Select Study of Air Pollution Reduction Programs around the World: Governance and Implementation Issues

Indian Institute of Technology-Delhi

Final report

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Table of Contents
List of Figures ............................................................................................................................ v
List of Tables ............................................................................................................................... vii
Nomenclature ............................................................................................................................. viii
Executive Summary ..................................................................................................................... x
1 Background of Air Pollution Problem in Tokyo ................................................................. 1
  1.1 Characterization of Tokyo ................................................................................................. 1
    1.1.1 Administrative structure ......................................................................................... 1
    1.1.2 Growth and development patterns ........................................................................... 2
    1.1.3 Geography ................................................................................................................. 2
    1.1.4 Climate ..................................................................................................................... 2
  1.2 Structure of the environmental organization in Japan ..................................................... 2
  1.3 National targets for reducing greenhouse gas emissions ............................................... 3
    1.3.1 National targets ...................................................................................................... 3
    1.3.2 Tokyo city targets for reducing greenhouse gas emissions .................................... 4
    1.3.3 Emissions/carbon trading schemes ....................................................................... 4
  1.4 Environmental quality standards in Japan .................................................................... 4
2 A Comprehensive Regulatory Framework ........................................................................... 7
  2.1 Origin and evolution of air pollution problems and its mitigation actions in Japan ... 7
  2.2 The regulatory framework for air pollution abatement .................................................. 10
    2.2.1 Air pollution acts in Japan ....................................................................................... 10
    2.2.2 Basic Environmental Pollution Control Law ......................................................... 15
    2.2.3 Pollution Parliament ............................................................................................... 16
    2.2.4 Environment Agency ............................................................................................. 17
    2.2.5 The Basic Environment Law ................................................................................... 17
  2.3 Regulatory framework ...................................................................................................... 18
    2.3.1 The regulatory regime for air pollution ................................................................... 19
    2.3.2 Air quality monitoring ............................................................................................ 20
2.3.3 Current air quality status in Japan.................................................................................20
2.3.4 Achievement in air pollution reduction .................................................................21
  2.3.4.1 PM$_{2.5}$ reduction .................................................................................................21
  2.3.4.2 Ozone reduction ..................................................................................................22
  2.3.4.3 NOx reduction ....................................................................................................22
2.3.5 Control of volatile organic compound........................................................................23
3 Other Important Steps in Air Pollution Reduction ..........................................................24
  3.1 Act on promoting green procurement ........................................................................24
  3.2 Emergency alerts ........................................................................................................24
    3.2.1.1 Issuance of alerts on PM$_{2.5}$ ...........................................................................26
    3.2.1.2 Issuance of alerts on O$_3$ ................................................................................26
    3.2.1.3 Domestic measures on PM$_{2.5}$ ......................................................................26
  3.2.2 VOC voluntary regulations .....................................................................................27
  3.2.3 Waste Management...................................................................................................28
  3.2.4 Success in household waste management ................................................................29
  3.2.5 Waste to energy incineration plant ..........................................................................30
4 Co-Benefit as Best Practices ............................................................................................32
  4.1 Clean diesel ................................................................................................................33
  4.2 Open burning (crop residue) ....................................................................................34
  4.3 Thailand’s eco-car program ........................................................................................34
  4.4 Multi-modal transport sharing in Kashiwa, Japan experimenting with next-generation
      transport ........................................................................................................................35
  4.5 The multiple benefits of clean energy in Japan: the case of Nagano .........................36
5 Electric vehicle Industry ....................................................................................................39
  5.1 About Nissan electric vehicle ....................................................................................39
  5.2 Electric vehicle policy ..................................................................................................39
  5.3 EV charging infrastructure ..........................................................................................40
5.4 Battery recycle and reuse strategy ................................................................. 41

6 Lessons from Beijing .......................................................................................... 43

6.1 Characterization of Beijing city ....................................................................... 43
   6.1.1 Administrative structure ............................................................................ 43
   6.1.2 Growth and development patterns ............................................................. 44
   6.1.3 Geography .................................................................................................. 44
   6.1.4 Climate ...................................................................................................... 45

6.2 Structure of the environmental organization in China .................................... 45
   6.2.1 Ministry of Ecology and Environment (MEE) ........................................... 45
   6.2.2 Origin of Ministry of Ecology and Environment ......................................... 45
      6.2.2.1 Mandates (responsibilities) of MEE .................................................... 47
      6.2.2.2 Organization structure of MEE ............................................................ 48

6.3 Environmental policy in China ......................................................................... 51
   6.3.1 Environmental regulatory framework of China ........................................... 53
   6.3.2 The regulatory regime for air pollution ...................................................... 53

6.4 The recent air pollution problem ...................................................................... 54

6.5 Sources of pollution in Beijing ........................................................................ 58

6.6 Actions taken by the Chinese government to curb air pollution ....................... 60
   6.6.1 Actions in the initial phase (before 2013) .................................................... 60
   6.6.2 Actions taken between 2013- 2017 ............................................................... 61

6.6.3 Vehicle policy in China ................................................................................ 63
   6.6.3.1 New vehicle emissions standards ......................................................... 63
   6.6.3.2 New energy cars ................................................................................... 63
   6.6.3.3 New Two-wheelers ............................................................................... 64
   6.6.3.4 Vehicle emission standard compliance and enforcement program ...... 65

6.6.4 Chinese 2020 action plan ............................................................................ 66

7 Recommendations for the Indian government ....................................................... 67
7.1 Recommendations from Japan ................................................................................. 67
  7.1.1 Air quality monitoring and alerts ........................................................................ 67
  7.1.2 Electric vehicle industry .................................................................................... 67
  7.1.3 Waste management ............................................................................................ 68
  7.1.4 Green promotion and rating .............................................................................. 68
  7.1.5 Co-benefits ......................................................................................................... 69
7.2 Recommendations from China .................................................................................. 69
7.3 Development of “Clean Air Partnership (CAP)” ...................................................... 70
  7.3.1.1 Activities of CAP ........................................................................................... 71
  7.9.1.1 Funding of CAP ............................................................................................. 72
8 Outreach and Outcomes of the Study .......................................................................... 73
  8.1 Publications ............................................................................................................ 73
    8.1.1 Peer-reviewed journal articles ............................................................................ 73
    8.1.2 Discourse and dissemination ............................................................................. 74
  8.2 Workshop and conference ...................................................................................... 76
    8.2.1 Workshop and conference organized .................................................................. 76
    8.2.2 Workshop and conference attended .................................................................. 78
  8.3 Report .................................................................................................................... 84
  8.4 Outreach to the Government .................................................................................. 85
List of Figures

Figure 1.1 A view of Tokyo city ........................................................................................................1
Figure 1.2 Structure of the environmental organization in Japan .................................................3
Figure 2.1 Chronological evolution of air pollution problems and action..............................9
Figure 2.2 Japanese Multipronged Air Pollution Reduction Approach.................................10
Figure 2.3 The main features of the Basic Law for Environmental Pollution Control ..........16
Figure 2.4 The regulatory framework of Japan ...........................................................................18
Figure 2.5 The regulatory regime for air pollution .................................................................19
Figure 2.6 Process of new regulation and its insurance of good implementation ..................19
Figure 2.7 Conceptual Diagram of Ideal Cooperation ..............................................................20
Figure 2.8 Strategy for control of VOC ..................................................................................23
Figure 3.1 Flow for issuing Warnings and Alerts ....................................................................25
Figure 3.2 Reporting/announcing system of emergency alerts ..................................................25
Figure 3.3 Leaflet on waste separation (Shinjuku City) ............................................................29
Figure 3.4 Sanitation workers give lessons to elementary school students ............................29
Figure 3.5 A process diagram of Ota incineration plant ...........................................................31
Figure 4.1 Asian Co-benefits Partnership good practice map ....................................................33
Figure 5.1 Holistic policy support for EV expansion .................................................................40
Figure 5.2 Quick Charging (QC) Network in Japan .................................................................41
Figure 5.3 Reuse Business with 2nd Life Battery .................................................................42
Figure 6.1 A view of Beijing ......................................................................................................43
Figure 6.2 Main responsibilities of Ministry of Ecology and Environment (MEE) ..................48
Figure 6.3 Organization structure of the MEE .......................................................................49
Figure 6.4 MEE offices and the department’s structure and their main role ............................50
Figure 6.5 Environmental governance structure in China ......................................................52
Figure 6.6 Environmental regulatory framework of China. .....................................................53
Figure 6.7 The regulatory regime for air pollution .................................................................54
Figure 6.8 Recent development of air problem .................................................................55
Figure 6.9 Beijing air quality metrics from 2005 -2009 ...........................................................55
Figure 6.10 Ambiguity in Beijing air quality metrics ...............................................................57
Figure 6.11 Local sources of PM2.5 in Beijing ........................................................................58
Figure 6.12 Major sources of PM2.5 in Beijing, Tianjin and Hebei (BTH) ..............................59
Figure 6.13 BTH air quality metrics ......................................................................................60
Figure 6.14  Steps taking by the Chinese government to reduce air pollution ..................61
Figure 6.15  Beijing 2013-2017 Clean Air Action Plan ..................................................62
Figure 6.16  Framework of financial incentives in China .................................................65
Figure 7.1  Strategy to increase waste segregation ..........................................................68
Figure 7.2  Outline of proposed Clean Air Partnership (CAP) ........................................71
Figure 8.1  Participants of “Blue Sky Initiatives for Delhi” ..............................................76
Figure 8.2  Participants of “Knowledge Exchange Session” ..............................................77
Figure 8.3  Picture with EPIC team members .................................................................78
List of Tables

Table 1.1 Air quality standards ................................................................. 4
Table 2.1 Acts/Actions passed by the Japanese government to curb Air pollution............. 10
Table 2.2: Current air quality status in Japan. ....................................................... 21
Table 3.1 Environmental measures to prevent exhaust from the incineration plan........... 30
Table 5.1 Nissan LEAF Models........................................................................ 39
Table 5.2 Nissan Vehicle Electrification Strategy.................................................... 39
Table 6.1 The regional centers of MEE ................................................................ 51
**Nomenclature**

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>CERCA</td>
<td>Centre of Excellence for Research on Clean Air</td>
</tr>
<tr>
<td>AQI</td>
<td>Air Quality Index</td>
</tr>
<tr>
<td>APAPPC</td>
<td>Action Plan for Air Pollution Prevention and Control</td>
</tr>
<tr>
<td>BCAAP</td>
<td>Beijing Clean Air Action Plan</td>
</tr>
<tr>
<td>MEP</td>
<td>Ministry of Environmental Protection</td>
</tr>
<tr>
<td>MEE</td>
<td>Ministry of Ecology and Environmental</td>
</tr>
<tr>
<td>NGOs</td>
<td>Non-governmental organizations</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organization</td>
</tr>
<tr>
<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>MEP</td>
<td>Ministry of Environmental Protection</td>
</tr>
<tr>
<td>MEE</td>
<td>Ministry of Ecology and Environmental</td>
</tr>
<tr>
<td>NGOs</td>
<td>Non-governmental organizations</td>
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<td>WHO</td>
<td>World Health Organization</td>
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<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organization</td>
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<tr>
<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross domestic product</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental impact assessment</td>
</tr>
<tr>
<td>NDRC</td>
<td>National Development and Reform Committee</td>
</tr>
<tr>
<td>CCER</td>
<td>Chinese Certified Emissions Reductions</td>
</tr>
<tr>
<td>DPFs</td>
<td>Diesel particulate filters</td>
</tr>
<tr>
<td>ULSD</td>
<td>Ultra-low-sulfur diesel (&lt; 10 ppm)</td>
</tr>
<tr>
<td>EPBs</td>
<td>Environmental protection bureaus</td>
</tr>
<tr>
<td>NAAQS</td>
<td>National Ambient Air Quality Standard</td>
</tr>
<tr>
<td>N</td>
<td>North</td>
</tr>
<tr>
<td>E</td>
<td>East</td>
</tr>
<tr>
<td>BJEPEB</td>
<td>Beijing Environmental Protection Bureau</td>
</tr>
<tr>
<td>%</td>
<td>Percent</td>
</tr>
<tr>
<td>/</td>
<td>Per</td>
</tr>
<tr>
<td>°</td>
<td>Degree</td>
</tr>
<tr>
<td>°C</td>
<td>Degree celsius</td>
</tr>
<tr>
<td>CNG</td>
<td>Compressed Natural Gas</td>
</tr>
<tr>
<td>CO</td>
<td>Carbon monoxide</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>Conc.</td>
<td>Concentration</td>
</tr>
<tr>
<td>IIT</td>
<td>Indian Institute of Technology</td>
</tr>
<tr>
<td>K</td>
<td>Kelvin temperature</td>
</tr>
<tr>
<td>LPG</td>
<td>Liquefied petroleum gas</td>
</tr>
<tr>
<td>PM₂.₅</td>
<td>Particulate matter less than 2.5 microns in diameter</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>Particulate matter less than 10 microns in diameter</td>
</tr>
<tr>
<td>ppm</td>
<td>Parts per million</td>
</tr>
<tr>
<td>SO₂</td>
<td>Sulfur dioxide</td>
</tr>
<tr>
<td>SO₅</td>
<td>Sulfur oxides</td>
</tr>
<tr>
<td>GHG</td>
<td>Greenhouse gas</td>
</tr>
<tr>
<td>STP</td>
<td>Standard temperature and pressure</td>
</tr>
<tr>
<td>t</td>
<td>Time</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>yr</td>
<td>Year</td>
</tr>
<tr>
<td>BTH</td>
<td>Beijing, Tianjin and Hebei</td>
</tr>
<tr>
<td>VOCs</td>
<td>Volatile organic compounds</td>
</tr>
</tbody>
</table>

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BTH = Beijing, Tianjin and Hebei

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viii
Executive Summary

Background

China and Japan are chosen as the study areas based on the similarity of experiences in terms of air pollution. Japan is further focused on due to a similar democratic set up. The Embassy of Japan in New Delhi was approached, and they readily coordinated a visit involving meetings with stakeholders in the Ministry of the Environment, Japan, industry, and research institutes/thinktanks. Japan has passed through a phase of severe pollution, and come out of it well. The first part of this report attempts to capture the Japanese experience based on the visit to Japan and associated research.

The second part of the report presents the Chinese experience to fight with air pollution problem. The information gathered in this part has been collated from different open resources and publications from various government and non-government organizations.

Air pollution problem and status

Japan’s rapid economic growth in the post-war period took its toll, with severe air pollution in large cities and areas surrounding industrial districts. Businesses could not afford the costs of investments in pollution abatement technology and wanted the government to take on the burden, providing them with low-interest loans or even outright grants of aid. In 1967, the national government began to acknowledge the pollution crisis and created the first official act “Basic Law for Environmental Pollution Control”. Yokkaichi Pollution along with three water pollution cases (Minamata and Niigata mercury poisoning cases; the itai-itai cases (ouch ouch)), referred to as the Big Four pollution cases received massive public support. The trial of the Big Four cases raised awareness of the public toward pollution issues and stimulated at least 3000 citizen movements by 1973. These lawsuits and citizens’ movements and pollution became a political issue. Thus significant activism in 1960s and 70s led to the courts intervening, decision-makers take it seriously, an indication of the seriousness level is the Pollution Parliament.

