x
- A dedicated facility is likely to adopt a more active approach in sourcing suitable financing opportunities as compared to facilities housed within an existing facility

KEY CONCERNS

- Setting up a new facility can be long drawn and time consuming, especially since it will require multiple levels of engagement and approvals from the Government installation

The overall structure remains the same as in option 1, except the fact that the facility must be set up afresh by the Government. While IREDA and PFC are under the administrative control of MNRE and MoP respectively, the dedicated facility on air pollution control financing may be housed under MoEFCC. The detailed roles and responsibility of relevant stakeholder for managing a dedicated financing facility under MoEFCC have been mentioned separately in section 8.5.

8.4.4 Option 3: New Facility managed by private player

In case there is limited buy-in from the Government in setting up a dedicated financing facility for air pollution

control, there can be a consideration to set up a facility duly managed by private players. However, there are certain advantages and concerns for the model as mentioned here-

Key Advantages:

It can be implemented quickly. Working with a private player is likely to be quicker to implement than a facility that is owned or managed by the government.

Key Concerns:

The cost of funds in case of a private facility is likely to be higher than in the case of Government-owned and managed facility.

Table 28: Lay out of suggested new financing facility housed under Private institutions

SR NO.	DESIGN ELEMENTS	DETAILS	EXPLANATION
1	Model	Direct financing	<ul style="list-style-type: none"> • Refinancing cannot work in this model as Pvt NBFCs cannot compete with banks in terms of cost of funds
2	Scope	Financing only	<ul style="list-style-type: none"> • TA would further increase cost • Target segments may not need TA assistance
3	Objective	Reduction in SO _x / NO _x / PM	<ul style="list-style-type: none"> • Focus on outcome (ends) rather than technologies (means)
4	Focus areas / target segments / projects	<ul style="list-style-type: none"> • Thermal • Iron & Steel • Cement 	<ul style="list-style-type: none"> • Most polluting segments-investments can have max impact on achieving target reduction • Concentrated industries • Large players with strong balance sheets to absorb debt

5	Nature of financing support	Debt	<ul style="list-style-type: none"> Grant is not scalable- investment required is <!-- Generator: Adobe Illustrator 23.1.0, SVG Export Plug-In --> <svg version="1.1" xmlns="http://www.w3.org/2000/svg" xmlns:xlink="http://www.w3.org/1999/xlink" x="0px" y="0px"
6	Size of fund / intervention	USD 500 mn	Considering 10% of the investment required in the target segments which can be catered by the facility in initial years
7	Key Financing Terms	Ticket size: USD 1 mn to USD 20mn	<ul style="list-style-type: none"> The upper and lower limits of ticket size have been fixed to accommodate large number of entities for financing leading to investment efficiency in pollution control interventions In line with nature of requirement in the sectors of focus
8		Interest Rate: 14% onwards	<ul style="list-style-type: none"> Determined by cost of funds + Cost of guarantee + spread ~500bps
9		Tenor: 3 years +	<ul style="list-style-type: none"> Determined by tenor of funds raised to avoid Assets and Liability Management (ALM) issue. <i>(For instance, if the facility is capitalised by funders with loans for 8 years, the facility cannot make 15 years investments)</i>
10		Collateral: Primary charge on the asset being financed	<ul style="list-style-type: none"> In line with existing practice of unsecured lenders where investment is made for asset creation
11		Pledge: Pledge on promoter shares may be required	<ul style="list-style-type: none"> Industry norm
12	Legal Structure	NBFC	<ul style="list-style-type: none"> Fund structure may be considered after accounting for average investment duration, tax considerations and investor preferences
13	Technical collaboration, if any	NA	<ul style="list-style-type: none"> Partnership with IREDA, PFC, and REC may be considered for building a pipeline
14	Capitalization Plan for the facility	Bilateral / Multilateral agencies <ul style="list-style-type: none"> KfW JICA ADB IFC /WBG 	<ul style="list-style-type: none"> Investors with appetite for making high risk long terms investments at comparatively lower cost will be required
15	Upstream structure	Upstream structure will involve consideration into areas such as <ul style="list-style-type: none"> Pooling Mechanism Pooling vehicle Location of pooling Fund raising Terms 	<ul style="list-style-type: none"> May be required only in case multiple investors participate

8.5 Operational details of the proposed financing facility

8.5.1 Governing structure: To be owned by Gol

The financing facility will be managed by a special purpose vehicle (SPV) which will normally plan, appraise, release funds, monitor and evaluate the financing of the pollution control intervention during pre and post financing phase. The SPV will be a limited company created under the Companies Act, 2013. Majority of its share (60%+) can be held by the Government while the rest can be owned by private investors. This is in line with the existing SPVs set up in areas such as smart city financing or infrastructure financing through PFC etc. The exact shareholding pattern can be settled based on the discussions / consultations with relevant stakeholders.

8.5.2 Key functions of the facility

The SPV will manage the financing facility, engage with key stakeholders and collaborate with the institutes at the city, state and national level for carrying out the financial and technical due diligence. The key responsibilities of the SPV will be broadly classified into four major aspects which includes initiate, evaluate and approve the proposal, monitor and evaluate the project post financing. Key roles will include the following:

- Assist enterprises in registering on the financing facility portal and preparing the preliminary detailed project report (DPR)
- Take measures to comply with the statutory requirements

of MoEFCC with respect to the NCAP plan

- Engage requisite third party for technical review and monitoring of the project and record review findings
- Establish a connection between academic institutions and the organizations to meet NCAP objectives
- Monitor and review the progress of the project and carry out timely disbursement offunds
- Manage the funds from various sources including Golpools

8.5.3 Source of funds and mobilization strategy

The facility can be operationalised by securing funding from bilateral and multilateral agencies, National Investment and Infrastructure Fund (NIIF), as well as with contributions from other Government schemes.

These sources are summarised as mentioned below:

A. Central Government schemes like NCAP, Swachh Bharat Mission, etc.

B. Leverage borrowings from financial institutions, domestic and external, including bilateral and multilateral institutions

C. Private sector investors

8.5.4 Process flow

Table 29: Step by step procedure for financing air pollution control interventions

STEPS	RESPONSIBILITY	PROCESS PHASE	DESCRIPTION
Step-1	Beneficiary & SPV	Application	<ul style="list-style-type: none"> • The beneficiary prepares the detailed project report (DPR) indicating the technology, costs, sectors, geographical location etc. in the proposal • SPV assists the beneficiary during the preparation of the required documents • The beneficiary registers online into the facility portal and uploads the relevant document. After successful submission receives an acknowledgement number for future tracking of the proposal

Step-2	SPV and designated third party engaged if required	Technical due diligence	<ul style="list-style-type: none"> • The technical aspects of the proposals are scrutinized such as the product/technology appropriateness, quality, durability etc. • The impact of the technology intervention is estimated and recorded
Step-3	SPV and designated third party engaged if required	Financial due diligence	<ul style="list-style-type: none"> • The cost parameters are scrutinized and compared with the market price • The balance sheet of the beneficiary is analysed such as amount of equity and debt already in place • The financial strength of the beneficiary is assessed to evaluate the repayment ability and risks
Step-4	SPV	Sanction of proposal	<ul style="list-style-type: none"> • Consensus is reached to derive the amount that can be financed to the beneficiary • An agreement is made between the beneficiary and the SPV which briefly covers the terms and conditions, financing modality, collaterals if any, disbursement schedule etc. • The proposal is sanctioned after meeting all the statutory requirements and the agreement is signed by both parties
Step-5	SPV & Beneficiary	Initial Disbursement	<ul style="list-style-type: none"> • After signing the agreement, SPV disburse initial amount to the beneficiary • Pollution control interventions begin at site • A periodic site inspection schedule is prepared jointly by the both parties
Step-6	SPV and Beneficiary, along with designated third party if required	Monitoring and subsequent disbursement	<ul style="list-style-type: none"> • Joint inspection is carried out to assess the progress of work • Joint inspection report is uploaded in the web portal • The actual impact of the intervention is also recorded once the control intervention becomes operational • The subsequent disbursement is carried out based on agreed milestones being met

9. Conclusion

The study provides some key insights on air pollution control technologies and mitigation strategies in India, especially to support and meet the time bound targets set by the Government of India under NCAP. Some key highlights of the study include:

A. There seems to be a huge market potential for air pollution control technology in India with an estimated investment requirement of INR 7.5 trillion per annum.

