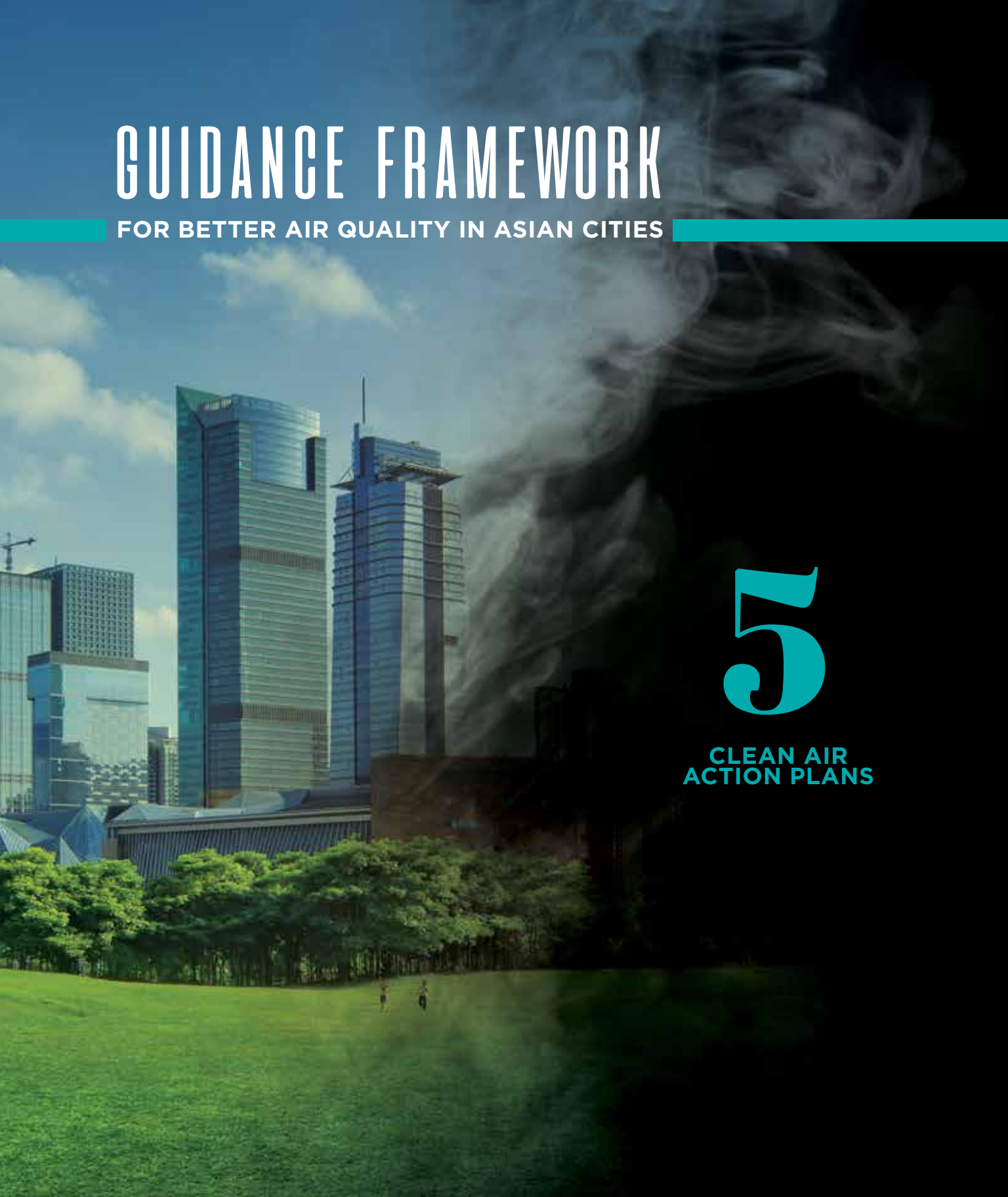
GUIDANCE FRAMEWORK

FOR BETTER AIR QUALITY IN ASIAN CITIES



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CLEAN AIR
ACTION PLANS

GUIDANCE FRAMEWORK

FOR BETTER AIR QUALITY IN ASIAN CITIES

Guidance Area 5: Clean Air Action Plans

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ABOUT THE GUIDANCE FRAMEWORK FOR BETTER AIR QUALITY IN ASIAN CITIES

The Guidance Framework is a voluntary and non-binding guidance document developed as an outcome of the biennial Governmental Meetings on Urban Air Quality in Asia, co-organized by Clean Air Asia and United Nations Environment Programme Regional Office for Asia Pacific (UNEP ROAP). It is an outcome of an extensive development process, which began in 2006 when the Long Term Vision for Urban Air Quality in Asia (LTV) was envisioned by representatives of environment ministries in the region. The LTV describes the desired state of urban air quality in Asian cities by 2030; the Guidance Framework serves as a guide for cities and countries to achieve this vision. In 2016, the Guidance Framework was launched as a pioneering approach to resolve air pollution challenges at the local- and national-levels. Centered on identified priority areas of concern in air quality management in the region, the Guidance Framework provides cities and countries with development capacity indicators and recommended steps and actions to improve air quality.

The Guidance Framework serves as a cornerstone document of Clean Air Asia's Integrated Programme for Better Air Quality in Asia (IBAQ Programme), which supports countries and cities in implementing the Guidance Framework through a range of targeted interventions, including knowledge-sharing platforms to strengthen regional collaboration, capacity building activities such as trainings, study tours and city twinning, and technical assistance at both the national and subnational levels.

ABOUT CLEAN AIR ASIA
www.cleanairasia.org

Clean Air Asia is an international NGO established in 2001 as the premier air quality network for Asia by the Asian Development Bank, World Bank and USAID. Its mission is to promote better air quality and livable cities by translating knowledge to policies and actions that reduce air pollution and greenhouse gas emissions from transport, energy and other sectors.

Clean Air Asia became a UN-recognized partnership in 2007, its network spanning 261 organizations in 31 countries in Asia and worldwide, with nine country networks: China, India, Indonesia, Malaysia, Nepal, Pakistan, Philippines, Sri Lanka, and Vietnam. It is headquartered in Manila and has offices in Beijing and Delhi. Clean Air Asia leads efforts to enable Asia's more than 1000 cities to reduce both air pollution and CO_2 emissions, and thereby contribute to more livable and healthy cities with blue skies and a low carbon footprint. Clean Air Asia helps to reduce emissions, through policies, plans, programs, and concrete measures that cover air quality, transport and industrial emissions and energy use.