Air pollution is not very recent in Beijing’s history; it started with the industrialization growth of China beginning in the 1960s. Rapid industrialization, along with fast urbanization, intensified the anthropogenic pollution level, especially the concentration of greenhouse gases and particulate matters. In 2007 concentration of PM$_{2.5}$ and Ozone reached about 34 % and 35% respectively above the normal range. Due to 2008 Beijing Summer Olympics, Beijing implemented several steps to control and reduce air pollution. However, in 2011, the city
burned 26.3 million tons of coal, 73% of which for heating and power generation and the remainder for the industry. Coal-burning accounts for about 40% of the PM$_{2.5}$ in Beijing and is also the chief source of nitrogen and sulfur dioxide. On 12 January 2013, the Air Quality Index (AQI) in Beijing rose to a record 755, called as the ”Blackest Day”. Hence, to control and reduce this severe air pollution, Beijing Municipal Government formulated the “Beijing Clean Air Action Plan (BCAAP, 2013-2017)” while China’s State Council implemented the “Action Plan for Air Pollution Prevention and Control (APAPPC, 2013-2017) on 10 September 2013.

Lessons learned and recommendations for India

The Japanese efforts were prompted by a spate of public movements, court cases that culminated in a concerted and intense regulatory effort in the *Pollution Parliament*. The regulatory framework went from strength to strength in response to the needs, and this adaptive and sincere approach, driven by a push from the topmost decision making levels, both offers us lessons, and has been a backbone for the Japanese clean air efforts. Chapters 1 and 2 present more details of the evolution of the Air Pollution Control Act (APCA) through its five amendments and other regulatory efforts. Several other things fell in place for Japan to finally see blue skies. While their details are presented in the report, a summary is as follows:

- Strong, adaptive, empowering Air Pollution Control Acts that incorporate locally designed standards and targets, introduction and management of voluntary reduction programmes and empowerment of local governments to implement the laws and targets
- Sincere monitoring and follow up action, including alerts.
- Encouraging green procurement.
- Effective waste management via systems (entire value chain), technology (incineration plants), people’s engagement (*Mottainai, 3R*), and outreach (by workers, leaders).
- Waste management and clean air awareness starting from school children itself.
- Facilitation of the EV ecosystem.
- Supporting research and strategization among research institutes (co-benefits).

India can learn from this experience, particularly through the following action items:

- Learning from specific instances of regulations, and their implementation through capacity building and regular exchange of best practices.
Better design of air quality monitoring, and more importantly, use of the monitored data, at least through a system of alerts.

- Strengthen EV ecosystem through innovative/non-financial incentives, infrastructural support and tax/subsidy incentives, cooperation among industry players.
- Education (including among schools) and outreach for waste management, especially segregation at source, without much none of recycling, incineration or any other process works well.
- Promotion of green products through Government e-Marketplace (GeM), green ratings, and legislation, if needed.
- Strategization, including its dissemination through case studies and other innovative means, that highlight co-benefits, i.e., how economy or “development” doesn’t always become a casualty in the fight against air pollution.

To control and reduce dangerous air pollution, Beijing launched various plans. The main targets of the “Beijing 2013-2017 Clean Air Action Plan” were to control air pollution by adequately dealing with automobile, industry, coal combustion, flowing dust, and other problems. APAPPC (2013-2017) was the most comprehensive and most stringent plan to control and, in some regions, reduce air pollution by the year 2017, setting stricter limits on the levels of PM$_{2.5}$ particles. The main targets of as follows:

1. By 2017, urban concentrations of PM$_{10}$ shall be decreased by 10% compared with 2012; the annual number of days with fairly good air quality will gradually increase
2. PM$_{2.5}$ concentrations for the Beijing-Tianjin-Hebei region shall be lowered by 25%, the Yangtze River Delta region lowered by 20%, and the Pearl River Delta region lowered by 15% in 2017 compared with 2013.
3. The annual average PM$_{2.5}$ concentration in Beijing shall be controlled below 60 $\mu$g/m$^3$ in 2017

According to the Chinese government report, Beijing has achieved some milestone targets, and an annual average PM$_{2.5}$ level reached 58$\mu$g/m$^3$ – a drop of 35%. As well as China’s three most significant city clusters (Beijing-Tianjin-Hebei (BTH), and the Pearl and Yangtze deltas) all beat their targets. But even so, no Chinese city yet reaches the World Health Organization’s (WHO) recommended annual average PM$_{2.5}$ level of 10$\mu$g/m$^3$. And as of the end of 2017, only 107 of China’s 338 cities of prefectural level or higher had reached the WHO’s interim standard of 35$\mu$g/m$^3$. Therefore to Winning the Blue Sky War Chinese government launched a
new 2018-2020 Three-year Action Plan regarded as the second phase of the APAPPC (2013-2017). The new plan matches the PM$_{2.5}$ target published in 2016 as part of the 13th Five-Year Plan for environmental protection: mandating falls of at least 18% in PM$_{2.5}$ levels on a 2015 baseline in cities of prefectural or higher level, and where standards have not already been met. The Three-year Action Plan will apply to all these cities. In comparison, the 2013 Action Plan only set PM$_{2.5}$ targets for the city clusters of BTH and the Pearl and Yangtze Deltas.

Following are the significant findings from China:

- Buy-in from the top leadership
- Clear responsibility (public interviews, special inspections, local government first responsibility, *incentives – higher promotion rates*)
- Innovations in supervision methods (*double random, open*)
- Tech ecosystem (policy, infra, prod, speed etc), essentially EVs

**Follow up mechanism - Clean Air Partnership:** Regular exchange of best practices and pilot of relevant and innovative ideas can happen through an Indo-Japan Clean Air Partnership levearing the Memorandum of Cooperation between the respective environment ministries in India and Japan, with a diverse and multi-stakeholder expert group driving activities and exploring the need and ways to grow the partnership. Suggested activities are discussed in detail in the report, and funding mechanisms to sustain it after some initial seed funding by JICA, and if relevant, an Indian agency, can be developed.
1 Background of Air Pollution Problem in Tokyo

This chapter presents a background of the air pollution situation in Tokyo. The origin, evolution, and context of the problem are discussed, and the analysis clearly reveals that Tokyo has gone through phases similar to Delhi (India), and consequently, there is much to learn. The chapter begins with a characterization of the Tokyo city in the next subsection.

1.1 Characterization of Tokyo

Tokyo is the capital and one of the 47 prefectures of Japanese. It is the most densely populated metropolitan city in the world [1] and home of 39 million residents.

1.1.1 Administrative structure

Tokyo city administration is more or less similar to the Delhi state. Tokyo city is officially governed as a "metropolitan prefecture," and combines features of both a city and a prefecture. The Tokyo Metropolitan Government has 23 Special Wards, each having a mayor, a council, and the status of a city. The Tokyo Metropolitan Government, which administers the whole
metropolis, is headed by a publicly elected governor and metropolitan assembly. Its headquarters are located in Shinjuku Ward.

1.1.2 Growth and development patterns

Tokyo, is a major economic center of Japan as well as world having a $2.5 trillion economy value and we consider Tokyo as a country, then it would rank 8th in term of world economy. Tokyo ranks first in the Global Economic Power Index [2] and third in the Global Cities Index [3].

1.1.3 Geography

Tokyo's mainland portion exists in the northwest of Tokyo Bay and measures approximately 90 km east to west and 25 km north to south. In Tokyo, the elevation is 40 m [1].

1.1.4 Climate

Tokyo falls in the humid subtropical climate zone with hot, humid summers, and snowstorms occur typically in winter weather [4]. The region experiences a one-month seasonal lag, with the warmest month being August, which averages 26.4 °C, and the coldest month being January, averaging 5.2 °C.

1.2 Structure of the environmental organization in Japan

The organizational setup has similarities to the Indian setup. The apex body is the Ministry of Environment with several departments. It maintains close coordination with several institutions and regional environmental offices. The setup is completed by a set of administrative agencies. This structure is described in Figure 1.2.
The sections 1.3 to 1.6 present the comprehensive environmental policy of Japan [5] and environmental control measurements by Japan government [6].

1.3 National targets for reducing greenhouse gas emissions

A key factor responsible for the Japanese success is the setting, announcement, and achievement of targets. This section describes these targets to give a perspective and benchmark for the Indian scenario.

1.3.1 National targets

Currently, at national level there are no official targets to mitigate greenhouse gas emissions. However, Japan is a party to the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. And under first commitment period (2008 to 2012) of Kyoto Protocol it achieved the target of 6% GHG emissions reduction. But is not bound by the Kyoto Protocol in the second commitment period (2013 to 2020).
At the G7 Summit in June 2015, however, Japan's Prime Minister announced Japan’s ambitious target of reducing global greenhouse gas emissions by 26 per cent by 2030 compared to 2013 and in July 2015 same target was officially submitted to the UN [4].

1.3.2 Tokyo city targets for reducing greenhouse gas emissions

Following steps have been taken by the Tokyo Metropolitan Government for reducing greenhouse gas emissions:

- Under the first compliance period (2010 to 2014) of Tokyo Metropolitan Government greenhouse gas emissions reduction scheme the target was set to reduce GHG emissions 6% or 8% (according to the type of the building) below base emissions. And under the second compliance period (2015 to 2019) the target was set to reduce GHG emissions 15% or 17% (according to the type of the building) below the base emissions. Notified building owners are having some credits given by the Tokyo Metropolitan Government to achieve their goals.

- From 1 July 2012, keeping in mind to reduce GHG emissions the act on purchase of renewable energy sourced electricity by electric utilities was enacted and a feed-in tariff scheme (FIT scheme) for renewable energy started [7]. Under that same Act, electric power distributors have to buy electricity from renewable energy sources for a government-guaranteed duration at a fixed price [4].

1.3.3 Emissions/carbon trading schemes

Japan started “Voluntary Emissions Trading Scheme” emissions trading scheme in 2005 and in 2013, the Voluntary Emissions Trading Scheme with the Domestic Credit Scheme was merged into the J-Credit Scheme [8]. Under the new scheme, the government certifies the amount of greenhouse gas emissions (for example, CO2) reduced or removed by carbon sinks as credit [4].

1.4 Environmental quality standards in Japan

Table 1.1 presents air quality standards and their measuring methods for different pollutants.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Environmental conditions</th>
<th>Measuring method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substance</td>
<td>Daily Average Requirements</td>
<td>Analytical Method</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Sulfur dioxide</td>
<td>The daily average for hourly values shall not exceed 0.04 ppm, and hourly values shall not exceed 0.1 ppm (Notification on May 16, 1973)</td>
<td>Conductometric method or ultraviolet fluorescence method</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>The daily average for hourly values shall not exceed 10 ppm, and average of hourly values for any consecutive eight hour period shall not exceed 20ppm (Notification on May 8, 1973)</td>
<td>Nondispersive infrared analyzer method</td>
</tr>
<tr>
<td>Suspended particulate matter</td>
<td>The daily average for hourly values shall not exceed 0.10 mg/m³, and hourly values shall not exceed 0.20 mg/m³ (Notification on May 8, 1973)</td>
<td>Weight concentration measuring methods based on filtration collection, or light scattering method; or piezoelectric microbalance method; or β-ray attenuation method that yields values having a linear relation with the values of the above methods.</td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>The daily average for hourly values shall be within the 0.04-0.06 ppm zone or below that zone (Notification on July 11, 1978)</td>
<td>Colorimetry employing Saltzman reagent (with Saltzman's coefficient being 0.84) or chemiluminescent method using ozone.</td>
</tr>
<tr>
<td>Photochemical oxidants</td>
<td>Hourly values shall not exceed 0.06 ppm (Notification on May 8, 1973)</td>
<td>Absorption spectrophotometry using a neutral potassium iodide solution; coulometry; ultraviolet absorption spectrometry; or chemiluminescent method using ethylene.</td>
</tr>
</tbody>
</table>
The annual standard for PM2.5 is less than or equal to 15.0 μg/m³. The 24 hour standard, which means the annual 98th percentile values at designated monitoring sites in an area, is less than or equal to 35μg/m³. (Notification on September 9, 2009)

Mass measurement with filter sample collection which is designated as a reference method, or alternative automated methods, designated as equivalent methods, which are proved to have measurement performance comparable to the corresponding reference method.

The next four chapters, viz., chapters 2 through 5, describe the key lessons from and attributes of the Japanese experience that made their air pollution reduction programme the success that it is. It is followed by learnings from China and then recommendations for the Indian context.
2 A Comprehensive Regulatory Framework

The lesson from Tokyo is based on the learning and personal high-level visits and meetings with different government officers, academicians, think tanks, and industry representatives.

2.1 Origin and evolution of air pollution problems and its mitigation actions in Japan

This chapter presents a point wise summary of the origin and evolution of air pollution and its implications in Japan. The origin and evolution of air pollution can be summarized as follows:

- Japan’s rapid economic growth in the post-war period has taken its toll, with severe air pollution problem pertained in major cities and areas surrounding industrial districts [10]. Businesses could not afford the costs of investments in pollution abatement technology and wanted the government to take on the burden, providing them with low-interest loans or even outright grants of aid.

- In 1959, a major oil refineries and petrochemical and power plants began operations in the city of Yokkaichi in Mie prefecture. Soon, around 1960 with the combustion of heavy oil containing high amount of sulfur (about 3%) started releasing a higher amount of SO\(_2\) into the atmosphere and lead to the cause of serious air pollution known as the Yokkaichi Pollution [10]. The existing Smoke and Soot Regulation Law of 1962 was ineffective against the new type of pollution by the petrochemical complex.

- Residents of the area lodged protests against it, but the operators ignored their pleas. Yokkaichi and the Yokkaichi city government began an investigation of the health effects of the pollution. Later, the Ministry of Health and Welfare (MHW) and the Ministry of International Trade and Industry (MITI) established the Kurokawa Investigation Task Force to investigate the air pollution problem at Yokkaichi and make recommendations. Following the Kurokawa recommendations, the complex installed higher stacks in 1963 and lowered the peak concentrations of SO\(_2\) ppm/hr. However, it also had the effect of expanding the pollution zone.

- In 1965, Yokkaichi city began a Special Medical Relief Program for Pollution-Related Diseases, financed by Mie Prefecture. Despite the remedial measures which had been taken, the pollution worsened from 1965-67.

- In 1967, the national government began to acknowledge the pollution crisis and created the first official act, “Basic Law for Environmental Pollution Control”.


In 1967, twelve victims filed suit against the petrochemical complex for damage to their health. The press provided extensive coverage of the trial. In 1972, the court issued a decision solidly upholding the plaintiffs’ claims. In response to the decision, Mie prefecture enacted the Environmental Pollution Control Ordinance. The new ordinance regulated total SO$_2$ mass emissions such that an air quality standard of 0.017 ppm/year would be met.

Simultaneously, the continuous monitoring of air pollution in major cities (Tokyo, Osaka, etc.) and surrounding industrial districts (Yokkaichi, etc.) was launched in 1962, followed by the implementation of the Air Pollution Control Law in 1968. In the same year, an online, real-time air pollution monitoring system was developed by the Government of Osaka Prefecture, linking 15 local monitoring stations via radio transmission. Other municipalities followed, setting up similar systems. Later, the central government modeled national legislation on the Yokkaichi project.