B. Several challenges currently constraint investment in air pollution control interventions; these challenges need to be addressed through an enabling ecosystem led approach to accelerate the flow of funds in this sector

C. Primary focus of the proposed financing facility is the industrial sector (comprising the thermal power plants as well as steel and cement industries); as

these sectors can drive maximum return (reduction in key pollutant levels) per dollar of investment initially

D. Leveraging an existing facility managed by public financial institution is the most practical option given its benefits over setting up of a new and dedicated facility.

Further, it is critical to engage closely with the relevant ministries for securing an approval to set up the pollution control investment facility with one of the existing public financial institutions. Also, there is a need to closely work with the chosen financial institution in order to develop the operating blue print of the facility as well as to handhold the institution during the initial pilot. In parallel, it is critical to initiate outreach and negotiations with bilateral and multilateral agencies as well as government agencies for financial support in order to capitalise the facility with financing on infrastructure terms (capital at lower than market interest rates for a long tenure).

In the end, Intellecip recommends a pilot to test both the economic returns as well as environmental benefits from the initial investments. This may assist in creating demand for air pollution control technologies among the industries and might help in catalysing the overall sector.



Image source: <https://archive.globallandscapesforum.org/glf-2014/?contestants=pollution-thermal-power-plant-sarni-betul-district-madhya-pradesh-india>

10. Annexures

10.1 Description of schemes and Existing Financing Facility

10.1.1 IREDA

About the Organization

IREDA is a 100% Government of India owned organization under the administrative control of the Ministry of New and Renewable Energy (MNRE)⁴⁴ and established in the year 1987. It's a Public financial institution (PFI) under Section 2(72) of Companies Act, 2013 and registered as the non-banking financial company (NBFC) with the Reserve Bank of India. It has more than 30 years of experience in financing renewable energy projects. It has been conferred with the Mini Ratna status in June 2015 by the Dept. of Public Enterprises. The bankers to IREDA includes Bank of India, CANARA bank, HDFC Bank, Yes Bank, Union Bank, Indus Bank Limited.

IREDA has played a strategic role in the Gol's initiatives for the promotions and development of RE sector in India. It has been involved in devising and implementing various policies and structural and procedural reforms in RE sector in India. The RE projects for biomass (up to 10 MW) and small hydro (up to 5 MW) has been refinanced by IREDA through the funds received from National Clean Energy Fund ("NCEF") under the IREDA-NCEF refinancing scheme. IREDA has also been involved in various Gol schemes including the Wind GBI Scheme, the Solar GBI Scheme and the Solar Water Heating System Capital Subsidy Scheme.

Targeted Sectors

IREDA provides financing to the projects in Renewable Energy (RE), Energy efficiency/ conservation and other environmentally sustainable technologies, also including power generation, transmission, renovation and modernization that are technically viable. The eligible sectors are as follows⁴⁵ :

- Wind Energy
- Hydro Energy
- Solar Energy

- Biomass including Bagasse and Industrial Cogeneration
- Biomass Power Generation
- Waste to Energy
- Energy Efficiency and Energy Conservation
- Bio-fuel/ Alternate Fuel including Ethanol and Bio-Diesel
- Hybrid Projects with RE technology
- New and Emerging Renewable Energy Technology

The applicants registered in India and fall under the following categories are eligible to avail financial assistance from IREDA.

- Private Sector companies/ firms/LLP
- Central PSU
- State Utilities/ Discoms/ Transco's/ Gencos/ Corporations
- Joint Sector Companies

Financial Products and Services

IREDA provides a comprehensive suite of financial products and services⁴⁶. This includes various fund-based financial products including long-term and short-term project and manufacturing loans, take out financing, bridge loans and bill discounting, and non-fund-based assistance, like performance guarantees, letters of comfort, letters of undertaking and refinancing schemes.

Within a span of 6 months between March 2017 to Sep 2017 IREDA has sanctioned loans as follows:

- 39,429.45 million of term loans for renewable energy and energy efficiency and conservation projects
- 12,500.00 millions of short-term loans to renewable energy developer and suppliers
- 198.28 millions of bridge loans for solar viability gap funding and generation-based incentives
- 6,671.32 millions of take-out financing replacing loans of other banks and financial institutions

The minimum loan eligibility from IREDA is Rs.50 lacs unless specifically exempted under any scheme/ programme. The quantum of loan from IREDA is normally up to 70% of the project cost and the repayment period generally ranges from 10 years to 15 years depending on the project cash flows, DSCR of the project, PPA period etc.

IREDA carries out grading of the projects on basis of the risk assessments. The rate of interest is linked with the grades as shown in the table below

⁴⁴ IREDA (link)

⁴⁵ Financing Norms and Schemes , IREDA 2018 (link)

⁴⁶Red Herring Prospectus, 2017 (link)

SR. NO.	BORROWER/ SECTOR	GRADE-1	GRADE-2	GRADE-3	GRADE-4
1	Schedule A, AAA rated PSU's	9.50%			
2	State Sector Borrowers	9.50%	9.80%	10.10%	10.35%
3	LoC for Refinance and others	Cost of Domestic Borrowing + 1% to 2% spread			
4	Roof top Solar	9.55%	9.90%	10.20%	10.50%
5	Wind Energy and Grid CONNECETD Solar PV	9.55%	10.00%	10.35%	10.75%
6	Co-generation, Hydro and CSP, Energy Efficiency, Energy Conservation & Solar Thermal/ Solar PV off-grid, Biomass Power and another sector	10.10%	10.60%	11.00%	11.25%
7	Manufacturing (All sectors)	Existing units-10.60%)		Green Field - 10.80%	

IREDA also offers advisory and consulting services to renewable energy projects and companies in terms of due diligence, financial feasibility assessment, risk minimization and mitigation services.

Financing Schemes

IREDA has launched various financing schemes to encourage the investors, developers, manufactures, suppliers in accelerating the installation of RE, EE technologies in India. The applicable interest rates under various schemes are tabulated below:

SR. NO.	SCHEME	CURRENT INTEREST RATES
1	Z for SDF supported Bagasse based Cogeneration Projects	Additional interest rate of 1% over and above the applicable interest rate shall be charged for the bridge loan portion
2	Loans against Securitization of future cash flows of existing RE projects (Corporate Loan	Additional interest rate of 1.25% over and above the applicable interest rate shall be charged.