The Better Air Quality (BAQ) Conference is a flagship event of Clean Air Asia covering the key sectors of transport, energy and industry, with a particular emphasis on government policies and measures. Policymakers, practitioners and industry leaders meet at BAQ to network, innovate, learn, and share experiences. The biennial event was first held in 2002 and attracts close to a thousand participants from Asia and the rest of the world.

ABOUT UNEP

www.unep.org

The United Nations Environment Programme (UNEP) is the leading global environmental authority that sets the global environmental agenda, promotes the coherent implementation of the environmental dimension of sustainable development within the United Nations system and serves as an authoritative advocate for the global environment. UNEP work encompasses assessing global, regional and national environmental conditions and trends; developing international and national environmental instruments; and strengthening institutions for the wise management of the environment. UNEP's mission includes to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

CONTENTS

PREFACE

Air pollution is now considered the world's largest environmental health risk. There have been a number of global efforts calling for air pollution actions in recent years. These global calls for action on air pollution strengthen regional and national initiatives and highlight the need to prioritize addressing this issue through a collaborative and integrated approach.

In 2006, the First Governmental Meeting on Urban Air Quality in Asia[1] recognized the need for guidance in implementing a Long Term Vision for Urban Air Quality in Asia, which describes the desired state of urban air quality management in Asian cities. During the Third Governmental Meeting, environment ministries from the region identified key challenges they are facing to improve urban air quality.

To set the way forward in achieving the vision for cleaner air, Clean Air Asia led the development of the Guidance Framework for Better Air Quality in Asian Cities (Guidance Framework) to address the needs and challenges in the region. It aims to provide a recognized guidance on improving urban air quality and is organized around priority areas of concern in the region, which were translated into key guidance areas with roadmaps on how to progress in a step by step manner.