Yokkaichi Pollution along with three water pollution cases (Minamata and Niigata mercury poisoning cases; the itai-itai cases (ouch ouch)), referred to as the Big Four pollution cases received massive public support: trial of the Big Four cases raised awareness of public toward pollution issues and stimulated at least 3000 citizen movements by 1973. These lawsuits and citizens’ movements caused the government to respond by creating increasingly stringent environmental legislation [11], notably through the pollution parliament in 1970. The Big Four verdicts themselves constitute one of the “most environmentally progressive” bodies of case law anywhere in the world.

Pollution became a political issue because of the high population density of Japanese cities, high investment to consumption ratios, and strategy that attempted to decentralize industrial development. The four big cases demonstrate how pollution became an issue of national concern, how formal legal responsibility became a worthy objective, how protection from pollution evolved into a right, and how litigation joined the citizens’ repertoire as a path to participation. They also highlight how rather than suing a company for willful damage and harm to human health, anti-pollution movements, in the absence of suitable government response, can sue government institutions for violations of administrative laws and procedures, and get favorable judgments, causing both fiscal and political damage to the government.
Figure 2.1 Chronological evolution of air pollution problems and action

Figure 2.1 shows the summary of the chronological evaluation of air pollution problems and actions taken by the Japanese government. While details of the regulations and implementation are presented in the next chapter, an overview of the Japanese approach is summarized below to highlights its key features and differences with other approaches:

- Japan uses a polluter pays principle (also punish polluters principle) - an example of a user-charge system recommended by economists. This gives the industry a stake in developing an anti-pollution technology. This lies in sharp contrast to the American preference for a bureaucratic-intensive regulatory approach.
- Many of the environmental regulations come through “administrative guidance” from regulatory agencies.
- A nationwide monitoring structure is developed to track concentrations of air contaminants and appropriate measures, including sulfur dioxide, nitrogen dioxide, photochemical oxidants, and suspended particulate matter. There are ambient air quality monitoring stations (1463) as well as roadside air quality monitoring stations (409).
The regulatory framework for air pollution abatement

This chapter describes the core regulatory framework for pollution abatement in Japan. Figure 2.2 summarizes their overall air pollution reduction approach to put things in perspective.

![Figure 2.2 Japanese Multipronged Air Pollution Reduction Approach](image)

The details of the core regulatory framework of the government are presented next sections.

2.2.1 Air pollution acts in Japan

Most of the air pollution acts in Japan originated after the 1950s. With time, these acts either got more stringent or replaced by new ones whenever issues surfaced. The package of regulations demonstrate that the lawmaking process in Japan is very active and alive. Table 2.1 summarizes the chronological evolution of acts passed by Japan to curb Air pollution.

<table>
<thead>
<tr>
<th>Year</th>
<th>Act</th>
<th>Salient Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1962</td>
<td>The Law of Smoke &amp; Soot Regulation</td>
<td>First attempt to develop comprehensive anti-pollution legislation. Regulated smoke, soot, dust, generated by combustion, heating, and melting processes from factories in designate area. Prefectural governments had power to monitor air quality routinely and to issue alerts if the pollution level posed a danger to health.</td>
</tr>
</tbody>
</table>
Did not apply to mines, power stations, and gas works, which were regulated by other, existing laws under the jurisdiction of MITI.

Impact: Effective in controlling the traditional types of pollutants—dense, visible smoke and heavy deposits—but it did not help to curtail SOx emissions. This was because the SOx emission standards were set in terms of the concentration of the pollutant at the stack. A factory could easily circumvent the intent of the law, while still complying with its specific terms, by increasing the numbers of stacks, using larger stacks, or diluting concentrations with fresh air. Moreover, the SOx emission limitations were not strict enough to do any good. SOx emission from the worst pollution in Yokkaichi were only 0.17% when the strictest standard was 0.18%.

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1967</td>
<td>The BASIC environmental pollution control LAW</td>
</tr>
<tr>
<td>1968</td>
<td>Establishment of the Air Pollution Control Act (APCA)</td>
</tr>
<tr>
<td>1970</td>
<td>Pollution Parliament</td>
</tr>
<tr>
<td>1971</td>
<td>Establishment of Environmental Agency</td>
</tr>
<tr>
<td>1978</td>
<td>Revision of APCA</td>
</tr>
<tr>
<td>1989</td>
<td>Revision of APCA</td>
</tr>
<tr>
<td>1990</td>
<td>Studded Tires Law</td>
</tr>
<tr>
<td>1992</td>
<td>Automotive NOx Law</td>
</tr>
<tr>
<td>1993</td>
<td>Basic Environmental Act</td>
</tr>
<tr>
<td>1996</td>
<td>Revision of APCA</td>
</tr>
</tbody>
</table>

In 1965, the government began to see the need for a comprehensive approach to pollution control. Pollution awareness had increased in all sectors. It was the main topic of political campaigns, where politicians described industrial pollution as a threat to human health, even to life.

Amendment of Smoke & Soot Regulation, APCA was the first attempt at exclusive focus on air pollution. This dynamic act became fulcrum of air pollution control, saw several amendments until as late as 2018 to respond to changing needs. Followed by Pollution Parliament.

In response to massive public demand. Revision of the Air Pollution Control Act, overall package of 14 acts: i) framework and broader definition of pollution ii) formal acknowledgment of national government’s responsibilities for environmental conservation accompanied by stronger regulation, iii) techniques for calculating costs to businesses of preventing environmental pollution, iv) introduction of nationwide uniform emission control, direct penalty, criminal prosecution of pollution crimes.

To implement and monitor the progress of the legal framework of pollution parliament.

Introduction of control of auto mobile exhaust gas.

Introduction of control of asbestos emission from facilities.

Maintenance of road conditions, development & promotion of alternative tires, prevention of dust using studded tires.

Introduction of additional control of NOx emissions in designated areas.

Introduction of concept environmental pollution prevention.

Introduction of control of sprayed asbestos emission in demolition.
Next, the salient features of the air pollution control acts are pictorially described, followed by a brief description of the other acts and regulatory measures.

### Air pollution control Acts 1

- Prior notification of facility installation
- Compliance with emission standards
- Compliance with special emission standards in designated area (Sox, Soot and dust)
- Compliance with additional emission standards in designated area (NOx, Cd, As, Pb, Soot and Dust)
- Compliance with total emission standards in designated area (SOx, NOx)
- Measurement and recording of their concentrations

**Soot and smoke emitting facilities**

- Boiler, Diesel engine, Gas turbine, Drying furnace, Metal furnace, Ceramic kiln, Waste incinerator etc.

**Dioxins emitting facilities**


**Soot and smoke**

- SOx, NOx, Cd, Cl, As, Pb, Soot and Dust

**Dioxins**

Stipulated by the Dioxins special law

Courtesy: Ministry of Environment, Japan
Air pollution control Acts 2

**VOC**

About 200 species except methane, HCFC-22, HCFC-124, HCFC-141b, HCFC-225ca, HCFC-225cb, HFC-42-10 mee

- VOC emitting facilities
  - Drying facilities for the manufacture of chemical products, Spraying and painting facilities, Drying facilities for painting, Drying facilities for printing, Industrial cleaning facilities, Storage
  - Best mix voluntary efforts to restrain emission
  - Notification of facility installation
  - Compliance with emission standards
  - Measurement and recording of their concentrations

**Mercury**

- Mercury emitting facilities
  - Coal fired power plants, Coal fired industrial boilers, Smelting and roasting processes used in the production of non-ferrous metals, Waste incinerators, Cement clinker production facilities
  - Notification of facility installation
  - Compliance with emission standards (corresponding Best Available Technology)
  - Measurement and recording of their concentrations

**HAPs**

23 Hazardous air pollutants of 248 candidate matters

- HAPs emitting facilities
  - Compliance with emission standards (Benzene, Trichlorethylene, Tetrachlorethylene)
  - Voluntary efforts to understand and restrain emission

Courtesy: Ministry of Environment, Japan
Air pollution control Acts 3

Particulates
- General Particulates
  - General particulates emitting facilities
    - Prior notification of facility installation
    - Compliance with standards for
      Conveyors, Accumulation grounds, Crushing and milling machines, Sifters, Coke ovens
- Asbesto
  - Designated particulates emitting facilities
    - Prior notification of facility installation
    - Compliance with site boundary standards
      Bale breakers, churning machines
- Demolition work etc.
  - Prior notification of work
  - Compliance with standards for work

Mobile Sources
- Automobile off-road vehicles
  - Additional emission standards are stipulated by the Automotive NOx/PM Law
    - Compliance with emission standards (NOx, PM, CO, HC)
    - Compliance with additional emission standards in designated area (NOx, PM)
    - Compliance with fuel (gasoline, diesel oil) standards (Sox)
- Ships
  - Stipulated by the Act on Prevention of Marine Pollution and Maritime Disaster
    - Compliance with emission standards (NOx)
    - Compliance with fuel standards (SOx)
    - Installment of release prevention equipment (VOC)
- Aircrafts
  - Stipulated by the Civil Aeronautics Act
    - Compliance with emission standards (NOx, Soot and Smoke, CO, HC)
2.2.2 Basic Environmental Pollution Control Law

In 1967, Japan enacted its first legislation, “Basic Environmental Pollution Control Law” based on the report the Ministry of Health and Welfare [12]. The main features of the Basic Law for Environmental Pollution Control are given in Figure 2.3.
Initially the law dealt with complementing healthy economic development and growth, and did not include any measurements of pollution controls, consequently environmental damage continued to intensify.

2.2.3 Pollution Parliament

In 1970, in response to public concern about pollution problems, the Japanese Prime Minister set up a headquarters to deal with environmental pollution, representing all responsible ministries/agencies [13] [14]. All 14 pollution bills were passed successfully. The main features of the bills were as follows:

1. Amendment of the Air Pollution Control Law
   - Follow-up administration
     - Shifting from a system of implementing restrictions in some regions to nationwide restrictions
     - Uniform base emissions standards+ additional standards
• Strengthening restrictions to ensure conformity to standards
  ➢ Direct penalty for violations
  ➢ Criminal prosecution for pollution crimes
• Extension of the application of the Air Pollution Control Act nationwide; acceptance of additional prefectural regulations
2. Reforms to the Basic Law on Environmental Pollution Control, including deactivation of articles on economic harmonization
3. Broader the Pollution Definitions
4. Formal recognition of the obligations of the national government to protect the environment, followed by tighter regulation
5. Methods for estimating the costs to businesses to avoid emissions

2.2.4 Environment Agency

In the evolution of Japan’s fight against air pollution, the formation of the environment agency, followed by its promotion to a ministry, is a key measure due to the following:

• Earlier, accountability for implementing pollution controls through new environmental pollution control laws was extended through various branches of government, jeopardizing the continuity of the government’s policy approach [14]. For example, atmospheric pollution fell under the control of both the Ministry of Health and Welfare and the Ministry of International Trade and Industry.

• In 1971, the Environment Agency was established to assume responsibility for the implementation and compliance of all pollution legislation and to provide a consolidated strategy for environmental policy.

• In 2001, following the reorganization of government departments, the department was renamed to the Ministry of the Environment to have a more cohesive approach to environmental policy.

2.2.5 The Basic Environment Law

The Basic Environment Law was implemented in November 1993 to establish a new path for the basic environmental policies in Japan. The primary aim of the legislation is to “protect the environment, by recognizing it as our essential life-support system to be passed on to future generations”. It is achieved by creating a community that is economically sustainable without damaging the environment and contributing significantly to the sustainability of the global environment.
Before the enactment of this law, Japanese environmental policies were based on two fundamental laws: the Basic Law for Environmental Pollution Control, enacted in 1967, and the Nature Conservation Law, enacted in 1972. These laws, which were formulated for combating extreme industrial emissions and protecting the natural environment, had performed quite successfully. However, since the socio-economic structure and lifestyle had gradually taken on the form of mass production, mass consumption, and mass disposal, the then existing legal framework, which operated mainly by enforcing controls, could no longer adequately resolve the newly emerging complex and diverse environmental concerns, such as urban and domestic pollution, and global environmental issues. Therefore to incorporate this, the Basic Environment Plan was reviewed in 1998 after five years of its implementation.

### 2.3 Regulatory framework

This sub-section deals regulatory framework exist in Japan to abate air pollution. It is comprised of administrative framework, regulatory enforcement, environmental non-governmental organizations and other pressure groups, and environmental permits as shown in Figure 2.4 [15].

---

**Figure 2.4** The regulatory framework of Japan [15]
2.3.1 The regulatory regime for air pollution

The regulatory regime for air pollution is comprised of prevention and control legislation, permits and regulator, clean-up/compensation, prohibited activities and penalties as shown in Figure 2.5 [15].

<table>
<thead>
<tr>
<th>Prevention and control legislation</th>
<th>Permits and regulator</th>
<th>Prohibited activities</th>
<th>Clean-up/compensation</th>
<th>Penalties</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Air Pollution Control Law is the primary legislation concerning air pollution.</td>
<td>The Air Pollution Control Law regulates various emissions, including due to soot and smoke, particulates, and volatile organic compounds (VOCs).</td>
<td>Certain concentration standards have been determined for specific substances, such as sulfur oxide and nitrogen oxide and emissions of these substances from facilities cannot exceed these standards.</td>
<td>According to the Air Pollution Control Law, the regulator does not have the authority to order polluters to clean up or pay compensation for air pollution. However, if a person becomes ill or dies due to exposure to the hazardous substances specified in the Air Pollution Control Law, the violator becomes liable for this, regardless of whether that violator was negligent.</td>
<td>Penalties can be directly imposed for non-compliance with emission standards. Governors of prefectures can also issue a rectification order or a temporary suspension order of the use of facilities. Any individual who breaches these orders is subject to not only fines but also imprisonment.</td>
</tr>
</tbody>
</table>

Figure 2.5 The regulatory regime for air pollution [15]

To summarize, Figure 2.6 shows the process of new regulation and its insurance of proper implementation in Japan, while Figure 2.7 depicts a conceptual diagram of ideal cooperation, a key feature responsible for the success of the regulatory framework.

**Figure 2.6** Process of new regulation and its insurance of good implementation [16]
2.3.2 Air quality monitoring

In Japan continuous monitoring of air pollutants is conducted at following two types of stations:

I. **Ambient air pollution monitoring station (APMS):** It monitors the ambient air quality of a fixed region in residential areas.

II. **Roadside air pollution monitoring station (RAPMS):** It monitors the ambient air quality near major roads or intersections with large traffic to measure air pollution emitted by automobiles.

These monitoring stations were built to monitor the atmospheric atmosphere continuously, in compliance with Article 22 of the Air Pollution Control Law. Most of these stations are run by the local governments. Air pollution is actively monitored by ordinance-designated local governments at 2,101 monitoring stations all over Japan. There are 1,463 APMS and 409 RAPMS, as of March 31, 2016.