3	Line of Credit to Non-Banking Financial Companies (NBFCs) for on-lending to RE/EEC Projects.	Cost of Domestic Borrowing Cost + 1% to 2% Spread. The annual commitment fee shall be 0.1% p.a., to be paid upfront on outstanding amount (w.e.f date of loan agreement).								
4	Short term loan assistance to RE Developers/Suppliers /Contractors	Highest int. rate of the sector + 0.50% p.a.								
5	Bridge loan assistance to RE Promoters/ Developer against Capital Subsidies /VGF available under various State/Central Govt. Schemes	Applicable interest rate for the project + 1% p.a. (on bridge loan portion only).								
6	Direct Discounting of MNRE Capital Subsidy & GBI Claims	0.90% per month (10.8% p.a.).								
7	Bill Discounting Scheme of Energy Bills for IREDA Borrowers	Prevailing highest interest rate for the Sector + 50 basis point. Processing Fees (Front end fee): 0.25% of the sanctioned loan amount.								
8	"Access to Energy" Loan Scheme under KfW Line	<table border="0"> <thead> <tr> <th>Loan Tenure</th> <th>Interest Rate p.a.</th> </tr> </thead> <tbody> <tr> <td>• Up to 2 years</td> <td>9.75%</td> </tr> <tr> <td>• 2 years to 4 years</td> <td>10.75%</td> </tr> <tr> <td>• More than 4 years</td> <td>11.50%</td> </tr> </tbody> </table>	Loan Tenure	Interest Rate p.a.	• Up to 2 years	9.75%	• 2 years to 4 years	10.75%	• More than 4 years	11.50%
Loan Tenure	Interest Rate p.a.									
• Up to 2 years	9.75%									
• 2 years to 4 years	10.75%									
• More than 4 years	11.50%									
9	Loan Scheme to promote the Concentrating Solar Thermal (CST) Projects for Industrial Process Heat Application	7% p.a., after considering interest UNIDO subvention. 12% on bridge loan, if any against MNRE subsidy.								
10	Policy for Financing Transmission Projects	Shall be aligned with Lead Lender/ Lead Arranger to the satisfaction of IREDA.								
11	Loan Scheme/Line of Credit for Financing Large Scale Roof Top	Discount of 30 BPS on the interest rates as applicable under the existing Loan scheme to Roof Top Solar PV Projects.								
12	REDA: Top-Up Loan Scheme	The prevailing int. rate of the project + 1.5% p.a. Processing Fee: 50% rebate.								

Source of Funds

The primary source of funds for IREDA includes domestic and foreign borrowing, internal resources and Govt of India guarantees and support.

- The international funding sources includes loans from the World Bank, the Asian Development Bank, Kreditanstalt für Wiederaufbau, Japan International Cooperation Agency European Investment Bank, Agence Française Développement and Nordic Investment Bank.
- IREDA issues green rupee-denominated bonds in the

international market (for example: of worth 19,500 million in Sep 2017) and domestic market (for example: of worth 7,000 million in March 2017)

- The bonds issued by IREDA are in accordance with Green Bond Framework meeting the requirements of the Climate Bonds standard version 2.0 issued by the Climate Bond Initiative (Green Bonds) and adheres to Green Bond Principles 2015 issued by the International Capital Markets Association (ICMA)
- The domestic borrowings and International borrowing by IREDA were 51,380.20 million and 69,281.60 million

respectively. The domestic borrowings included taxable and tax-free bonds as well as term loans from other banks and financial institutions in the domestic market.

Monitoring Mechanism

IREDA follows a systematic approach in monitoring the funds mobilization to the agencies. The following steps have been taken to ensure proper utilization of funds released to the borrowers by IREDA⁴⁷ :

- Disbursement against sanction linked with the physical and financial progress of the project
- Periodic inspection of projects by IREDA officials and engineers
- Utilization Certificate by Chartered Accountant while releasing the instalments of disbursement
- Periodical audit by internal auditor
- Formation of a Risk Management Committee for top level oversight
- Obtaining rating from independent rating agencies for the project proposals and ongoing surveillance by them.
- Constitution of Credit Committee for inter-departmental review of Project proposals prior to sanction
- Strengthening of recovery mechanism

10.1.2 Power Finance Corporation (PFC)

About the Organization

PFC is a company registered under erstwhile companies Act 1956 incorporated on 16th July 1986. It is under the administrative control of the Ministry of Power and was conferred the title of Navratna CPSE in June 2007. It is a registered non-banking finance company with RBI.

PFC is the nodal agency for the implementation of programme such as Independent Transmission Projects (ITP), Restructured Accelerated Power Development Reforms Programme (R-APDRP) and integrated Power Development Scheme (IPDS), Ultra-Mega Power Projects(UMPP). PFC works closely with Govt of India, State Government, power sector utilities, other power sector intermediaries and private sector clients for the implementation of policies and procedural reforms in the power sector.

Targeted Sectors

PFC is the leading financial institution in India focused on power sector development. It provides a gamut of financial product and services from the project conceptualization stage to post commissioning stage to the clients in power sector. It provides financial assistance to the sectors of power generation, power transmission and power distribution. PFC is also committed to promote Renewable

Energy Projects and energy efficiency projects through issuance of green bonds. The proceeds of such Green Bonds broadly cover the following:

a. Renewable Energy

- Solar Energy- Photovoltaic solar electricity, concentrated solar power, infrastructure and manufacturing, transmission
- Wind Energy - offshore and onshore wind farms, infrastructure and manufacturing, transmission
- Bioenergy- renewable feed stocks, infrastructure and manufacturing, networks
- Hydropower- Run of river and small hydro as approved by Govt of India
- Geothermal- geothermal electricity, geothermal heat pump (GHP) technology
- Energy distribution and management- transmission and grid infrastructure, smart systems/meters, heating management
- Energy Storage- hydro storage systems, thermal heat storage, new technologies

b. Energy efficiency

- Energy efficiency technology/products manufacturing and supply
- Cogeneration/ tri-generation/ combined heat and power
- Waste heat recovery
- Electrical vehicles

Financial Product and Services

PFC provides a comprehensive range of financial products and services across power generation, transmission and distribution. They are clustered in three broad groups as tabulated below⁴⁸:

FUND BASED	NON- FUND BASED	FEE BASED SERVICES
Project Finance, short term loans, buyers line of credit, bridge loans, corporate loans and debt refinancing schemes	Default payment guarantee, credit enhancement guarantees, letter of comfort	Technical advisory and consultancy services

⁴⁷PIB Govt of India, 2013 (link)

The interest rates vary from 10% to 13% depending on the type of projects, schemes and profiles of borrowers(CPSU, Private etc.)⁴⁹.