This voluntary, non-binding document consists of seven individually published chapters covering each of the Guidance Areas. Policy and decision makers in Asia, as well as other relevant stakeholders, can use one or a combination of the Guidance Framework chapters to develop local roadmaps or action plans depending on their priority areas of concern.

The Guidance Framework consists of seven main books with these titles:

- Introduction
- Guidance Area 1 - Ambient air quality standards and monitoring
- Guidance Area 2 - Emissions inventories and modeling
- Guidance Area 3 - Health and other impacts
- Guidance Area 4 - Air quality communication
- Guidance Area 5 - Clean air action plans
- Guidance Area 6 - Governance

These guidance areas come with an Information Sourcebook, which is a compilation of resources to support the implementation of Guidance Framework roadmaps. There is also an accompanying training course on Guidance Framework implementation, which is available online in the Clean Air Asia website and Integrated Programme for Better Air Quality (IBAQ Programme) website: www.cleanairasia.org/ibaq

The Guidance Framework was developed together with a team of international and regional experts and practitioners and has undergone an extensive review process through the Governmental Meetings and the involvement of external reviewers. The draft document was also shared in a number of international events, including the Asia Pacific Clean Air Partnership (APCAP) Joint Forum organized by UNEP ROAP in November 2015. The Guidance Framework was welcomed by participants from 24 countries in Asia and the Pacific, involving environment ministries, intergovernmental organizations, non-governmental organizations, and experts.

1 Governmental Meetings on Urban Air Quality in Asia are biennial meetings organized by the United Nations Environment Programme Regional Office of Asia and the Pacific (UNEP ROAP) and Clean Air Asia that convene environment ministries with the aim to harmonize approaches across the region in tackling air pollution and related fields.

ABBREVIATIONS

AQI	Air Quality Index
AQM	Air Quality Management
ASEAN GIZ CASC	Association of Southeast Asian Nations—Deutsche Gesselschaft für Internationale Zussammenarbeit Clean Air for Smaller Cities
CAAP	Clean Air Action Plan
CPCB	Central Pollution Control Board
CO	Carbon monoxide
CO_2	Carbon dioxide
DPSIR	Driving Forces-Pressures-State-Impacts-Responses
EEA	European Environment Agency
EI	Emissions Inventory
GHG	Greenhouse Gas
NOx	Nitrogen oxides
PM	Particulate Matter
PM_{10}	Particulate Matter (≤ 10 micrometers in diameter)
$PM_{2.5}$	Particulate Matter (≤ 2.5 micrometers in diameter)
PRD	Pearl River Delta
SA	Source Apportionment
SEI	Stockholm Environment Institute
SO_2	Sulfur dioxide
SPM	Suspended Particulate Matter
UNEP	United Nations Environment Programme
UNEP-PCFV	United Nations Environment Program Partnership for Clean Fuels and Vehicles
USEPA	United States Environmental Protection Agency
YRD	Yangtze River Delta

The **key features** of a clean air action plan include: **instruments and strategies** to comply with **air quality** and emission standards; **adoption and implementation** of control measures; continuous improvement after compliance, and anticipation of **future trends** such as **national policies and international commitments**.

CHAPTER 6

GUIDANCE AREA 5: CLEAN AIR ACTION PLANS

6.1 Introduction

A clean air action plan (CAAP) intends to improve air quality and public health by identifying cost-effective measures to reduce emissions from sectors such as transport, industries, waste deposits and residential burning, among others. A CAAP is also a collection of regulations, policies and programs for cleaner air. The process of CAAP development is led by the government and involves stakeholders.

Clean air action plan approaches vary depending on the contexts of cities and countries, as well as their needs and capacities to develop and implement a CAAP. Nevertheless, there are good examples of CAAPs available for the different developmental stages of air quality management (AQM) that may apply to cities.

In general, the key features of CAAP include: instruments and strategies to comply with air quality and emission standards; adoption and implementation of control measures; continuous improvement after compliance, and anticipation of future trends such as national policies and international commitments.