2.3.3 Current air quality status in Japan

Table 2.2 presents the current air quality status in Japan.
Table 2.2: Current air quality status in Japan.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Yearly average value (2016)</th>
<th>Achievement rate of AQS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur Dioxide (SO₂)</td>
<td>0.002 ppm</td>
<td>100%</td>
</tr>
<tr>
<td>Nitrogen Dioxide (NO₂)</td>
<td>0.009 ppm</td>
<td>100%</td>
</tr>
<tr>
<td>Suspended Particulate Matter (SPM)</td>
<td>0.017 mg/m³</td>
<td>99.6%</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>0.3 ppm</td>
<td>100%</td>
</tr>
<tr>
<td>Photochemical Oxidants (O₃)*</td>
<td>0.047 ppm</td>
<td>0.1%</td>
</tr>
<tr>
<td>Fine Particulate Matter (PM₂.₅)</td>
<td>11.9 µg/m³</td>
<td>88.7%</td>
</tr>
<tr>
<td>Benzene</td>
<td>0.78 µg/m³</td>
<td>100%</td>
</tr>
<tr>
<td>Trichloroethylene</td>
<td>0.37 µg/m³</td>
<td>100%</td>
</tr>
<tr>
<td>Tetrachloroethylene</td>
<td>0.11 µg/m³</td>
<td>100%</td>
</tr>
<tr>
<td>Dichloromethane</td>
<td>1.2 µg/m³</td>
<td>100%</td>
</tr>
<tr>
<td>Dioxins</td>
<td>0.021 pg-TEQ/m³</td>
<td>100%</td>
</tr>
</tbody>
</table>

* O₃ value 0.047 ppm is a yearly average of daytime maximum 1-hour values.

The key highlights are:

I. The concentration of almost all air pollutants is already low.

II. The key concerns for Japan are PM₂.₅ and O₃ with 88.7% and 0.1% compliance, respectively.

2.3.4 Achievement in air pollution reduction

Due to the enforcement of different laws from time to time, Japan has achieved a significant reduction of the following pollutants:

2.3.4.1 PM₂.₅ reduction

Achieving the environmental standard for particulate matter (PM) was even worse; in 1998, only 36 percent of roadside air pollution monitoring stations achieved the standard for ambient air quality. The reason for these shortcomings was recognized as the heavy use of diesel trucks. PM2.5’s environmental quality standards (EQS) had been set in 2007, after which monitoring under national and local government administration finally started. There is still much more uncertainty regarding the primary and secondary formation of PM2.5 and its atmospheric temporal and spatial variability. Recently, step-by-step regulation reinforcement for
automobile exhaust gas has contributed to the reduction of PM$_{2.5}$. In the last two years, transboundary PM$_{2.5}$ has seemed to be decreased. PM$_{2.5}$ have changed from national problem to regional problem. Still, control of PM$_{2.5}$ is a challenge for Japan.

2.3.4.2 Ozone reduction

In addition, in most advanced countries including Japan, various legislative measures have been taken to reduce photochemical ozone pollution [17]. Fortunately, Japan has not yet achieved a decline in ground level O3 to a level below that which is harmful to human health [18].

2.3.4.3 NOx reduction

The emissions from mobile sources were said to be a primary reason for the increase in nitrogen oxides (NOx) concentration in the atmosphere. In response, in June 1992, the Japanese government enacted the Automobile NOx Regulation Law to control automobile emissions (The law’s official name is “the Law concerning special measures for total emission reduction of Nitrogen Oxides from automobiles in specified areas”). This law is implemented in the metropolitan areas of Tokyo, Nagoya, and Osaka, which were designated as nonattainment areas [19].

Despite these measures, in the 1990s levels of NOx did not decline in metropolitan areas. In 1998, only 43 per cent of roadside air pollution monitoring stations in the non-attainment areas met the national ambient air quality requirement for NOx. In light of these conditions, in 2001 the Automobile NOx-PM Law (NOx-PM Law), a updated version of the Automobile NOx Control Law, was adopted. This new enacted law is designed to decrease the levels of PM as well as NOx in the nonattainment areas.

The NOx-PM Act includes a clause called the vehicle type regulation. The vehicle type regulation forbids the use and registration of vehicles in the non-attainment regions after some grace periods, unless the vehicles meet the 2005 emissions standard set out in the legislation. The emission standards of 2005 are much more rigorous than former standards. The NOx-PM Act is unique in enforcing the regulation on currently used vehicles. Most of the automotive regulations apply to newly manufactured vehicles; those already used by customers or businesses are exempted.

The legislation is called vehicle type regulation, because the ban ’s timing depends on the type of vehicle and the first year of registration. For example, a standard-size diesel truck newly
registered in 1989 was banned in the nonattainment area in 2004, whereas a diesel passenger
car newly registered in the same year could be used until 2005. The Ministry of Internal Affairs
and Communications conducts regulatory impact analyses of the regulation in Japan.

2.3.5 Control of volatile organic compound

Hazardous air pollutants (HAPs) have also been identified at low concentration levels in recent
decades, causing public concern about the negative effect on human health of long-term HAP
exposure. Most HAPs are composed by volatile organic compounds (VOCs). Most specifically,
most of them are considered to be carcinogenic to humans or possibly carcinogenic to them.
As per amendment of Air Pollution Control Act (1996) local government started monitoring of
these toxic VOCs in the atmosphere as per the “guideline for hazardous air pollutants
monitoring” and the “manual for monitoring method of hazardous air pollutants” published by
the Ministry of the Environment (MOE) [20]. The Strategy for control of the VOC emission
reduction scheme is based on the best mix approach representing a combination of voluntary
efforts and statutory regulation (Figure 2.8).

![Figure 2.8 Strategy for control of VOC][16]

To control the substances designated, including benzene and trichloroethylene, a "Guideline
for the Promotion of Voluntary Control of Hazardous Air Pollutants by Business Entities" has
been established by the Ministry of the Environment and the Ministry of Economy, Trade and
Industry in Japan. Information are provided in the "VOC Voluntary Regulations" section of
the Act.
3 Other Important Steps in Air Pollution Reduction

In addition to a core regulatory framework to define, monitor, prohibit, and manage air pollution, Japan has taken a number of other steps for clean air. This chapter describes them and highlights their key features.

3.1 Act on promoting green procurement

The law on promotion of procurement of eco-friendly goods and services (act on Promoting Green Procurement) [21] and Basic Policy on Promoting Green Purchasing aims to encourage the purchase of equipment with lower environmental impacts by government and public organizations, in order to create a priming effect and facilitate the change in demand for eco-friendly products in Japan as a whole.

Each fiscal year, for purchase stationary, office furniture, appliances and lighting, passenger and freight vehicles, the government agencies are required to devise a green procurement strategy, taking into account their budget and planned projects. In addition to price and quality factors, procurement decisions include environmental considerations, including global warming, air pollution, waste and biodiversity.

3.2 Emergency alerts

Whenever the concentration of soot, smoke, and VOCs cross the standards limit, government issues emergency alters. Figure 3.1 shows the Flow for issuing Warnings and Alerts in Japan.
Figure 3.1 Flow for issuing Warnings and Alerts [16]

Figure 3.2 Reporting/announcing system of emergency alerts [22]

Figure 3.2 shows a reporting/announcing system of emergency alerts. For example, the environment department in Osaka prefecture sends FAX or email to cities and related another department, such as education department and health department, and they contact the schools
and social welfare schools (An attached file is a format of the FAX). Also, the environment department gives info via the internet and contact with news media. In addition, the environment department sends a FAX to some industries to order them to reduce their emission. These industries submit their emission reduction plan in an emergency to the prefecture in advance. Also, the environment department request drivers not to drive their vehicles voluntary cooperating with the road traffic information center [22].

3.2.1.1 Issuance of alerts on PM$_{2.5}$

Issuance of alerts on PM$_{2.5}$ is made on the following conditions:

**Provisional Guideline Value for Alerts: Daily average $> 70 \mu g/m^3$**

- Judgment in the early time period, in mornings (5:00-7:00): $> 85 \mu g/m^3$
- Judgment prepared for afternoon activities (5:00-12:00): $> 80 \mu g/m^3$

If over the value,

  Prefectures or designated municipalities notify to the public to refrain from non-essential outing, or long hours of outdoor strenuous exercise as much as possible.

3.2.1.2 Issuance of alerts on Ox

Issuance of alerts on Ox is made on the following conditions:

**Cabinet ordinance values for warning: Hourly value $> 0.12 \mu g/m^3$**

If over the value,

  Prefectures or designated municipalities ask for cooperation to reduce dust and smoke, VOC emissions, as well as for voluntary reduction of vehicle operation.

**Cabinet ordinance values for Alerts: Hourly value $> 0.4 \mu g/m^3$**

If over the value,

  Prefectures or designated municipalities request to reduce volume and density of dust and smoke, VOC emissions, to reduce facility operation and prohibit vehicle operation.

3.2.1.3 Domestic measures on PM$_{2.5}$

Based upon the fact that there have been issues to be scientifically clarified with regard to the PM$_{2.5}$ generation mechanism or attributable proportion of individual sources, the short, mid and long term agendas is spelled out and the step by step measures are determined and promoted.
Short term agenda
Based on current knowledge, existing air pollution control policies will be further promoted, with the perspective of PM$_{2.5}$ measures.

- Strengthening of emission regulations of Soot and Dust, NOx will be reviewed.
- Measurement against Evaporative Fuel emissions will be strengthened.
- Measures against motor vehicle emissions should be steadily implemented.

Mid and long term agenda
Phenomenon clarification, information gathering will be worked on, and depending on progress, additional measures will be examined.

- The status of VOC which have the ability to generate PM$_{2.5}$ and photochemical oxidant will be clarified, and countermeasures of them will be examined.
- Air pollution sources with high attributable proportion will be estimated through sources of information gathering and advanced simulation, etc.

3.2.2 VOC voluntary regulations
The term voluntary approach is defined by Organization for Economic Co-operation and Development (OECD, 1999) as schemes whereby firms make commitments to improve their environmental performance beyond legal requirements, including voluntary public programmes, negotiated agreement, and unilateral commitments. To refer to the programmes based on voluntary approaches, various terms are used, such as voluntary environment programs (VEPs) [23].

In Japan, the scheme to utilize voluntary actions together with legal regulation (best mix) was first employed in the reduction of volatile organic compounds (VOCs). The emission control system started in 2005 with a goal of reducing the total VOC emissions in 2000 by 30% by 2010. In the target year of 2010, this scheme resulted in overachievement of the VOC emission reduction target with participation from 9,365 companies representing 43 business associations. Following are the three motivations for firms to participate in VEPs [23]

I. Regulatory threat: A most widely proposed drive of firms to participate in VEPs is the threat of regulation or taxation. In other words, it is assumed that firm is more likely to join a VEP if the associated costs are lower compared with the anticipated cost of compliance with (current or expected) government mandates or other schemes [23].
II. **Market forces:** Alternatively, it is theorized that market forces can shape the environmental behavior of firms. An example is a case that firms perceive a shift in demand and supply toward more green products. Source of market pressures can include not only consumers and suppliers but also customers, competitors, trade associations, community groups, and investors [23].

III. **Informal mechanisms:** Another avenue of research claims that compliance can be achieved through informal mechanisms. Such mechanisms include shaming and public exposure and new values, norms to guide preferences for collective action [23].

The Ministry of the Environment is charged with regulation on specific industries (mostly large emitters), while Ministry of Economy Trade and Industry (METI) is responsible for promoting voluntary actions implemented by industries. With respect to voluntary actions, METI has encouraged industries to develop voluntary action plans and report status of implementation annually, and an expert committee under METI has reviewed their progress and published the result of the review. To promote voluntary actions, METI also has developed and distributed guidelines and manuals, which shows how to reduce VOC emissions from each sector. Japan Environmental Management Association for Industry (JAMI) has supported voluntary actions by giving companies advice and information to reduce VOCs. Low-interest loans are provided by Japan Finance Cooperation (JFC) in order to give companies an incentive to introduce VOC reduction equipment.

### 3.2.3 Waste Management

In Japan, waste management is a core part of sustainable development, including air pollution abatement. The 3R (Reduce, Reuse and Recycle) program was intensively promoted by the government in the 1970’s and 80’s and the framework principle and strictly follow it and made it successful using people engagement through the notion and lenses of *Mottainai*, their traditional expression for waste management, working towards a recycling-oriented society. As a result, the following characteristics of their waste management framework emerged:

- Segregation waste at point source is strictly followed by every household.
- Municipalities responsible for waste management determine rules for separation and sorting of garbage by categories such as burnable or recyclable (Figure 3.3).
3.2.4 Success in household waste management

The following measures are seen to be crucial to successful household waste management:

- Waste management is an integrated part of the school curriculum, and they have kid-friendly versions of waste management efforts.
- Municipalities provide leaflets explaining the rules and send sanitation workers to classrooms to give lessons to elementary school students, with the aim of asking for citizens’ cooperation in the thorough separation of garbage.
3.2.5 Waste to energy incineration plant

Clean Authority of Tokyo has installed a number of Waste to Energy incineration plants to manage the municipal solid waste of Tokyo city. The following are the key features:

- The plants, especially the Ota plant, is clean and visitor friendly, and acts as a museum for public awareness with a good number of visitors, including school children.
- Combustibles segregated waste is put into incineration plants. Power generation and heat recovery are performed. Plant operations take place in an efficient and well-organized manner. Table 3.1 presents measures to prevent exhaust from the plants.

Table 3.1 Environmental measures to prevent exhaust from the incineration plan.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counter exhaust emissions</td>
<td></td>
</tr>
<tr>
<td>Soot and dust</td>
<td>Removed by bag</td>
</tr>
<tr>
<td>Dioxins</td>
<td>Generation of dioxins is restricted through control of incineration process, bag filters, decomposed in catalyst reaction tower using catalysis</td>
</tr>
<tr>
<td>Mercury</td>
<td>Removed by adsorption into activated carbon bag filters</td>
</tr>
<tr>
<td>Hydrogen chlorides and sulfur oxides</td>
<td>Removed by injecting slaked lime into bag filters and through a chemical reaction with caustic soda solution in the gas scrubber</td>
</tr>
<tr>
<td>Nitrogen oxides</td>
<td>Decomposed in the catalyst reaction tower through reaction ammonia.</td>
</tr>
<tr>
<td>Counter wastewater emission</td>
<td>Wastewater is treated in wastewater treatment facilities to meet the standard values and released into sewer</td>
</tr>
<tr>
<td>Counter odor</td>
<td></td>
</tr>
<tr>
<td>Waste bunkers</td>
<td>Air from inside the waste bunker is sent to the incinerator, where odor is incinerated and decomposed</td>
</tr>
<tr>
<td>Platforms</td>
<td>Entrances/ exits are sealed with air curtains, and deodorizing agents are spread</td>
</tr>
<tr>
<td>Waste collection vehicles</td>
<td>A washing facility for waste collection vehicle is installed</td>
</tr>
<tr>
<td>To counter noise and vibration</td>
<td>Sound proof walls &amp; vibration controlled equipment are installed</td>
</tr>
<tr>
<td>Environmental measures for bottom, fly ash</td>
<td>Ash is melted, and hazardous substances are stabilized using chemicals.</td>
</tr>
</tbody>
</table>

As an illustration, Figure 3.5 shows the process diagram of the Ota incineration plant.
Figure 3.5 A process diagram of Ota incineration plant [25]
4 Co-Benefit as Best Practices

The Institute for Global Environmental Strategies (IGES) has launched and maintained the Asian Co-benefits Partnership (ACP) as a good practice initiative under the initiative of the Ministry of the Environment, Japan [26]. Many actions mitigate climate change while simultaneously delivering other development benefits such as cleaner air, healthier communities, and greener cities.