Financing Schemes

PFC has been providing various financial products and services as mentioned above under different schemes and mechanisms. The details some of the financing schemes are tabulated below:

SR NO	FINANCING SCHEME	SALIENT FEATURES
1	<u>Take out Financing</u>	<ul style="list-style-type: none"> PFC enters into the agreement to take over the loan of a power project from existing lender.
2	<u>Asset Acquisition</u>	<ul style="list-style-type: none"> PFC provides funding to an entity acquiring assets of another entity to expand its operational activity and increase market competitiveness The repayment period shall not exceed 10 years
3	<u>Bridge Loan</u>	<ul style="list-style-type: none"> PFC sanctions bridge loans for the already sanctioned project term loan and the loan amount is not disbursed due to pending formalities The repayment period is of 1 year with an additional 0.5% interest over the term loan
4	<u>Buyers Line of Credit</u>	<ul style="list-style-type: none"> PFC provides a term loan facility to the utilities to purchase machinery, equipment and capital goods The minimum line of credit is Rs 1 crores and not exceeding Rs 500 crore per financial year with a repayment period not exceeding 15 years
5	<u>Corporate Loan</u>	<ul style="list-style-type: none"> Term loan or guarantee scheme is provides for investment in equity of new power projects or acquisition of existing power plants The extent of funding is normally 50% of the project present value. The maximum sanctioned loan limits to 1000 crore The security of repayments is through following: <ul style="list-style-type: none"> Primary security on pledge of movable and immovable assets of commissioned projects, state Govt guarantees etc. Collateral security on personal guarantee, corporate guarantee, pledge of shares of existing company Payment security mechanism through escrow coverage, quadruple agreements among borrower, PFC, Borrower banker, Power Purchaser The repayment period does not exceed 10 years

⁴⁸PFC Investor presentation(link)

⁴⁹PFC Interest rates (link)

6	<u>Credit Facility for Purchase of Power through Power Exchange</u>	<ul style="list-style-type: none"> • PFC provides financial assistance to the power utilities to settle their dues of power exchange • The maximum loan limit is Rs 100 crore per borrower and the loan needs to be paid within 90 days with applicable interest rates • The security for the loan is generally the escrow cover, bank guarantees etc.
7	<u>Debt Refinancing Policy</u>	<ul style="list-style-type: none"> • Refinancing support is provided exclusively to the commissioned projects in power sector including Renewable Energy projects • The repayments are structured as front loaded, back loaded, equal periodical installments etc. depending on the nature of project cash flows and assessment of overall risks • The securities are normally the charge on assets, pledge of shares, DSRA, Personal/ corporate guarantee
8	<u>Energy saving Project</u>	<ul style="list-style-type: none"> • Eligible entities are ESCOs executing EE projects and entities adopting EE measures themselves • PFC provides term loans and as well as Re-financing or replacing the existing high cost term loans • The payments are secured through escrow account mechanism governed by agreement between owner, ESCO, their bankers and lenders or by Bank guarantee • The extent of financial assistance is normally 90% of the project cost for state/ central sector borrowers and about 50%-70% of the project cost to private entities • The maximum repayment period is of 5 years
9	<u>Short Term Loan</u>	<ul style="list-style-type: none"> • The loan is provided to meet immediate requirement of funds for purchase of fuel of power plant, purchase of consumables, essential spares, emergency procurement/works for generating plant and T&D networks • The limit of financial assistance is Rs 1000 crore and has to be paid within 1 year from the date of disbursement • The security of loan is in form of Escrow account, Government guarantees, charge on assets etc.

10	Short Term Loan for SPV in Government Sector	<ul style="list-style-type: none"> • PFC provides short term finance to meet working capital required for fuel, maintenance spares, O&M expenses, receivables etc. • The extent of assistance is limited to 25% of the working capital and to a maximum of Rs 500 crore per borrower • The loan repayment period is maximum of 3 years • The security of loan is in the form of Government Guarantee, charge on assets, escrow account coverage etc.
11	Solar PV Policy to Private Sector	<ul style="list-style-type: none"> • PFC provides financial assistance to projects not exceeding Debt Equity Ratio of 75:25 • Security of the loan is in form of charge on asset, collateral security such as personal/corporate guarantee, pledge of shares • The maximum moratorium period for repayment of principal is 1 year
12	Policy for Investment in equity of Power Projects	<ul style="list-style-type: none"> • Instruments for investments in equity are in form of equity shares, preferences shares, sub-ordinated debt with equity conversion option, bonds with warrants/ equity conversion option, convertible debentures
13	Guidelines for funding Grid connected Solar Thermal Private Sector Power Generation Projects	<ul style="list-style-type: none"> • The minimum size of the projects considered are more than 5MW • Debt to equity ratio shall not exceed 70:30 • The Power Purchase Agreement (PPA) period should be more than the PFC loan repayment period to mitigate any financial risks • The collateral security of the financing is in form of personal guarantee, Debt service reserve account <p>- The moratorium period in repayment of loan shall be up to 1 year</p>

Source of Funds

The primary source of funds for PFC are the domestic and international borrowings, equity share of Govt of India, Foreign portfolio investors, insurance and mutual funds, others. The domestic borrowings of PFC are in the form of short term and long-term loans from banks, commercial paper, tax free bonds and taxable bonds/ debentures.

The external commercial borrowing (ECB) of PFC are in the form of syndicated loans from international banks and multilateral organizations, Indian Rupee denominated bonds and USPP notes. PFC also raises funds up to USD 1

billion by issue of Medium-term Note (MTN) denominated in foreign currency as well as in INR to overseas investors.

10.1.3 PAT scheme

About the Scheme

Perform Achieve and Trade scheme (PAT) is one of the salient features of the National Mission for Enhanced Energy Efficiency (NMEEE) among the eight missions under the National Action Plan on Climate Change (NAPCC) of the Govt of India. It was launched by the Bureau of Energy Efficiency (BEE) under Ministry of Power on 4th July, 2012 at New Delhi⁵⁰. It is an innovative regulated instrument

⁵⁰EX India (link)

associated with a market-based mechanism to minimize the specific energy consumption (SEC) in energy intensive industries. It enhances the cost effectiveness through certification of excess energy savings.

The specific energy consumption targets are issued

to energy intensive industries depending on their vintage and their operational parameters. The industries overachieving the targets are issued with the Escerts (Energy Saving Certificates) which can be traded. Similarly, the industries underachieving the targets are enforced to pay the penalties or purchase the Escerts.



SE: Specific Emission

ES-Certs: Emission saving certificates

Targeted Sectors and Sub sectors

namely: Aluminum, Chlor-Alkali, Thermal Power Plant, Cement, Pulp-Paper, textile, Iron & Steel, fertilizer with a designated consumer size of 478 numbers in total. The targets for each sector identified were as follows:

SECTOR	THRESHOLD LIMIT FOR QUALIFICATION AS DC(MTOE)	NO OF DC	ANNUAL ENERGY CONSUMPTION (MILLION MTOE)	ENERGY REDUCTION TARGET FOR PAT-1 (MILLION MTOE)
Cement	30.000	85	15.01	0.815
Pulp and Paper	30.000	31	2.09	0.119
Aluminum	7.500	10	7.71	0.456
Chlor-Alkali	12,000	22	0.88	0.054
Fertilizer	30.000	29	8.2	0.478
Iron & Steel	30.000	67	25.32	1.486
Textile	3,000	90	1.2	0.066

Thermal Power	30.000	144	104.56	3.211
Total		478	164.97	6.685

Source:GIZ, BEE (2012)

The PAT cycle-II includes Discoms, Railways and Refineries to the existing sector of Cycle-I. The total number of DC identified were 621 from 11 sectors and the total energy reduction target was 8.869 million MTOE. The PAT cycle-III consists of 116 DC's from 6 sectors namely Thermal Power Plant, Cement, Aluminum, Paper and Pulp, Iron and Steel

and Textile, the cycle period being 2017-18 to 2019-20. The PAT cycle-IV having its period from 2018-19 to 2020-21 includes 8 sectors namely: Petro Chemical, Cement, Pulp and Paper, Iron and steel, Textile, Thermal Power Plant, Hotels and Chlor Alkali with 109 DC's identified.