6.1.1 Objective

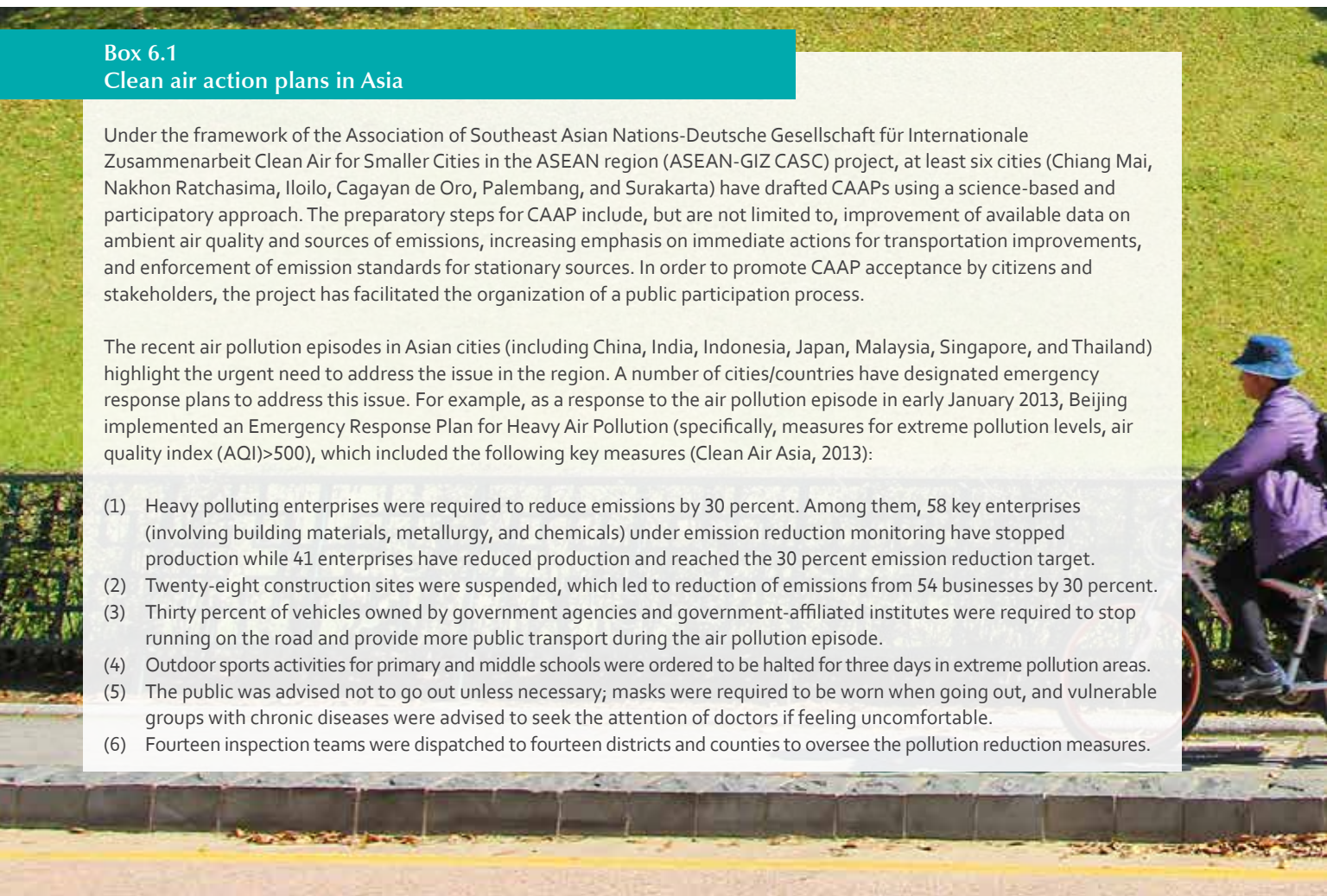
To include and/or strengthen AQM in relevant policies and legislations of cities and countries in the Asian region through CAAP development; and, ultimately, protect public health and the environment against impacts of air pollution.

6.1.2 Importance of clean air action plans

Air quality management requires concerted and incremental efforts – tailored to the goals and resources available in the area – to address the growing air pollution problems in the region.