Numerous activities alleviate environmental change while at the same time conveying other advantages, for example, cleaner air, and greener urban cities. The benefits of collecting these activities are known as "co-benefits: from advanced cookstoves to renewable energy technologies, Asia has become home to numerous actions capable of generating co-benefits. The past decade, a multi-stakeholder expert working group from India and Japan has witnessed several attempts to increase awareness and build the capacity needed to integrate co-benefits into critical decisions. From spreadsheet calculators for key sectors to action plans for mitigating short-lived climate pollutants (SLCPs), Asia has also become home to numerous efforts that could help mainstream co-benefits. Figure 4.1 presents the Asian Co-benefits Partnership good practice map for some of the current good practices.
Figure 4.1 Asian Co-benefits Partnership good practice map [27]

The rest of this chapter presents some case studies of co-benefits documented under the ACP. The case summaries borrow heavily from the ACP documents [27].

### 4.1 Clean diesel

In 2012, the International Agency for Research on Cancer (IARC) classified diesel engine exhaust as carcinogenic [28]. One of the more useful and exciting diesel control programmes was launched by the Tokyo Metropolitan Government (TMG), not by the national government of Japan. In 1999, before the national government introduced stricter diesel vehicle regulations, the TMG established a “NO Diesel vehicle campaign. The campaign prohibited the entry of noncompliance (not satisfy PM emissions standards) diesel used vehicle and forced them to retrofitted with an emission control system.

In India, from 1984 to 2004, diesel consumption rapidly increased and led to deteriorating the air quality of megacities, including National capital, Delhi [29]. To reduce pollution levels, the
Indian Supreme Court issued a decision that required the entire Delhi public transportation fleet buses, taxis, and auto-rickshaws to switch to compressed natural gas (CNG) [30].

4.2 Open burning (crop residue)

Open burning of crop residue (rice and wheat straw, sugar cane) emits large numbers of pollutants that deteriorate the ambient air quality and impact on environment and people's health. In India, during the winter session, emissions from paddy straw burning in Punjab and Haryana states deteriorate the air quality of Delhi and its surrounding regions. Abating these emissions is challenging because it is difficult to enforce burning bans, primarily when farmers use them for land clearing depend on the practice for subsistence agriculture. It has led some to argue that programmes need to use market-based instruments beyond restrictions and bans to incentivize changes in the practice [27].

One of the most successful approaches to control it is the biogas generation by anaerobic digestion of paddy straw. Punjab-based Sampurn Agri Ventures has set up a biogas-based power plant using paddy straw that can help curb air pollution caused by stubble burning by farmers. The plant utilizes 20 tonnes of paddy straw per day produces and produces 1 MW power per hour for 8 hours a day. The company plans to establish 42 such plants across Punjab to produce bio-CNG, and it has signed an MoU with Indian Oil Corporation (IOC) for the supply of CNG produced from these plants [31, 32, 33].

4.3 Thailand’s eco-car program

In 2007, Thailand launched Eco-car Program to boost domestic manufacturers and draw investors and make Thailand automobile sector globally competitive and encourage exports of less pollution emitting cars compared to conventional cars [34].

The Program has been implemented in two phases:
1) Eco-car Program I ran from 2007 – 2013
Both phase boost the production of Eco-car, including the bodies, engines, and other parts. In the fourth year of programme manufacturing of Eco-car reached to at least 100,000 units annually.

Benefits of the programme:

- Corporate tax exemption for up to eight years.
- Up to a 90 percent reduction on import duties for machinery and equipment for two years.

**Co-benefits:** Fuel economy policies and measures provide an opportunity for policymakers to reduce fuel consumption and offer savings for both importing and non-importing countries while bolstering fuel security. Besides, these policies and measures reduce CO₂ emissions.

**Way Forward:**

Following the achievement of the Eco-Car Program Phase I, Thai government launched Phase 2 in 2013. Aside from environmental protection, the Eco-Car Program Phase II is a piece of a national plan intend to expand the yearly vehicle production and reinforce its situation in Southeast Asia. It will also help in ensuring that the eco-cars produced in Thailand meet global standards.

4.4 **Multi-modal transport sharing in Kashiwa, Japan experimenting with next-generation transport**

In 2005, the opening of Tsukuba express (a Japanese Metropolitan Intercity Railway railway line) led to the creating of a new commuter town in Kashiwa-Noha region of the city. Due to this, Kashiwa started to face several environmental issues, including increased congestion, traffic accidents, air pollution, and greenhouse gas (GHG) emissions [35]. The town has put in place several transport-related initiatives to solve the problem. The first scheme was the initiative for environmentally sustainable transport (EST) supported by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), and the Ministry of the Environment (MOE). The second scheme was the experiments to boost Intelligent Transport Systems (ITS) by the Cabinet Office. Kashiwa City launched various experiments, including bicycle sharing, multi-modal sharing, and ITS spots. In March 2010, the city government developed the “Kashiwa City Integrated Transport Plan” to address urban transport challenges and meet various mobility needs.

**Co-benefits:**

The experiments on sharing played a key role in both the ITS Model Project and the Kashiwa-Noha International Campus Town Initiative. The Campus Town Initiative set a target of increasing the share of bicycles by 10 percent. To accomplish the target, the city government and the Public Corporation for Urban Development launched a bicycle sharing system called “Kashiwa Smart Cycle” in 2010. Also, a multi-modal transport sharing system, which
expanded the scope of shared mobility to electric motorcycles and vehicles, was set up on an experimental basis in June 2011 and continued until January 2016. The operation of the system was supported by stakeholders such as private companies and universities. This sharing model reduced vehicular congestion and as well as air pollution.

**Challenges and the way forward**

The biggest challenge for the multi-modal transport sharing scheme was to secure a sustainable financing source for activities to maintain. To make the program commercially feasible, the cost of acquiring and keeping the sharing stations was a major challenge. During the experiment, various operational problems have also been recognized. They include customer information management and members’ cards, selection of station locations, maintenance of helmets for motorcycles, charging of electric vehicles, and operation of electric power-assisted bicycles. For the next step, it is essential to identify an appropriate business model, while affirming that sharing is a vital part of sustainable urban planning and transport plan. Although the implementation of the scheme was limited compared to the car-sharing systems of Europe and North America, however, it recognized the importance of involving local stakeholders and develop a mutually beneficial system for both business and citizens.

**4.5 The multiple benefits of clean energy in Japan: the case of Nagano**

In 2000, Nagano’s foreign energy import expenditure started to rise and reached to around 400 billion yen per year, mainly due to rises in global oil prices. To tackle this, Nagano decided to implement new measures for managing natural resources and capitalizing on renewable energies in the region. This newly adopted policy was called “Establishing self-supporting communities with 100% renewable energy [36].”

The main three objectives of this policy were as follows:
1) Environmental: reducing greenhouse gas (GHG) emissions
2) Economic: limiting financial outflows
3) Community: revitalizing local resources

Nagano prefecture also adopted four pillars of activities to achieve these broad objectives:

1) Laying the groundwork for local partnerships
2) Incubating locally based businesses by utilizing prefectural facilities
3) Introducing comprehensive renewable energy programs
4) Programs to help businesses, households, other stakeholders achieve policy targets

The establishment of the Renewable Energy Network (Shinshu-Net) was an excellent example of the first pillar in this new policy. Within two years, Shinshu-Net worked established a locally-based partnership association and committee network involving 18 Local partnership committees from the prefecture and municipal governments, private businesses, non-profit organizations (NPOs), and other appropriate stakeholders. The network then worked with these committees to disseminate local renewable energy by debating future visions with appropriate stakeholders, conducting the required studies, sharing data, capacity building training, and so on.

An example of the second pillar, local business incubation, is a public-private solar power project in Suwa city called "Ohisama Bun San Project." This example was Shinshu-net's first partnership project. The project showed the feasibility of using prefectural infrastructure to incubate local companies. More concretely, Nagano prefecture lent the roof of a public sewage plant to a private company, Okayasanso Co. Ltd. that had been selected by public offering. The company then installed solar panels on the roof. The initial cost of the panels was about 700 million yen for both construction and administration; about 87 percent of needed equipment and infrastructure.

An example of the third pillar included Governments' support starting from initial consultation, location selection and consensus-building guidance, legal advice, technical information, and upto subsidies. The profitability and credibility of these enterprises enhanced as a consequence of this assistance. This, in turn, made securing a loan from commercial banks simpler for companies.

As for the last pillar, Nagano Prefecture endorsed the introduction of more renewable electricity to homes and companies. With regard to the household industry, the prefecture established an office to advise residents of Nagano who are interested in incorporating renewable energy into their households.

**Co-benefits:** Nagano's renewable power policy has brought several advantages to the area: revitalizing the local economy, creating employment, reducing power import spending, and improving the health of forest systems (through sound management methods, avoidance of sediment outflows, and local community returns).
Challenges: Challenges start with inadequate staff with excellent understanding and experience of energy working companies. The absence of a business attitude in the local community is yet another limitation that could prevent people from achieving the goal of “establishing self-supporting communities with 100% renewable energies” indicated in prefecture’s strategy for environment and energy plan.
5 Electric vehicle Industry

The introduction of Electric Vehicle (EV) is considered as a major initiative to curb megacity air pollution caused by internal combustion engine vehicles. Japan is among the leading producers and users of EV across the world, and Nissan is the leading manufacturer of EVs. This chapter describes the current status, particularly of Nissan and the EV ecosystem, including policy and infrastructure support.

5.1 About Nissan electric vehicle

Nissan is a Global Electric Vehicle (EV) leader, and it is the first EV company that has sold more than 400000 (LEAF) models. Table 5.1 presents the specification of Nissan LEAF models, and Table 5.2 shows the Nissan vehicle electrification strategy.

<table>
<thead>
<tr>
<th>Table 5.1 Nissan LEAF Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>Distance per Charge JC08 Mode</td>
</tr>
<tr>
<td>Motor</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Battery</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5.2 Nissan Vehicle Electrification Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategy</td>
</tr>
<tr>
<td>Sell 1 million units/year of EV, ePower vehicles</td>
</tr>
<tr>
<td>Introduce 8 new EV models</td>
</tr>
<tr>
<td>Introduce Cross-Over EV as a Global model</td>
</tr>
</tbody>
</table>

The significant roadblocks in EV penetration by Nissan as well as other players remain the range (how far can an EV go in a single charge), charging infrastructure, and price. Their approach to addressing these challenges are summarized in the rest of this chapter.

5.2 Electric vehicle policy

The policy support expected by the EV industry ranges from direct market support through procurement to indirect support, such as incentives to EV users. The incentives could be in the form of cash incentives, tax exemption, and removal of restrictions on the movement (such as congestion charging) of other (ICE) vehicles for EVs. Figure 5.1 presents a framework for
holistic policy support for EV expansion. Nissan, like other players, invests in advocating for this support. Similarly, policy support to EV infrastructure (charging) is crucial to its growth.

![Figure 5.1 Holistic policy support for EV expansion [37]](image)

In the Japanese EV policy support experience, it has been observed that the government gives more priority to infrastructure support and financial incentives, but not so much to non-financial measures such as exemption from driving restrictions. The industry is currently trying to get reductions in highway toll for EV users, since it is significant, but facing difficulty due to coordination with multiple ministries.

### 5.3 EV charging infrastructure

Japan, supported by the government in a variety of direct/indirect ways, has an enviable quick charging network. Not only is it a world leader in the QC network, the sheer number of QC stations today in Japan is slightly more than the number of gas stations. This has been made possible by innovative policy support by the government and collaborative efforts by the industry, even among competitors. For instance, the four big automakers, viz., Nissan, Toyota, Honda and Mitsubishi announced a project in July 2013 to jointly promote development and installation of charging infrastructure for EVs. The government, on its part, has been supporting by picking up almost 50-70% of the capex for setting up EV chargers. These efforts and collaborative approach has borne fruits, and Figure 5.2 presents a summary of Quick Charging (QC) Network in Japan.
In terms of future outlook in Japan:

- Resolving charging congestions, charger rollout at multi-residential houses will be key.
- Japan plans to roll out ultra-fast charging standard by 2020.

### 5.4 Battery recycle and reuse strategy

Discussions with Nissan revealed reuse of EV batteries could give a surprisingly good push to the EV industry. This is because even after getting unfit for EVs, EV batteries can be reused in other equipment. New startups are developing markets for reuse of these old Li-ion batteries. However, most of the countries currently do not allow reuse of batteries since they contain heavy metals that could lead to problematic environmental consequences. However, if a mechanism can be created to address these concerns, it can be quite useful to EV manufacturers. Figure 5.3 presents a summary of the reuse business, indicating applications and key players in Japan.
Figure 5.3 Reuse Business with 2nd Life Battery [37]
6 Lessons from Beijing

The information present in this chapter has been collected from various reports available on the internet and other open sources.

6.1 Characterization of Beijing city

Beijing is the capital of the People's Republic of China, one of the oldest cities in the world, the most populous capital city and second-largest Chinese city by urban population after Shanghai [39]. It is one of the oldest cities in the world and has seven UNESCO World Heritage Sites [40]. Figure 6.1(above) showing the location of the Beijing Municipality, surrounded by Hebei and Tianjin Municipality [41].

6.1.1 Administrative structure

The city, located in northern China, is governed as a municipality under the direct administration of the central government with 16 urban, suburban, and rural districts [42].
6.1.2 Growth and development patterns

Beijing's economy ranks among the most developed and prosperous in China. Beijing has set its annual economic growth at 6.5 percent in the year of 2018, which is expected slightly below the 6.7 percent achieved in 2017, Beijing economy had accounted for 3.5 percent of the national gross domestic product (GDP) in 2017 [43]. The city has a post-industrial economy that is dominated by the tertiary sector (services), which generated 76.9% of output, followed by the secondary sector (manufacturing, construction) at 22.2% and the primary sector (agriculture, mining) at 0.8% [42].

The development of Beijing continues at a rapid pace, and the vast expansion has created a multitude of problems for the city. Beijing is known for its smog as well as the frequent "power-saving" programs instituted by the government. To reduce air pollution, some major industries have been ordered to reduce emissions or leave the city. Beijing Capital Steel, once one of the city's largest employers and its single biggest polluter, has been relocating most of its operations to Tangshan, in nearby Hebei Province [43, 44, 45]. Premier Li Keqiang said that the “three tough battles” for China's economy are reducing poverty, controlling pollution and curtailing risks [46].