FEATURES	CYCLE			
	PAT- 1	PAT- 2	PAT- 3	PAT- 4
Sectors	Cement, Pulp and paper, Aluminum, Chlor-Alkali, Fertilizer, Iron & Steel, Textile, Thermal Power Plant	Cement, Pulp and paper, Aluminum, Chlor-Alkali, Fertilizer, Iron & Steel, Textile, Thermal Power Plant, Discoms, Railways and Refineries	Thermal Power Plant, Cement, Aluminum, Paper and Pulp, Iron and Steel and Textile	Petro Chemical, Cement, Pulp and Paper, Iron and steel, Textile, Thermal Power Plant, Hotels and Chlor Alkali
Number of DC's	478	621	116	109
Energy Reduction Target (Million MTOE)	6.68	8.869	1.1	0.699
Period of implementation	2012- 2015	2016-2017	2017-2018	2018-2020

Source:GIZ, BEE (2012) ⁵¹

Governing Structure

The PAT scheme is being implemented with the involvement of key stakeholders which includes industries, industry association, state designated agencies (SDA),

energy exchanges and regulatory bodies. The involvement of stakeholder is broadly classified as mentioned in the table below:

STAKEHOLDER	RESPONSIBILITY
Ministry of Power (MoP)	Policy Maker
Bureau of Energy Efficiency (BEE)	Administrator and Nodal agency
Designated Consumer (DC)	Implementer

⁵¹ Enhancing Energy Efficiency through Industry Partnership, GIZ, BEE, CII(2018)

State Designated Agency (SDA)	State Administrator
State Electricity Regulatory Commission (SERC)	Adjudicator
Empaneled Accredited Energy Auditors	Verifier
State Electricity Regulatory Commission (SERC), CERC/POSOCO, Power exchanges- IEX and PXIL	Trading Regulator, Registry
Power exchange- IEX	Trading platform

The roles of some of the key stakeholders are as follows:

i. **BEE:** BEE discharge the role of administrator of Escerts.

- Defines the procedure for interface between power exchange and Registry, Administrator and Registry, and registry and Designated Consumer(s) in line with the Energy Conservation Rules
- Provides support to the commission on exchange of Escerts on power exchanges
- Disseminates relevant market information to all stakeholders
- Ensures transparency in the exchange of Escerts
- Coordinates with Power Exchange and Registry for smooth interface

ii. **CERC:** CERC regulates the exchange of Escerts on Power Exchanges. It functions as the market regulator and discharges the following responsibility:

- Defines the procedure for interface between power exchange and Registry, Administrator and Registry, and registry and Designated Consumer(s) in line with the Energy Conservation Rules
- Monitors the operation and performance of Power Exchange
- Issue direction to Bureau to the discharge of its function

iii. **POSOCO:** POSOCO discharge the following functions:

- Aids in registration process of Escerts and credits Escerts to DC's on approval from Ministry
- Handles the process and procedures of Escerts trading/ exchange
- Coordinates and disseminates information with DC's, Power Exchanges, BEE and Regulators

- Provides assistance in development of IT platform for maintenance of data base of Escerts

Market Transformation of PAT Cycle-I

The implementation of PAT Cycle-I has accelerated the market towards energy efficiency in India. It has resulted into unlocking of various energy saving opportunities. The key points are mentioned below:

a. Investment in Energy Efficient Technology:

The evaluation of PAT Cycle-I states that the energy conservation measures adopted by the industries resulted in 8.67 million MTOE reduction in energy consumption which surpassed the actual target specified i.e. 6.68 million MTOE. The total investment as assessed for carrying out the energy efficient measures was Rs. 261 billion. About 38,50,000 Escerts was issued to the 306 facilities which overachieved the energy consumption target and about 110 facilities were directed to purchase 14,50,000 Escerts for under achieving the targets.

b. Waste heat recovery and AFR utilization:

The transformation of market for energy saving opportunities in PAT Cycle has been the key driver for installation of waste heat recovery in various industries namely Thermal Power plants, Iron & Steel, cement on a larger scale. It has also enhanced the utilization for Alternate Fuel and Raw Material.


















c. Creating Business Opportunities for Energy Professionals and Technology Suppliers:

PAT scheme has created business opportunities for Energy professionals. The certified energy professionals through National Certification Examination for Energy Managers and Energy Auditors are created by BEE to carry out the auditing of the industries under the PAT scheme. The business for such professionals was estimated to be Rs 500 million under the PAT Cycle-I. The scheme has also opened up avenues for the technology supplier to carry out manufacturing, designing, engineering, installing

of the energy efficient technology in the designated industries. The huge investments and high demand of the technology not only facilitated implementation of innovative technology, but also led to aggressive research and development activities in the country.

Trading Report of PAT Cycle 1

The trading report has been retrieved from IEX which clearly indicates the price of ESCerts traded at the particular day and also the volume of certificates traded. The price of ESCerts varies from Rs 200 to Rs 1200 depending on the supply and demand mechanism on the particular day. The details are shown below.

DAY	SELL BID (ESCERTS)	PURCHASE BID (ESCERTS)	TRADE VOLUME (ESCERTS)	PRICE DISCOVERED (RS/ESCERT)	NO OF PARTICIPANTS	DEMAND SUPPLY CURVE
26/09/2017	2,39,644	50,904	10,904	1200	39	
3/10/2017	2,36,031	51,925	23,295	1200	40	
10/10/2017	3,48,587	64,459	43,078	1000	52	
17/10/2017	3,81,443	40,538	40,148	800	45	
24/10/2017	3,49,806	42,271	41,455	600	52	
31/10/2017	3,83,379	21,037	19,359	500	51	
7/11/2017	4,36,394	11,521	10,351	350	61	
14/11/2017	3,19,810	12,241	12,125	200	45	
21/11/2017	3,36,121	10,963	7,513	200	53	
28/11/2017	3,68,361	1,17,514	36,580	250	64	
05/12/2017	3,55,226	2,62,331	46,928	350	73	
12/12/2017	4,33,769	4,95,553	1,23,520	525	85	
19/12/2017	8,31,224	7,30,885	4,49,818	1000	112	
26/12/2017	10,94,568	3,65,980	2,20,791	899	126	
02/01/2018	7,77,567	1,45,150	28,983	500	78	
09/01/2018	8,24,707	1,52,195	74,895	501	79	
16/01/2018	8,94,445	1,10,511	1,09,161	450	81	