The 2010 Global Burden of Disease estimates over 2.1 million premature deaths and 52 million years of healthy life lost due to ambient fine particle air pollution in the developing countries of Asia, where air pollution levels are the highest in the world (Lim et al., 2012). A number of cities in Asia, including several Chinese cities, have already developed CAAPs in the wake of recent air pollution episodes (Box 6.1 and Box 6.2).

To include and/or strengthen air quality management in **relevant policies and legislations** of cities and countries in the **Asian region** through clean air action plan development; and, ultimately, **protect public health** and the environment against **impacts of air pollution**.



Box 6.1
Clean air action plans in Asia

Under the framework of the Association of Southeast Asian Nations-Deutsche Gesellschaft für Internationale Zusammenarbeit Clean Air for Smaller Cities in the ASEAN region (ASEAN-GIZ CASC) project, at least six cities (Chiang Mai, Nakhon Ratchasima, Iloilo, Cagayan de Oro, Palembang, and Surakarta) have drafted CAAPs using a science-based and participatory approach. The preparatory steps for CAAP include, but are not limited to, improvement of available data on ambient air quality and sources of emissions, increasing emphasis on immediate actions for transportation improvements, and enforcement of emission standards for stationary sources. In order to promote CAAP acceptance by citizens and stakeholders, the project has facilitated the organization of a public participation process.

The recent air pollution episodes in Asian cities (including China, India, Indonesia, Japan, Malaysia, Singapore, and Thailand) highlight the urgent need to address the issue in the region. A number of cities/countries have designated emergency response plans to address this issue. For example, as a response to the air pollution episode in early January 2013, Beijing implemented an Emergency Response Plan for Heavy Air Pollution (specifically, measures for extreme pollution levels, air quality index (AQI)>500), which included the following key measures (Clean Air Asia, 2013):

(1) Heavy polluting enterprises were required to reduce emissions by 30 percent. Among them, 58 key enterprises (involving building materials, metallurgy, and chemicals) under emission reduction monitoring have stopped production while 41 enterprises have reduced production and reached the 30 percent emission reduction target.
(2) Twenty-eight construction sites were suspended, which led to reduction of emissions from 54 businesses by 30 percent.
(3) Thirty percent of vehicles owned by government agencies and government-affiliated institutes were required to stop running on the road and provide more public transport during the air pollution episode.
(4) Outdoor sports activities for primary and middle schools were ordered to be halted for three days in extreme pollution areas.
(5) The public was advised not to go out unless necessary; masks were required to be worn when going out, and vulnerable groups with chronic diseases were advised to seek the attention of doctors if feeling uncomfortable.
(6) Fourteen inspection teams were dispatched to fourteen districts and counties to oversee the pollution reduction measures.

Box 6.2
China's National Clean Air Action Plan

China has been making efforts and is building its capacity for CAAP development. The CAAP in China can be categorized by scope (national, regional, provincial, or city level), duration (five-year plan, three-year plan, and one-year plan) and focus area. China's State Council released its Action Plan for Air Pollution Prevention and Control (Action Plan) on 12 September 2013, eight months after the widely reported air pollution episode that occurred in January 2013, which covered one-sixth of China's territory. The Action Plan sets the roadmap for air pollution and control for the next five years in China with a focus on three key regions – Beijing-Tianjin-Hebei area (Jing-Jin-Ji), Yangtze River Delta (YRD) and Pearl River Delta (PRD). The Action Plan release was reported publicly by state media on the website of the China central government, Xinhua News Agency, and CCTV as a crucial step forward for air pollution prevention and control in China.

General requirements

A new air pollution prevention and control mechanism will be established in which the government takes the leading role in incorporating enterprises' initiatives, market drivers, and public participation. The new mechanism relies on regional management and stage by stage control, which promotes industrial structure optimization, science and technology innovation, and quality economic growth. The ultimate goal is to achieve environmental, economic and social benefits, and strive to build a beautiful China.

Goal

After a five-year initiative, the overall national air quality will be improved. Heavily polluted days shall be reduced dramatically. Regional air quality in Jing-Jin-Ji, YRD, and PRD will be improved. Through a follow-up initiative lasting another five years or even longer, there will be less and less heavily polluted days until they are eliminated and the national air quality is improved significantly.