6.1.3 Geography

Beijing is situated at the northern tip of the roughly triangular North China Plain, which opens to the south and east of the city. Mountains to the north, northwest and west shield the city and northern China's agricultural heartland from the encroaching desert steppes. The northwestern part of the municipality, especially Yanqing County and Huairou District, are dominated by the Jundu Mountains, while the western part is framed by Xishan or the Western Hills. The Great Wall of China across the northern part of Beijing Municipality. Mount Dongling, in the Western Hills and on the border with Hebei, is the municipality's highest point, with an altitude of 2,303 meters [47].

The urban area of Beijing, on the plains in the south-central of the municipality with an elevation of 40 to 60 meters, occupies a relatively small but expanding portion of the municipality's area.

The latitude of the Beijing municipality ranges from 39° 27' to 41° 03' N and in longitude from 115° 25' to 117° 30' E [47].
6.1.4 Climate

The city's climate is a slightly dry, monsoon-influenced humid continental climate, characterized by hot, humid summers due to the East Asian monsoon, and generally cold, windy, arid winters that reflect the influence of the vast Siberian anticyclone. Yet during the winter, winds from the northwest must cross the mountains that shield the city, keeping the city warmer than other locations of similar latitude in China. Spring can bear witness to sandstorms blowing in from the Mongolian steppe, accompanied by rapidly warming, but generally dry, conditions. Autumn, like spring, sees little rain but is crisp and short. January averages −3.7 °C, while July averages 26.2 °C. Annual precipitation is around 570 millimeters, falling mostly in the summer months. Extremes have ranged from −27.4 to 42.6 °C [47].

6.2 Structure of the environmental organization in China

This section presents the origin, responsibilities, organization structure, and regional centers of the Ministry of Ecology and Environment of China.

6.2.1 Ministry of Ecology and Environment (MEE)

The origin of the Chinese Ministry of Ecology and Environmental (MEE) was similar to the origin of the Indian Ministry of Environment, Forest and Climate Change after they participated in the first United Nations Conference on the Human Environment held in Stockholm, Sweden from June 5-16, 1972. In China, MEE is responsible for implementing environmental policies, as well as the enforcement of environmental laws and regulations [48, 49].

6.2.2 Origin of Ministry of Ecology and Environment

The Origin of Ministry of Ecology and Environment is provided below in chronological order.

1973

China established the Environmental Protection Leadership Group.

Oct. 1974

The Leading Team for Environmental Protection was officially established under the State Council.

Responsibilities

Development of guidelines, policies, and regulations; finalize national plans for environmental protection; organize and coordinate the environmental protection effort of local areas and State departments and urge for the inspection on such effort.

May 1982

In 23rd Standing Committee meeting decided to incorporate the leading team for Environmental Protection under the State Council to establish the Ministry of Urban and Rural Development and Environmental Protection, one of the internal departments of which was Environmental Protection Bureau.

1983

Chinese government announced that environmental protection would become a state policy.

May 1984

Establishment of Environmental Protection Commission under the State Council

Tasks

- Deliberate and finalize relevant guidelines and policies for environmental protection
- Propose requirements for planning, and lead, organize, and coordinate the national environmental protection effort

Administration

One of the Vice Premiers under the State Council held a concurrent position as the Chairman of the Commission, which operated through its office under the Ministry of Urban and Rural Development and Environmental Protection (Environmental Protection Bureau, acting on behalf of the Ministry).
6.2.2.1  Mandates (responsibilities) of MEE

Figure 6.2 represents the primary responsibilities of the MEE.
6.2.2.2 Organization structure of MEE

The MEE is a state council department. Figure 6.3 presents the organizational structure of the MEE. There are 19 departments under MEE at the judicial level in the government ranking system [50]. They carry out regulatory tasks in different areas and make sure that the agency is functioning accordingly (Figure 6.4).
Figure 6.3 Organization structure of the MEE [50]
Figure 6.4 MEE offices and the department’s structure and their main role [50]

6.2.2.2.1 Regional centers of MEE

The main responsibilities of regional centers are to help in local inspections and enforcement. MEE has five regional centers with one headquarter in Beijing (Table 6.1).
Table 6.1 The regional centers of MEE

<table>
<thead>
<tr>
<th>S. NO</th>
<th>Region</th>
<th>Head Office</th>
<th>Enforcement Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Eastern Center</td>
<td>Nanjing</td>
<td>Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, and Shandong</td>
</tr>
<tr>
<td>2</td>
<td>Southern Center</td>
<td>Guangzhou</td>
<td>Hunan, Hubei, Guangdong, Guangxi, and Hainan.</td>
</tr>
<tr>
<td>3</td>
<td>Northwestern Center</td>
<td>Xi'an</td>
<td>Shaanxi, Gansu, Qinghai, Xinjiang, and Ningxia.</td>
</tr>
<tr>
<td>4</td>
<td>Southwestern Center</td>
<td>Chengdu</td>
<td>Chongqing, Sichuan, Guizhou, Yunnan, and Tibet.</td>
</tr>
<tr>
<td>5</td>
<td>Northeastern Center</td>
<td>Shenyang</td>
<td>Liaoning, Jining, and Heilongjiang.</td>
</tr>
</tbody>
</table>

6.3 Environmental policy in China

Environmental policy in China is formulated by the National People's Congress and managed by the MEE of the People's Republic of China.

The central government regulates and coordinates all the activities. However, the actual monitoring and enforcement are primarily undertaken by local governments. The environmental work of non-governmental forces, such as lawyers, journalists, and non-governmental organizations, is limited by government regulations [51]. Figure 6.5 shows the environmental governance structure in China.
Figure 6.5 Environmental governance structure in China [51]
6.3.1 Environmental regulatory framework of China

Environmental regulatory framework of China consist of legislation concerning the environment, main environmental laws, and laws relating to specific fields of environmental protection as shown in Figure 6.6. The environmental regulatory framework of China is regulated, supervised and managed by multiple administrative authorities jointly, such as environmental protection authorities at the county level and above, and their authorized environmental supervision institutions at local level.

![Image of environmental regulatory framework of China](image)

**Legislation concerning the environment**
- Laws promulgated by the National People’s Congress and its Standing Committee
- Administrative regulations formulated by the State Council
- Department rules formulated by ministries and commissions under the State Council
- Local regulations formulated by each province and municipality

**Main environmental laws**
- Environmental Protection Law
- Law on Environmental Impact Assessment
- Cleaner Production Promotion Law
- Circular Economy Promotion Law

**Laws relating to specific fields of environmental protection**
- Atmospheric Pollution Prevention and Control Law
- Marine Environment Protection Law
- Water Pollution Prevention and Control Law
- Water Law.
- Grassland Law
- Forestry Law

Figure 6.6 Environmental regulatory framework of China [52].

6.3.2 The regulatory regime for air pollution

In China, the regulatory regime for air pollution mitigation is comprised of prevention and control legislation, administrative regulations, local regulations, permits and regulators, prohibited activities, clean-up/compensation, and penalties as shown in Figure 6.7.
### Regulatory regime for air pollution

<table>
<thead>
<tr>
<th>Prevention and control legislation</th>
<th>The administrative regulations</th>
<th>The local regulations</th>
<th>Permits and regulator</th>
<th>Prohibited activities</th>
<th>Clean-up /compensation</th>
<th>Penalties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Protection Law</td>
<td>The Environmental Protection Law provides fundamental principles and regimes, while the Law on Prevention and Control of Atmospheric Pollution provides specific rules on Atmospheric Pollution prevention and control.</td>
<td>The government of each province, autonomous region, and cities with subordinate districts can formulate the local regulations regarding Air pollution prevention and control based on their practical demands. Generally, municipal emission standards regarding air pollutants are stricter than those at the national level.</td>
<td>The environmental protection authorities issue two types of permits, and every entity must obtain both permits: Environmental protection acceptance (approval of the environmental impact assessment [EIA] and construction project completion). Emission permit to release polluted air emissions.</td>
<td>Emission of atmospheric pollutants by way of circumventing regulation. Encroachment, destruction, or unauthorized removal or change of atmospheric quality monitoring facilities and auto-monitoring equipment. Importing, mining, selling, and using non-compliant fuel. Manufacturing, importing or selling motor vehicles and vessels, and non-road mobile machinery that emits atmospheric pollutants beyond the required standards.</td>
<td>The Law on Prevention and Control of Atmospheric Pollution does not provide that polluters must clean up and compensate for the atmospheric pollution. However, it does ensure that if the emission of air pollutants causes any damage, the polluters must be liable.</td>
<td>The main penalties for violating the Law on Prevention and Control of Atmospheric Pollution are administrative. Departments entitled to impose administrative penalties include environmental protection authorities, quality supervision authorities, inspection and quarantine authorities.</td>
</tr>
</tbody>
</table>

#### Figure 6.7 The regulatory regime for air pollution [53].

### 6.4 The recent air pollution problem

Figure 6.8 presents the leading cause of the recent development of the air problem. And Figure 6.9 shows the Beijing air quality metrics from 2005 -2009.
Factors like Beijing's urbanization and pollution caused by burning of fossil fuel, strongly increased the extent of anthropogenic emissions but also changed the meteorological situation fundamentally.

For example, surface albedo, wind speed and humidity near the surface were decreased, whereas ground and near-surface air temperatures, vertical air dilution and ozone levels were increased.

Lead to health issues of many inhabitants.

Figure 6.8 Recent development of air problem

Beijing Air Quality Metrics for April and May Alone over Period 2005-2009

- Average API
- Number of Blue Sky Days
- Estimated Avg PM10 (μg/m³)

Figure 6.9 Beijing air quality metrics from 2005-2009 [54]
Streets et al., (2007) estimated the concentration of PM$_{2.5}$ and Ozone about 34% and 35–60%, more than the normal level, respectively [55]. In 2011, the city burned 26.3 million tons of coal, 73% of which for heating and power generation [56]. Coal-burning accounts for about 40% of the PM$_{2.5}$ in Beijing and is also the chief source of nitrogen and sulfur dioxide [57]. In January 2013, fine airborne particulates in Beijing increased several times compared with World Health Organization guidelines [58]. In mid-January 2013, Beijing's air quality at the US embassy went off the US Environmental Protection Agency's air quality index. It was widely reported as "crazy bad" category and later changed to "beyond index" [59].

However, the Beijing Environmental Protection Bureau (BJEPB) monitored different readings. Since the BJEPB and US Embassy measure different pollutants according to different criteria (Figure 6.10), the pollution levels and the impact to human health reported by the BJEPB are often lower than that reported by the US Embassy [60].
Figure 6.10 Ambiguity in Beijing air quality metrics [60]
6.5 Sources of pollution in Beijing

As per the Beijing Municipal Environmental Protection Bureau, mobile sources, including automobiles, boats, and planes, were the most significant contributor for locally generated PM$_{2.5}$ (Figure 6.11) [61].

A majority of China's provinces experienced air pollution that blew in from neighboring regions in 2015 (Figure 6.12) and concluded that transient pollution between neighbor areas intensified the concentration of pollutants. Therefore coordination between neighbor areas is very important in the fight against air pollution.
Beijing had set an air pollution reduction target for PM$_{2.5}$ at 60 micrograms per cubic meter by 2017. The city averaged 80.9 micrograms in 2015. To reach regional targets, Beijing, Tianjin and Hebei (BTH) have created a coordination mechanism to share statistics and conduct joint inspections. Governments have also tightened their oversight of companies discharging air pollutants along major transmission routes in the region [62]. Figure 6.13 shows the concentrations of PM$_{2.5}$ at BTH from 2013 to 2016.

Figure 6.12 Major sources of PM$_{2.5}$ in Beijing, Tianjin and Hebei (BTH) [62]
6.6 Actions taken by the Chinese government to curb air pollution

The following section compiled the various policy action taken by the Chinese government to mitigate air pollution.

6.6.1 Actions in the initial phase (before 2013)

In 2008, before and during the start of the Summer Olympics in Beijing, the Chinese government spent nearly 17 billion USD to reduce air pollution in the city [63]. It implemented the following schemes to improve the air quality:

- Including halting work at all construction sites,
- Closing many factories in Beijing permanently,
- Temporarily shutting industry in neighboring regions,
- Closing some gas stations [64]
- Cutting motor traffic by half by limiting drivers to odd or even days (based on their license plate numbers) [65]
- Reducing bus and subway fares,
- Opening new subway lines,
- Banning high-emission vehicles [66] [67]
- The city further assembled 3,800 natural gas-powered buses, one of the largest fleets in the world [63]
Beijing became the first city in China to start the Chinese standards equivalent to the Euro 4 emission standard [68].

Since 2012, the city has been converting coal-fired power stations to burn natural gas [69] and aims to cap annual coal consumption at 20 million tons.

### 6.6.2 Actions taken between 2013-2017

After the incident of “Blackest day” (Figure 6.14) China’s the State Council implemented the Action Plan for Air Pollution Prevention and Control (APAPPC, 2013-2017) [55] and Beijing Municipal Government formulated Beijing Clean Air Action Plan (BCAAP, 2013-2017) [70] to control air pollution (Figure 6.14).

![Image](image.png)

**Figure 6.14 Steps taken by the Chinese government to reduce air pollution**
At the end of August 2015, the Chinese government has issued the Air Pollution Control Law, implemented from 2016. Experts believe that although the law is inevitably flawed in some aspects; however, if 80% of the law could be applied, it is going to significantly improve the air quality [71]. This law has been scrutinized three times. Compared to the revised Air Pollution Control Law in 2000, the new version doubled the entries. Almost all the laws in the current version have been amended and revised to fit the current situation [72]. In 2015, as per China Environmental Bulletin, the national urban air quality improved, and the PM$_{2.5}$ average concentration decreased by 14.1% compared to 2014.

Meanwhile, the Ministry of Finance established a fund of 10.6 billion Yuan to improve the air quality and to control the air pollution around the BTH and the surrounding areas, Yangtze River, and other key areas. The government is also actively promoting renewable energy vehicles with an annual production of 390,000, four times more than the production in 2014 [62].
6.6.3 Vehicle policy in China

Mobile source emission is one of the major contributors to PM$_{2.5}$ pollution in China, in particular the diesel fuel vehicles. According to a MEP document, diesel fuel vehicles contribute over 90% of particulate matter from all vehicles [73]. The amended Air Pollution Prevention and Control Act provides that no entities or individuals are allowed to manufacture, sell or import on-road or off-road vehicles, or ships that fail to meet the emission standard requirements [74]. The automobile manufacturers can be required to recall the on-road and off-road vehicles whose air pollution emissions exceeding the standards due to design or manufacture defects [75].

6.6.3.1 New vehicle emissions standards

In addition, China is progressively reducing emissions from mobile sources through strengthened vehicle fuel quality standards and vehicle emission standards. The sulfur content in vehicle diesel fuel must decrease to below 50 ppm in 2015 and then to below 10 ppm in 2018 nationwide [76]. The sulfur content in vehicle gasoline must decrease to below 50 ppm in 2014 and then to below 10 ppm in 2018 nationwide [77]. As the fuel quality improves, the diesel fuel vehicle emission standard China 4 was implemented on January 1, 2015 nationwide [68] and the light-duty vehicle emission standard China 5 will be implemented in 2018 nationwide as well [78].