Source: IEX India ⁵²

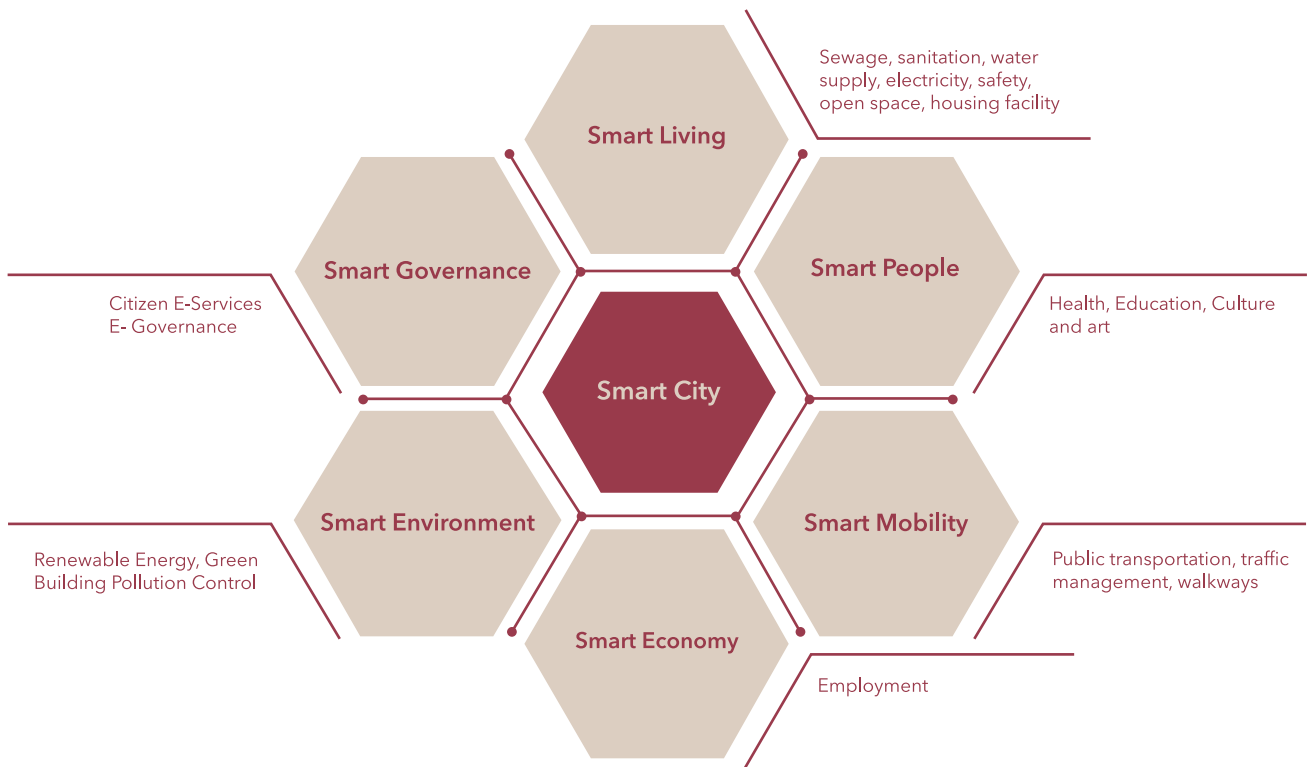
⁵² IEX India(link)

10.1.4 Smart City Financing

Introduction

The smart city mission for 100 cities was established in the

year 2015 under the Ministry of Urban Development (MoUD). The key components of the smart cities include smart living, smart people, smart mobility, smart governance, smart environment and smart economy.⁵³



The central Government has an allocated budget for each city which needs to be matched by the state government and the local urban body in raising the funds. The funds are channelized through a special purpose vehicle (SPV) which is created to manage the implementation of the smart city projects. The SPV is a limited company created under the companies act 2013. The major share (60%) is retained by the Government and the rest 40% is shared by the private investors.⁵⁴

Targeted sectors:

Under the Smart City Mission launched by MoUD, the smart projects are focused on the sectors which broadly cover safety, solid waste management, social sectors, storm water drainage, environment, NMT & pedestrian, sewerage, water supply, housing, IT/ICT solutions, energy, economic development, area development, urban transport, water & sewerage provision, waste water treatment, primary education, health care, slum up gradation, local roads, public transport, solid waste management, sanitary landfills, maintenance of cremation & burial grounds, street lights, public parks, play grounds and libraries.

Source of Finance

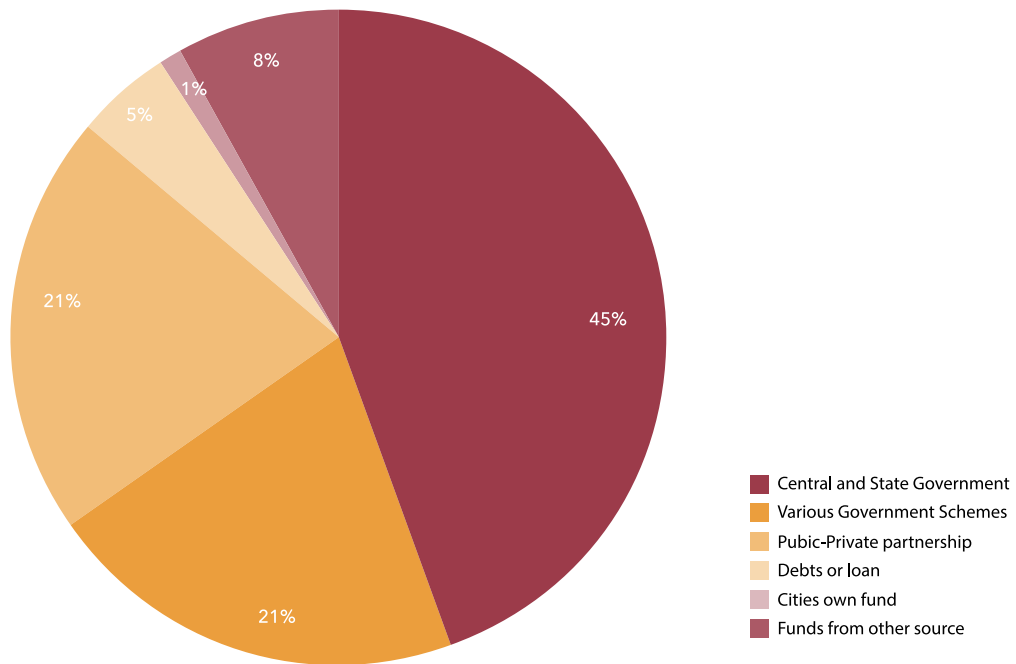
The various source of finance for the smart city projects are from the Property tax, Professional Tax, Entertainment tax, Advertisement tax, Octroi and entry tax, Gol funds, matching contributions by states/ urban local bodies, User charges, Public Private Partnership, FFC recommendations, Municipal bonds, Borrowings from bilateral and multilateral, National Investment and Infrastructure Fund (NIIF), Convergence with other Government schemes.

The source of funds is broadly classified into clusters as follows¹²:

- Central and State Government (45%)
- Convergence of various government schemes (21%)
- Public-private partnerships (21%)
- Debts or loans (5%)
- Cities own fund (1%)
- Funds from other sources (8%)

⁵³ Smart and Sustainable Cities of the Future, key initiatives under smart city mission, Govt of India; Deloitte (2019) link

⁵⁴ An overview of the smart cities mission in India, CPR(2018) link



The Government of India at the center has allocated a budget of Rs 48,000 crores for the smart city mission scheme. The equivalent contribution is envisaged by the state and the urban local bodies (ULB) and the funds are mobilized from the following⁵⁵:

- a. States/ ULBs own resources from the collection of user fees, beneficiary charges and impact fees, land monetization, debt, loans, etc.
- b. Additional resources transferred due to an acceptance of the recommendations of the Fourteenth Finance Commission (FFC).
- c. Innovative finance mechanisms such as municipal bonds with credit rating of ULBs, Pooled Finance Mechanism, Tax Increment Financing (TIF)
- d. Other Central Government schemes like Swachh Bharat Mission, AMRUT, National Heritage City Development and Augmentation Yojana (HRIDAY)
- e. Leverage borrowings from financial institutions, including bilateral and multilateral institutions, both domestic and external sources
- f. States/UTs may also access the National Investment and Infrastructure Fund (NIIF), which was announced by the Finance Minister in his 2015 Budget Speech, and is likely to be set up this year
- g. Private sector through PPPs

Scheme Implementation and Fund utilization mechanism

The implementation of the mission at the city level is carried out by the special purpose vehicle (SPV) which normally plans, appraises, release funds, implements, manages, operates, monitors and evaluates the smart city development project. The SPV is provided with a dedicated and substantial revenue stream to make it-self sustainable and raise additional resources from the market. The contributions from the Government is specially utilized for establishing infrastructure that provides benefits to the public. The projects can be executed through joint ventures, subsidiaries, public-private partnership (PPP) and turnkey contracts.