The 2018 standard of fewer than 10 ppm of sulfur will allow the use of diesel particulate filters (DPFs) which can reduce the black carbon emissions from diesel by over 90%. The use of ultra-low-sulfur diesel (ULSD, < 10 ppm) along with DPFs is a very effective way to reduce particle pollution from vehicles, so a requirement to also use DPFs, especially for new vehicles, could be an effective complement to the 2016 National Ambient Air Quality Standard (NAAQS), by reducing the contribution of both the sulfur and black carbon to particle pollution. Major provinces and cities have been leading on implementation of vehicle fuel quality standards and vehicle emission standards.

6.6.3.2 New energy cars

The following segment presents the types of new energy cars and Chinese policy for the same.
6.6.3.3 New Two-wheelers

China continued to global leader both new registrations and the global stock of electric two-wheelers in 2016, with sold of 26 million [79]. The high growth rate in electric two-wheelers is partially due to the country’s policies to limit air pollution hazards, such as its ban on gasoline-powered motorcycles, limits on the issuing of licenses, and the division of lanes [80]. Additionally, two-wheelers have reached cost parity with ICE models, making them affordable and attractive to consumers.
6.6.3.4 Vehicle emission standard compliance and enforcement program

The national-level environmental protection authority, MEP, focuses its compliance efforts on new vehicle type approval and COP testing. The institution implementing the programs is the Vehicle Emission Control Center under MEP. Local I/M programs are implemented by provincial and municipal environmental protection bureaus (EPBs).
6.6.4 Chinese 2020 action plan


The new plan matches the PM$_{2.5}$ target published in 2016 as part of the 13th Five-Year Plan for environmental protection: mandating falls of at least 18% in PM$_{2.5}$ levels on a 2015 baseline in cities of prefectural or higher level, and where standards have not already been met.

This three-year Action Plan will apply to all these cities. In comparison, the 2013 Action Plan only set PM$_{2.5}$ targets for the city clusters of Beijing-Tianjin-Hebei and the Pearl and Yangtze Deltas [82].
7 Recommendations for the Indian government

This chapter compiles the recommendation for the Indian government in mitigating air pollution. These recommendations are based on learning from Japan and China.

7.1 Recommendations from Japan

The Japanese experience can be beneficial in India’s efforts for clean air. This is because of the similarities involved between India and Japan, and the success achieved by Japan. Both have faced extreme pollution due to their developmental needs, and both attempted solutions in a democratic framework. This chapter summarizes some recommendations for the Indian context based on the project visit to Japan. While an overview has been obtained as a result of the study visit, a mechanism to delve deeper into the implementation details and ongoing exchange of best practices is also recommended. This chapter makes specific recommendations for government action items as well as a mechanism for sustained engagement.

7.1.1 Air quality monitoring and alerts

The following two action items are not present in India right now, but can be implemented without too much investment:

- Japan measures ambient and roadside emissions at carefully planned and distinct locations (APMS & RAPMS). This presents a clearer picture of the contribution of moving sources and the distinction in air quality exposure of residences and roads.
- Japan’s system of issuing alerts, as presented in section 3.2, is an effective tool in air quality management by warning and engaging citizens and other stakeholders.

7.1.2 Electric vehicle industry

The following recommendations can be made for India based on the Japanese experience:

- Government support for charging infrastructure. For e.g., picking up a good chunk of capex, as in Japan.
- Government support to EV usage through discounts in tolls and priorities in parking, toll lanes and restricted areas.
- Serious consideration and policy support, if found viable, for reuse of EV batteries.
- Partnerships, through government convening or calls, among the EV players for EV infrastructure and other implementation aspects.
7.1.3 Waste management

Waste management and air pollution are intricately linked to each other. The Swachh Bharat Abhiyan has resulted in more awareness, household waste management remains a concern. No waste management effort, such as recycling and incineration, can succeed in the absence of segregation at source, which is still not effective in India. Based on lessons learned from Japan, Figure 7.1 presents well defined action items.

![Figure 7.1 Strategy to increase waste segregation.](image)

Apart from citizen engagement, the following action items emerge:

- A fundamental problem of Indian waste incineration plants is the lack of waste segregation. Once that is done, waste incineration plants can be set up, possibly with Japanese support, before moving waste to landfills.
- Waste incineration plants, once designed properly, can be open to the public, thus making instruments for more awareness and accountability of waste management processes.

7.1.4 Green promotion and rating

Apart from air quality management, green products can be promoted in the following ways:
• Government procurement of green items, empowered by appropriate regulation and through the Government e-Marketplace (GeM).
• Green ratings for eco-friendly products can be developed, and those with higher green scores can be given recognition and more visibility on platforms such as GeM.

7.1.5 Co-benefits

Fighting air pollution often seems to be at loggerheads with economic growth and development. To enable India to find solutions to its air pollution problems while also addressing developmental needs, the government can support the study and highlighting of co-benefits as a critical element in the strategy for air pollution reduction. The Institute for Global Environment Strategies (IGES), which is heavily supported, and acts as a key independent thinktank partner of the ministry of environment of Japan, can support in this endeavor. Some details of this approach and specific case studies are presented in chapter 4.

7.2 Recommendations from China

Based on this study, the following is a summary of measures were taken by the Chinese government to successfully reduced PM2.5 levels over 22% across China:

1) Adaptation of science-based policy approach (emission inventory, data monitoring, air quality modelling, source apportionment), and regionally coordinated vigorous policy enforcement.
2) Target-oriented approach
3) Buy in from the top (for strict enforcement)
4) Clear responsibility (public interviews, special inspections, local government first responsibility, incentives – higher promotion rates)
5) Innovations in supervision methods (double random, open)
6) Tech ecosystem (policy, infra, prod, speed etc.), essentially EVs
7) A more participatory approach
8) Close coordination among the Centre, the states, and the municipal corporations.

All the above mentioned measures could also be considered for adoption by the Indian government. Some measures may be easier said than done. However it is important to note the following: item 1) above has already been deftly incorporated by the MoEF&CC, Government of India, 2) seemed difficult initially, but with the introduction of NCAP, this has already become a reality. Further, items 4) through 8) are only a matter of time once 3) is ensure,
although, admittedly, a humongous task and in some ways a work in progress over the past several decades since they are needed for almost all other governance measures to succeed as well. A classic case in point about how 3) expedites 4) through 8) is the Swacch Bharat Abhiyan\(^1\) of the Government of India, which in a short span of less than 6 years has seen remarkable action on each front mandated by 4)-8). In fact, its success has likely played some role in making the government confident to launch an unprecedented mission of piped water to every home in India, including its vast expanse of rural areas. The government has even formed a new ministry by merging some erstwhile independent ministries/departments and adding new ones – always a complicated task in the complex mesh of Indian government – showing its resolve to do what it takes to make the mission a success.

### 7.3 Development of “Clean Air Partnership (CAP)”

Implementation of any recommendation above will need a detailed and specific study and sustained exchange of knowledge for guidance through at least the initial phase of implementation. Based on discussions with key stakeholders, an Indo-Japan Clean Air Partnership is proposed. The partnership can be facilitated by the Memorandum of Cooperation signed between the environment ministries of India and Japan in 2018 (Annexure A1).

The key objective is to leverage the MoC and the excellent India-Japan relationship to share best practices and run some pilot projects in India with Japan’s help. It can be run by a multi-stakeholder (diverse) group as outlined in Figure 7.2.

- The network could meet once every 3/6 months (alternatively in India and Japan, maybe) and exchange knowledge/best practices.
- In India, IIT Delhi would convene the group along with CPCB/MoEF, and in Japan, the MoEJ, along with a relevant university/thinktank (such as IGES) identified by them.
- Possible use of overseas development aid (ODA) for the initial funding of the partnership can be explored (leveraging the MOC). With this funding, the group, apart from the best practices exchange, can also explore technology/solutions pilot/demonstration by innovators/technologists of Japan in India, and even vice versa.

\(^1\) [https://swachhbharatmission.gov.in/sbmcms/index.htm](https://swachhbharatmission.gov.in/sbmcms/index.htm)
7.3.1.1 Activities of CAP

Activities of CAP would be based on the mutual context of the Indian and Japanese and are listed below. More can be evolved by CAP, based on need and interest.

1) Regular visits and deep study and exchange of best practices
2) Anticipate the future, ahead of all countries, and study PM$_1$ including its sources, impact
3) Air Quality management programs focusing on PM$_{2.5}$
4) Mass awareness programs, particularly in light of non-attainment of PM$_{2.5}$ standards in both India and Japan. A specific part here could be the development of programs/curriculum (contextualized to each country) for schools children
5) Explore technology/solutions demonstration by Japanese organizations/agencies in India and vice- versa, particularly for the recommendations in sections 6.1 through 6.5

Figure 7.2 Outline of proposed Clean Air Partnership (CAP).
7.9.1.1 Funding of CAP

Its activities could be initially supported by overseas development aid (ODA) through Japan International Cooperation Agency (JICA) to take off, then explore joint projects (to be submitted to various international agencies) by research and practitioner teams of both countries can be explored.
8 Outreach and Outcomes of the Study

The project has several outcomes, ranging from knowledge creation through papers, dissemination using popular media, network building through workshops and visits, and outreach to the government. This chapter describes these outcomes in detail.

8.1 Publications

One of the most long-lasting contributions of any research is the knowledge creation and discourse/thought building that happens through it. This chapter summarizes the publications obtained through the research.

8.1.1 Peer-reviewed journal articles

- Published a paper on “Air pollution: impact and interventions” in the international journal of Air Quality, Atmosphere & Health [83], a prestigious journal in the area of air pollution. The article summarizes the importance of clean air as a fundamental requirement for the existence of life on earth, the impact of air pollution or various aspects of human life, and key interventions that have been successful in mitigating the same. It’s a first of its kind broad brush on this topic, very useful as a white paper on this topic.

**Abstract:** Clean air is a fundamental requirement for the existence of life on earth. However, with the rapid rate of economic development, globalization, and increasing energy demand, a large amount of emissions and waste are generated, leading to severe air pollution. This paper surveys the literature to provide an overview of the impact of air pollution on various aspects of human life. The impact is categorized broadly into health and socio-economic aspects and further subcategorized into multiple dimensions of health and socio-economic consequences. The survey reveals that the impact of air pollution is comprehensive, ranging from chronic to life-threatening diseases, and from malfunctioning of specific organ systems to subjective well-being. Additionally, evidence of the impact of air pollution on unexpected dimensions such as housing prices, larger economy, academic outcomes, and more is uncovered, leaving no doubt on the need to address this problem with the attention of the highest order. This evidence can be used to trigger more research and give policy-makers a starting point for clean-air campaigns. Merely highlighting the seriousness of the issue is not enough, and hence
the paper also surveys the broader literature to identify interventions for clean air developed by public and private stakeholders across the world. While none of them may be ripe for blind duplication, this paper aims to provide decision-makers and researchers a bouquet of solutions to choose from while developing clean air programs and research agenda.

- Submitted a paper on “Governance and Policy Framework for Air Pollution Control Strategies” in *Environmental Science & Policy*, a reputed international peer reviewed journal. The article describes how air pollution has drawn attention of governments’ world over, particularly some selected countries that have passed through a bad phase and now recovered impressively, and continue to be active in managing the situation well. It summarizes the governance framework of these countries and offers recommendations for countries that are fighting this menace currently.

**Abstract:** Air pollution has drawn a lot of attention from the government, non-government organizations, and scientific communities, due to its profound consequences on the environment and human health in the recent past. Over the last few decades, major economic countries across the world, such as the United States of America, the United Kingdom, China, Japan, South Korea, and India, have encountered severe air pollution. These nations have developed well-defined clean air governance as well as significant policy initiatives to abate air pollution. This paper presents and compares the governance actions and policy framework actions taken across these countries to tackle air pollution issues. The paper discusses the air pollution status and trends followed by environmental regulatory schemes and recommendations. A process of environmental policy making is then analyzed in the six chosen countries, involving the accountable agencies of policy making and the impact of laws to tackle air pollution. This paper finds out that a robust regulatory framework, along with time-bound targets are essential for reaching clean air goals, especially in case developing countries such as China and India.

### 8.1.2 Discourse and dissemination

Published an OP-ED in Indian express on “A passage to clean air” where, among other things, we highlight that Delhi needs an ‘Air Quality Manager’ with clearly defined powers and mandate [84].
Abstract: Globally, rapid economic and social development has resulted in severe air pollution that kills around 7 million people every year, and India is home to 14 of the world’s 20 most polluted cities. Diwali has just passed and “Parali” is ongoing, along with accompanying murmurs and hints of action to ameliorate the air quality situation in Delhi. However, to win the battle against air pollution, India needs a comprehensive action plan for the whole year.

It is noteworthy that China had also faced severe air pollution problems. On January 12, 2013, the Air Quality Index (AQI) in Beijing rose to a record 755 called as “Blackest Day”. In response, the Chinese government announced an Air Pollution Action Plan with a PM 2.5 reduction target of 33 per cent in Beijing by 2017, with 2013 as the base year. The measures adopted were costly, controversial and implemented with seriousness, enabling the city to achieve its target. Along similar lines, in 2017, the South Korean government also set a target of PM 2.5 reduction by 30 per cent by 2022, with base year 2017.

We feel that India needs three action measures to begin its journey towards clean air. The first is a comprehensive plan and setting of goals. On this count, the Indian government announced the “National Clean Air Programme (NCAP)” and set a target to cut down PM levels by 30 percent in five years, with 2019 as the base year.

The second Delhi now needs an “Air Quality Manager” with a clearly defined mandate and powers. This need is so obvious that it is conspicuous by its absence.

Our last action item is about driving a change in perspective. A view often touted about pollution reduction plans is that they are economically and politically difficult. However, clean air programmes can actually provide significant economic opportunity in areas of technology, business, innovation, and enterprise while addressing the challenges of air pollution. Some evidence for this already exists, and some steps have already been taken. For instance, both India and China are focusing on renewable energy sources (especially solar photovoltaic) to reduce the air pollution problem. So clean air, apart from better health and quality of life, can also bring in higher GDP, more jobs, more business, social benefits and higher tax revenues. It certainly doesn’t look like an economically or politically difficult proposition. Who can complete this picture, though, and take it to the masses? Perhaps, a visionary leader and statesman.
8.2 Workshop and conference

This section presents the various workshops and conferences organized and attended as part of the study project. These events provided the platform to interact with different stakeholders working in the area. Also helps us in building storing network with them.

8.2.1 Workshop and conference organized

The following workshops and conferences were organized as part of the study project:

- Organized a workshop on "Blue Sky Initiatives for Delhi" in collaboration with the Embassy of Japan held on 15th April 2019 at IIT Delhi. The conference brought various stakeholders from the government, academia, and private sector together to learn and explore pollution reduction strategies from across the world and the way forward. Presentations and discussions were scheduled during the conference on City Clean Air Action Plans – Opportunities and Challenges, Introduction of Japan’s Blue Sky Initiatives, etc.