The SPV is registered as a limited company and the promoters are the state/UT and the ULB having 50:50 equity shareholding. The funds provided by the Gol are treated in the form of a tied grant and kept in a separate grant fund. Such grant funds are utilized as per the conditions stipulated by the MoUD.

Under this scheme the funds are distributed as per the following¹⁴:

- a. 93% of the funds are allocated for the project
- b. 5% of the funds are allocated for administrative and office expenses (A&OE) for state and ULB (for pilot studies, capacity building, preparation of proposals, engagement of project management consultants)
- c. 2% of the fund are allocated for MoUD (Mission Directorate, Research, Pilot studies, capacity building and concurrent evaluation)

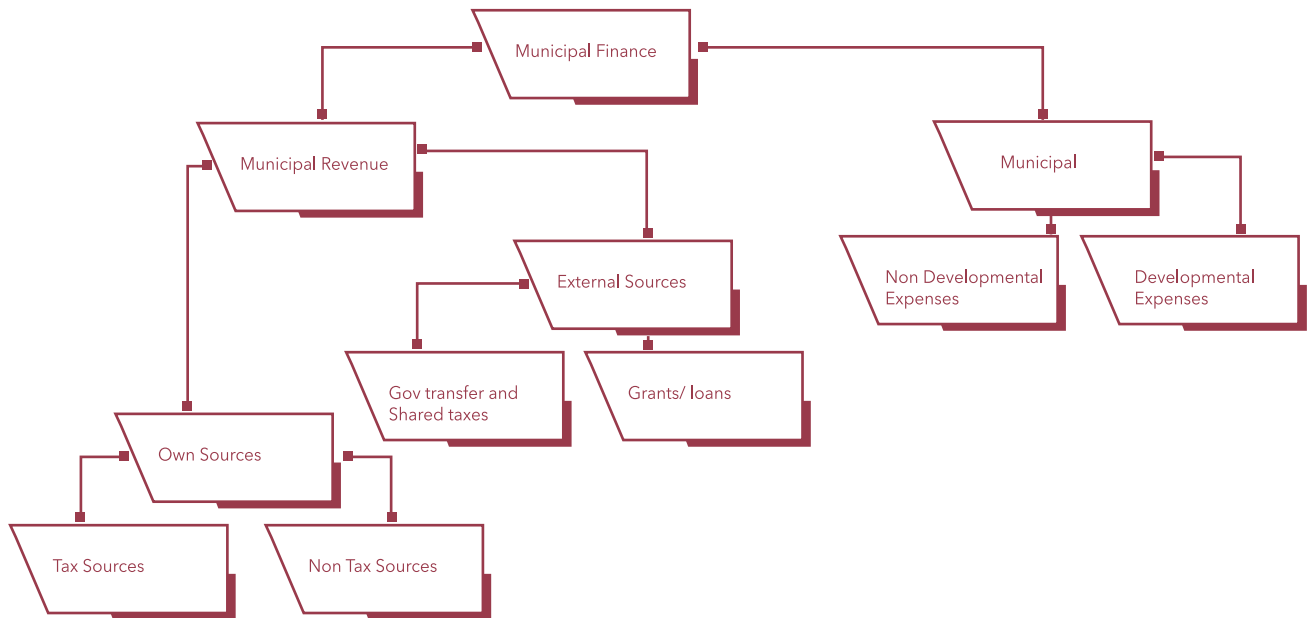
⁵⁵ Smart Cities : Mission Statement and Guidelines; MoUD(2015) link

10.1.5 Municipal Financing

Municipal Corporation in respective cities and towns are entrusted with funds to ensure sustainable environment for citizens in terms of proper waste management, proper roads and sanitation etc. Such features are also

mentioned under NCAP and hence it would be sensible to link some of the action plans of the NCAP with municipalities and utilise the municipality finance to achieve some of the outcomes under NCAP effectively. The schematic layout of the municipal finance is shown in the figure below:

Figure 20: Structure of Municipal Financing⁵⁶



Details on funding sources for Municipal Bodies

ITEMS	DESCRIPTION
Tax Sources	Property Tax, Octroi tax, Advertisement tax, Professional Tax
Non-Tax sources	Fees and fines, user charges, rents from assets
Grants and loans	Capital income and revenue income
Non-developmental expenses	Establishment expenses, wages and salaries, general administration. expenses, loan charges
Developmental expenses	Operation and maintenance of public assets, development of new assets

10.2 City Specific study

The National clean air programme identifies 122 non-attainment Indian cities which violate National Ambient Air Quality Standards (NAAQS). Patna, the state capital of Bihar, is one of them. It is considered to be among the top 5 most polluted cities in the world as per WHO. Through one of the reports, the study team tried to analyse the air pollution

control measures envisaged for the city of Patna. The mentioned report⁵⁷ has reflected on the interventions pertaining to the sectors namely transportation, industries, waste management, residential and others.

The details of the control interventions along with the possible source of funding from the existing schemes of GoI are capsulated in the table below:

⁵⁶India Municipal Finance Report,2011(link)

⁵⁷Comprehensive City Action Plan for the city of Patna, 2019 (link)

Table 30: Source of financing for control intervention in the city of Patna

SECTORS	POLLUTION CONTROL INTERVENTIONS	POSSIBLE SOURCE OF FINANCING
Transportation	Introduction of EVs / CNG vehicles in the city	Smart City Mission
	Enhancement in the public mode of transportation	Smart City Mission, AMRUT
	Building CNG and EV charging stations	Smart City Mission
	Provision of incentives for E-Vehicles	FAME
Waste Management	Implementation of Efficient municipal solid-waste management strategies	City Municipality, AMRUT
	Proper construction and demolition waste management	Swatchh Bharat Mission
Domestic	Introduction of improved cook stoves	UnnattChulha Abhiyan
	Increment in LPG connection in rural areas	Ujjwala Yojana
Others	Construction of road pavements	City Municipality
	Enhancement of green cover in the city	AMRUT
	Addition of mechanical sweepers	Centre grants
	Installation of manual and continuous Air quality Monitoring Stations	Smart City Mission
Industries	Introduction of advanced technologies in Industries	Respective industries with innovative mechanism

10.3 List of Indicative Questionnaire Guide

GOVERNMENT AGENCIES	
AREA	KEY QUESTIONS
SECTORS	What are the major sectors contributing to air pollution?
	What are the priority sectors that Government would like to focus on improving air quality?
	What are the efforts being taken up by the Government to improve air quality in these sectors? What are the sector specific policies?
TECHNOLOGY	What are the key technologies identified by the Govt for implementation of NCAP?
	Is there a need of research and development of new pollution control technology to meet the time bound target?
	Technology barriers? Are the existing technologies adequate enough to overcome the rising pollution issues?
	Is the Government promoting the use of air pollution control technology? What are the future plans with regards to these technologies?

	How does the Government collaborate with public and private entities for implementing such technologies?
CHALLENGES	What are the key challenges faced by Government over the years in implementing pollution control devices? Technology barrier/economic barrier/social barrier or institutional / organizational barrier
	Can you please share details of specific financial challenges faced by the Government in implementing the pollution control technologies?
POLICY INSTRUMENTS	What are the key policies and regulations?
	Are the policy instruments more centre/ state specific?
	What are the probable recommendations/solutions for overcoming the said barriers with policy instruments such as incentives, subsidies, regulations, capacity building?
FINANCING	What are the key financial instruments / mechanism used by the Govt for pollution control?
	Is the budget allocated for controlling pollution levels is adequate or external funding / financing is necessary for driving the control technologies in the market? What is the quantum of financing required?
	What is your take on setting up a pollution control financing facility in India? How can it be linked with the Government and its agencies for effective implementation?

TECHNICAL AND RESEARCH INSTITUTIONS	
AREA	KEY QUESTIONS
TECHNOLOGY	What are the existing pollution control technologies currently in use across various sectors / subsectors?
	How effective is the technology in reducing the air pollution? Is there a need for improvisation?
	What are the emerging pollution control technologies? What is their potential and for which sector are they most relevant?
CHALLENGES	What are the primary barriers for implementation of pollution control technology in India?
	What are the probable recommendations/solutions for overcoming the said barriers?
	How difficult it is to commercialise an innovative technology?
STAKE HOLDER SUPPORT	What kind of Government support is required to improve implementation of such technologies at scale?
	How can the financial institutions help in addressing the challenges?

FINANCIAL INSTITUTIONS	
AREA	KEY QUESTIONS
INVESTMENT PORTFOLIO	What kind of financing support do you provide
	What is the investment mandate? How is the fund structured?
	Do you have any sector and / or geography focus?
	How many investments have you made? What is the ticket size (avg. and range)?
	What is the size of your investment portfolio?
	What mix of business models and technologies do you have in your portfolio?
	How many investments do you have for pollution control technologies? Which sectors?
CRITERIA FOR INVESTMENT	What is your investment approach towards clean technologies preferably air pollution control technologies? a) How do you select businesses? b) Investment duration? c) Investment conditions? d) Expected IRR? e) Exit strategy? f) If debt, interest rate and collateral requirements?
	Do you prefer to invest in Govt enterprises or Private entity?
	What technologies are you looking to invest in in the future?
	What is the most preferable payback period for the air pollution control technologies?
CHALLENGES	What are the challenges perceived by you in financing clean technologies in India?
POLICY INSTRUMENTS	What unique policies and scheme would you like the Government to implement in the area of air pollution control technology?

10.4 List of thermal power plants in India to install FGD

STATE	THERMAL POWER STATION	CAPACITY MW
Andhra Pradesh	Simhadri Super Thermal Power Plant	2000
	Dr Narla Tata Rao TPS	1760
	Rayalaseema Thermal Power Station	1650
	Sri DamodaramSanjeevaiah TPS	1600
	Vizag Thermal Power Station	1040
	Meenakshi Thermal Power Station	1000
	SGPL Power Station	1320
	Sembcorp Energy India Limited	1320
	Simhapuri Thermal Power Station	600

Assam	Lakwa Thermal Power Station	157
	Namrup Thermal Power Station	111
	Bongaigaon Thermal Power Station	750
Bihar	Barauni Thermal Power Station	220
	Barh Super Thermal Power Station	3300
	Kahalgaon Super Thermal Power Station	2340
	Nabinagar Super TP Project (upcoming)	1980
	Kanti Thermal Power Station	610
Chhattisgarh	Korba West Thermal Power Station	840
	Korba East Thermal Power Station	440
	Dr Shyama Prasad Mukherjee TPS	500
Gujarat	Ukai Thermal Power Station	850
	Gandhinagar Thermal Power Station	870
	Wanakbori Thermal Power Station	1470
	Sikka Thermal Power Station	240
	Dhuvaran Thermal Power Station	220
	Kutch Thermal Power Station	290
	Surat Lignite TPS	500
	Akrimota Thermal Power Station	250
	Mundra Thermal Power Station	4620
	Sabarmati Thermal Power Station	400
Jharkhand	Matrishri Usha Jayaswal Mega Power Plant	1080
	Maithon Power Plant	1050
	Koderma Thermal Power Station	1000
	Jojobera Power Plant	547
	Chandrapura Thermal Power Station	630
	BPSCL Power Plant	302
	Bokaro Thermal Power Station B	630
	North Karanpura Thermal Power Station	1980
	Tenughat Thermal Power Station	420
	Patratu Super TPS (Upcoming)	4000

Karnataka	Raichur Thermal Power station	1720
	Bellary Thermal Power station	1700
	Yermarus Thermal Power Station	1600
Madhya Pradesh	Amarkantak Thermal Power Station	210
	Sanjay Gandhi Thermal Power Station	1340
	Satpura Thermal Power Station	1330
	Shree Singaji Thermal Power Station	2520
	DadaDhuniwale TPP (Upcoming)	1600
Maharashtra	Chandrapur Super Thermal Power Station	3340
	Koradi Thermal Power Station	1980
	Khaparkheda Thermal Power Station	1340
	Bhusawal Thermal Power Station	1420
	Nashik Thermal Power Station	630
	Parli Thermal Power Station	1130
	Paras Thermal Power Station, Akola	500
Odisha	Ib Thermal Power Station	960
	Talcher Super Thermal Power Station	3000
	Talcher Thermal Power Station	460
Punjab	Guru Hargobind Thermal Plant	920
	Guru Nanak Dev Thermal Plant	460
	Guru Gobind Singh Super Thermal Power Plant	1260
Rajasthan	Suratgarh Super Thermal Power Plant	1500
	Kota Super Thermal Power Plant	1240
	Giral Lignite Power Plant	250
	Chhabra Thermal Power Plant	2320
	Barsingsar Thermal Power Station	250
	VS Lignite Power Plant	135
Tamil Nadu	Ennore Thermal Power Station	450
	Mettur Thermal Power Station	1440
	North Chennai Thermal Power Station	1830
	Tuticorin Thermal Power Station	1050

Telangana	Kakatiya TPP	1100
	Kothagudem TPS	1720
	Ramagundam TPS	62.5
	NTPC Ramagundam	2600
	Singareni TPP	1400
	Bhadradi TPP	540
	Telangana Super TPP	1600
	Yadadri TPP (Upcoming)	4000
Tripura	Monarchak Thermal Power Plant	100
Uttar Pradesh	Anpara Thermal Power Station	3830
	Obra Thermal Power Station	1288
	Panki Thermal Power Station	210
	Parichha Thermal Power Station	1140
	Harduaganj Thermal Power Station	655
West Bengal	Kolaghat Thermal Power Station	1260
	Bakreswar Thermal Power Station	1050
	Sagardighi Thermal Power Project	1600
	Bandel Thermal Power Station	450
	Santaldih Thermal Power Station	500
	Farakka Super Thermal Power Station	2100
	Durgapur Thermal Power Station	350
	Mejia Thermal Power Station	2340

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