This conference provided a platform for Indian academicians to closely study about the Japanese way of air pollution reduction strategies and firmed up the interest of the Japanese Embassy to support the visit of Indian academia to Japan.
Knowledge Exchange Session (Tutorial) by Dr. Jack Broadbent (Executive Officer, Bay Area Air Quality Management District) was held on April 15 from 9.30 to 11.30 AM at the Mechanical Engineering Committee Room (Block 2, 265). He shared the best practices to combat air pollution, innovative strategies to mitigate air pollution, implementation of the U.S. clean air act and measures to control transportation and industry induced pollution.

Figure 8.2 Participants of “Knowledge Exchange Session”

Invited Dr Ken Lee who is the executive Director for EPIC India, Mr. Ashirbad and EPIC team members on 8 April, 2019 at IIT Delhi to discuss different aspects of air pollution reduction strategies. During the discussion, they shared that how the Energy Policy Institute at the University of Chicago (https://epic.uchicago.in/) use their economics research to work closely with government and industry partners to identify innovative ideas, pilot them on the ground, and rigorously measure outcomes. Making efforts to address challenges around air pollution is one of the critical areas of their work. On top of the different efforts that they were making
with State Governments in India, they also recently launched the Air Quality Life Index (https://aqli.epic.uchicago.edu/) - a pollution index that tells us how much longer we would live if we breathed cleaner air.

Figure 8.3 Picture with EPIC team members

8.2.2 Workshops and conferences attended

The following workshops and conferences were attended as part of the study project:

- ETAuto EV Conclave was held on 20 February 2019 at New Delhi. A lot of eminent industrialists were spoken on their experiences on Electric vehicle technology, Policy Challenges & Support, Industry Readiness, Changing Skill Set, Battery Technology, Missing Links in EV Penetration, Charging Infrastructure Solutions, and EV & shared Mobility. We interacted with different stakeholders working in the area of electric vehicle. Analysed how the successful adoption of EV could play a significant role in air pollution mitigation, especially in metro cities. It also helped in identifying problems on EVs, particularly batteries swapping, and their reverse logistics.
Workshop Series on Confronting Air Pollution at its Source, sponsored by the North India Office, U.S. Embassy in New Delhi held from 11th and 19th March 2019 at The American Center (24 Kasturba Gandhi Marg, New Delhi). The workshops was organized by RTI International (USA) with support from RTI International India office, and in academic collaboration with Professor Umesh Kulshrestha of Jawaharlal Nehru University, New Delhi. The objectives of the workshops were to gather selected experts from the U.S. and India from three specific source sectors (construction dust, crop rotation/crop residue burning, and vehicular movement [including road dust]) to meet, exchanged ideas and develop a path forward to mitigate the air pollution problem at the source.

High Level Workshop on Tackling the Challenges of Urban Air Pollution linking Research and Policy for Air Quality Improvement was held at the India Habitat Centre, Lodhi Road, New Delhi from 6-7 March 2019. It was organized by University of Birmingham and partners including Indian Institute of Technology Delhi, All India Disaster Mitigation Institute, Population Council India and Urban Management Centre. The objective of this international workshop was to bring together stakeholders from the global south and north to explore practical examples of how cities can better understand the challenges posed by air pollution and how this information can be used to inform air quality improvement policies. The workshop also provided an opportunity for urban stakeholders (government officials, academics, representatives of the international development community and civil society actors) to share practical experiences of researching air pollution and developing air quality interventions.

1st annual flagship conference was organized by the Center of Excellence for Research on Clean Air (CERCA) on 20th Dec 2018. In the inaugural session, Mr. Arun Duggal co-chairman of CERCA has introduced the idea behind the inception of CERCA at IIT Delhi. Then he launched the CERCA Newsletter and said that the newsletter would be circulated among the various stakeholders to spread the news on Clean Air in Delhi. After that Prof. Nomesh Bolia, Prof. Sagnik Dey and Prof. Vimlesh Pant made progress updating presented of their respective projects. Prof. Nomesh Bolia said that cities like Beijing, Tokyo, and Seoul had faced the similar kind of air pollution problems and they
have been effectively managing their air pollution problems. We have to learn from these cities. Prof. Ramgopal Rao (IIT Delhi Director) presented the welcome remark. He further said that air pollution is a technical problem and being a technological institute we should have technologies to solve the challenges. He mentioned that IIT have different technologies to monitor air pollution, but it needs funding to launch on a commercial scale. He also focused on policy and administrative measurements to solve the problem. In concluding Session, Prof. Nomesh Bolia presented the conference report.

➢ Air Quality Workshop “The Path to Clean Air – Reducing Fine PM Concentrations” conference was organized by the Center of Excellence for Research on Clean Air (CERCA) on June 25, 2019. Dr. Sudheer Chintalapati Joint Director, MoEFCC discussed the National Clean air programme (NCAP) and the role of MoEFCC and CPCB in pollution reduction planning and strategy. He started his presentation with the action taken in Delhi NCR to curb air pollution. He discussed action taken at the policy level, transportation, and industrial sector, and he also discussed various steps taken in control of biomass and solid waste and dust emissions. Due to the programme mentioned above average annual PM2.5 decreased by about 7% and 15% in 2018 over 2017 and 2016 respectively in Delhi. Dr. James Schauer, U.S Science Envoy, presented on mobile source emissions, including Greenhouse Gas Emissions and Air Pollution. He further discussed the available advanced technologies to reduce vehicle air pollution like catalytic converter, Diesel Particulate Filters (DPF) and Diesel Oxidation Catalysts (DOC) and Diesel Engine SCR (Urea Injection). He also discussed the chronological development of more stringent vehicular air pollution standards in USA. Mr. Ritesh Bhatia, IPS Foundation, presented on Agricultural Burning—causes, enforcement mechanisms, alternatives, areas for collaboration. He first discussed the origin of the paddy stubble problem in Punjab and discussed the possible solution to the problem. He found that in field management is economical and can be implemented immediately. He then presented a case study where wheat sowing and germination were compared with Happy Seeder and on a burnt field, and both plots have the same wheat yield. It clearly showed that in situ management of crops is the most cost-efficient and immediately applied solution to a burning problem. However, it required awareness, adoption, and behavior change among farmers.
NITI Aayog and USAID jointly organized the first India Energy Modeling Forum (IEMF) Workshop on March 13-14, 2019 in New Delhi. The objectives of the workshop were to flesh out options for institutionalizing an energy modeling forum in India, while also sharing recent, policy-relevant analysis from a range of research teams. Approximately 100 policy makers and researchers from India, the U.S., Europe and other regions participated. The workshop included eight panels with various topical research spotlights and opportunities to explore the vision of IEMF. The participants enthusiastically supported the idea of creating an Indian Energy Modeling Forum. Priority research topics include air quality, energy-water-land nexus issues, renewable deployment, and long term strategies. At the close of the meeting, NITI Aayog invited several experts from research organizations and industry to join a small, near-term working group to work out details of the IEMF’s governance structure, research priorities and potential funding approach.

In his summary remarks, Dr. V K Saraswat, Member, NITI Aayog said India’s several interlinked energy related challenges can only be met by long-term planning and coordinated action by various stakeholders and he emphasized that India needs an IEMF to create synergy and coherence, linking analysis and decision making. The forum’s role should be energy and environment, and environment means creating the links between all important systems. He laid special emphasis on ensuring social, environmental and economic costs of energy production and consumption are accurately calculated to future-proof decision making and policy planning.

NITI Aayog and GIZ India jointly organized a National Sensitization Workshop on State Energy Action Plans (EAP) on 8 November 2019 in order to share the key learning and benefits achieved during energy planning exercise with the states. The basic objective of the sensitization workshop was to share knowledge and experience on the following:

- Inter-dependency between State EAP and National energy security / policy / plan;
- To discuss what approach, methodology are to be used for developing State Energy Action Plan (EAP);
o Share experience while developing state energy calculator and State EAP;
o Work out next steps for designing national EAP framework.

The key highlights from the workshop deliberations were –
o State Energy Action Plans are critical and there is a need to support the states developing EAP;
o A smooth interface between the IESS, India Energy Model and the State Energy Calculators/Models will help to move towards a more accurate and optimal planning to meet our energy requirements, with reduced emissions;
o Data is the key to the Policy analysis. NITI Aayog has taken steps to address this by constituting 8 sub-groups on energy data management in supply side and demand side of energy. Based on the sub groups report, the proposal is being formulated to strengthen Energy Data management in India. NITI Aayog is also planning to establish an open source data dashboard in the near future;
o Participation of all relevant stakeholders is critical to the energy planning exercise. There is a need to identify a relevant anchor institution for the energy planning exercise that can convene and actively engage with the stakeholders, when updating the plan periodically;
o Some states expressed an interest to develop city level Energy Action Plans along the lines of the State Energy Action Plans;

➢ Prof. Sukumar Mishra delivered a distinguished lecture on Microgrid Control on 10th February 2020 at IIT Delhi. The talk started with basic concepts of the power grid, microgrid, difference between AC/DC, Role of electrical engineering, and Point of Common Coupling (PCC). After that, it discussed the need for microgrid, benefits, and challenges of grid integration of different types of renewable energy systems. Renewable generation from wind and solar has increased substantially during the past few years and forms a significant proportion of the total generation in the grid. The integration of these renewable energy sources into the utility grid can be at either the transmission level or the distribution level, depending on the scale of generation. Large renewable energy generation such as wind farms are directly interconnected to the transmission system. Small scale distributed generation is generally interconnected to the medium or low voltage distribution systems. Both types of interconnections present different challenges that must be carefully analyzed before systems are designed. Electricity generation using renewable energy sources is often taking place in a small
scale due to the dispersed nature of the resources. Good examples are small hydro, solar photovoltaics, biogas, biomass and small wind turbine based electricity generation systems. The interconnection of these small scale renewable generation to the distribution grid violates their fundamental assumptions. Therefore these systems are preferred to operate into decentralized mode without connecting to the main grid into Decentralised Energy Systems (DREs). Certain special requirements need to be satisfied when interconnecting DREs work in order to ensure safe and reliable operation. Therefore, a microgrid network is utilized in DREs for energy generation and consumption.

- Clean Energy Access Network (CLEAN) organized a summit on India Energy for All Summit (IEAS) on February 4-5, 2020. IEAS aims to fast track India’s clean energy transition by scaling-up the use of Decentralized Renewable Energy (DRE) and supporting the bid to achieve its global commitment on Nationally Determined Contributions and the UN Sustainable Development Goals. Currently, more than 14000 micro-grid are operational in India. Presented a case study of DRE based financially viable model: Changemakers from the Gumla district of Jharkhand State shared their story of empowerment by a solar-powered ‘Dal Mill’, and how a local livelihood generating unit has enhanced their health, economic and educational conditions drastically. In Special Address Michael Satin from USAID- India, spoke about how the Clean Energy movement can bring people out of poverty; the importance of access to off-grid, and the need to use electricity in a productive manner. In Special Address by Shri. Nishant Tiwary IPS, OSD, MNRE, highlighted that “DRE uplifts the performance of the country on various SDG parameters. India, to be a global leader in sustainable development, needs to accelerate responsible consumption of DRE”. In Keynote Address H.E Shri. Upendra Tripathy from ISA highlighted how solar-powered technologies have transformed lives and have the potential to transform lives of millions of families further. In other sessions, speakers discussed innovative clean technologies, including solar water pumps, innovative payment, deep freezer technology, and clean cooking solutions by integrating DRE for enhancement of livelihood. They also talked about the potential of DRE as an income source for the communities.
8.3 Report on Japanese Experience with Air Pollution Reduction

- A report on “Japanese Experience with Air Pollution Reduction” has been submitted to the Prime Minister’s Office, Government of India and a copy to CERCA. The report is based on the learning and personal high-level visits and meetings with different government officers, academicians, think tanks, and industry representatives. Before the visit Japan was chosen as an area to study based on the similarity of experiences in terms of air pollution as well as a democratic set up. The Embassy of Japan in New Delhi was approached, and they readily coordinated a visit involving meetings with stakeholders in the Ministry of the Environment, Japan, industry, and research institutes/think tanks. Japan has passed through a phase of severe pollution, and come out of it well. This report attempts to capture the Japanese experience based primarily on a visit to Japan and associated research. The key highlight of the study are as follows:
  - Strong, adaptive, empowering Air Pollution Control Acts that incorporate locally designed standards and targets, introduction and management of voluntary reduction programmes and empowerment of local governments to implement the laws and targets
  - Sincere monitoring and follow up action, including alerts.
  - Encouraging green procurement.
  - Effective waste management via systems (entire value chain), technology (incineration plants), people’s engagement (Mottainai, 3R), and outreach (by workers, leaders).
  - Waste management and clean air awareness starting from school children itself.
  - Facilitation of the EV ecosystem.
  - Supporting research and strategization among research institutes (co-benefits).

- Final project report of “Select Study of Air Pollution Reduction Programs around the World: Governance and Implementation Issues”. The report presents a 360° views on different actions and steps taken by stakeholders in the mitigation of severe air pollution. China and Japan are chosen as the study areas based on the similarity of experiences in terms of air pollution. Japan is further focused on due to a similar democratic setup. The first part of this report attempts to capture the Japanese experience based on the visit to Japan and associated research comprising from chapters 1 to 5. The sixth chapter presents the Chinese experience to fight with the air pollution
problem. The information gathered in this part has been collated from different open resources and publications from various government and non-government organizations. The seventh chapter presents the recommendation to the Indian government based on Japanese and Chinese experiences. The eight chapter presents the outreach and outcomes of the study. The project has several outcomes, ranging from knowledge creation through papers, dissemination using popular media, network building through workshops and visits, and outreach to the government.

### 8.4 Outreach to the Government

- **PMO Meeting**

On 20 June 2019, the PI held a meeting with top bureaucratic at PMO specifically with Su. Debashree Mukherjee and submitted Japan findings to the Indian PMO. Briefly discussed possible steps/recommendations that could be taken by the Indian government to mitigate air pollution. Also, submitted a proposal of Indo-Japan Clean Air Partnership because the implementation of any recommendation above will need a detailed and specific study and sustained exchange of knowledge for guidance through at least the initial phase of implementation. The partnership can be facilitated by the Memorandum of Cooperation signed between the environment ministries of India and Japan in 2018. The key objective is to leverage the MoC and the excellent India-Japan relationship to share best practices and run some pilot projects in India with Japan’s help. It can be run by a multi-stakeholder (diverse) group as outlined.

- **Ministry of Environment, Forest & Climate Change (MoEF&CC)**

The MoEF&CC, Government of India has also been informed about this project, including to the honorable minister himself. Meanwhile, we have also kept in touch with contact persons in the Ministry of Environment of Japan, who had kept us in loop about the upcoming G20 environment ministers meeting that was to happen earlier this year, but was postponed due to the Covid-19 outbreak. Communication has been slightly derailed this year owing to the Covid-19 situation, but we intend to keep making sustained efforts. However, we do know that relevant people in the ministry do know about CERCA and the project PI, as indicated by an invitation extended to the PI to be a part of the expert committee for assessment of the scientists of MoEF&CC and its subordinate offices.
Annexure

A1- Memorandum of Cooperation (MoC) signed in 2018 between the Ministry of the Environment (MoE) of Japan and the Ministry of Environment, Forest and Climate Change (MoEFCC) of the Republic of India in the Field of Environmental Cooperation.
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