Specific indicators

By 2017, the urban concentration of PM_{10} shall decrease by 10 percent compared with 2012, and annual number of days with fairly good air quality will gradually increase. Concentration of $PM_{2.5}$ in Jing-Jin-Ji, YRD and PRD region shall respectively fall by around 25 percent, 20 percent and 15 percent. Fine particulate matter annual concentration in Beijing shall be controlled below 60 $\mu g/m^3$.

Measures

In June 2013, 10 measures – called the National 10 Measures – were disclosed in a strongly worded statement by the State Council to prevent and control air pollution. The Action Plan is the detailed implementation plan of the National 10 Measures:

- Increase efforts of comprehensive control and reduce emission of multi-pollutants
- Optimize the industrial structure, promote industrial restructure
- Accelerate the technology transformation and improve the innovation capability
- Adjust the energy structure and increase the clean energy supply
- Strengthen environmental thresholds and optimize industrial layout
- Improve environmental economic policies through the market mechanism
- Improve law and regulation system; carry on supervision and management based on law
- Establish the regional coordination mechanism and the integrated regional environmental management body
- Establish monitoring, alerting, and emergency response system for air pollution episodes
- Clarify the responsibilities of the government, enterprise, and society; mobilize the public to participate in environmental protection

Mechanism Development

- Establishment of regional collaboration mechanisms in Jing-Jin-Ji and YRD with the participation of provincial governments and relevant central ministries in the region;
- Air pollution monitoring and alert system will be established together by environmental protection and meteorological agencies.

New incentives

- Central government will disclose 10 best and 10 worst air quality cities monthly;
- Targets for $PM_{2.5}$ in three key regions and PM_{10} in other key areas will be considered as compulsory targets in the social and economic development objectives for provinces and be part of the performance evaluation indicators for provincial leaders.

PM_{10} - Particulate matter ≤ 10 micrometers in diameter; $PM_{2.5}$ - Particulate matter ≤ 2.5 micrometers in diameter

Source: Ministry of Environmental Protection, 2013

A **clean air action plan** is necessary for air quality management because it will enable the government as well as wider stakeholders to **mobilize resources** in the **most effective and efficient manner** to achieve air quality objectives.

A CAAP is necessary for AQM because it will enable the government as well as wider stakeholders to mobilize resources in the most effective and efficient manner to achieve air quality objectives. Air quality objectives are derived from the long-term vision and goals of improving air quality. An example of vision and goal statements and objectives of improving air quality in Palembang City, Indonesia is shown in Box 6.3. The Indonesian city of Palembang has recently completed its Clean Air Plan under the framework of ASEAN-GIZ CASC project (ASEAN-GIZ CASC, 2014; Clean Air Asia, 2012).

Box 6.3
Vision and goal statements and objectives of improving air quality in Palembang City, Indonesia

Vision:
Clean and healthy air in Palembang

Goal:
To improve air quality through implementation of science-based strategies for emissions reduction that contributes to public health and reduced environmental and climate change impacts

Objectives:
To achieve and maintain air quality within the ambient air quality standards for which there is an accepted risk for human beings and the environment, with the indicator of performance at a minimum of 340 days in a year compliance with the National Ambient Air Quality Standards for criteria pollutants by 2018.

Source: ASEAN-GIZ Clean Air for Smaller Cities, 2015

The experience of developed countries demonstrates that the CAAP has been an efficient instrument of air pollution control. With the CAAP, multi-year efforts to reduce emissions have been made through various control measures and clear frameworks for implementation and enforcement of the control strategies. As a result, emissions from anthropogenic sources have been substantially reduced, and most developed countries reported improvement in their nation's urban air quality (United States Environmental Protection Agency [USEPA], 2012; European Environment Agency [EEA], 2015).

On the other hand, efforts to reduce emissions are yet to be seen in most developing countries even as accelerating urban growth is likely to cause increased air pollution–generating activities. Clean air is most often a least-priority program in developing countries. It is not well-known that for developing cities and countries that do not have established procedures for AQM and have limited AQM capacity, a simplified CAAP could be developed so as not to delay addressing the air pollution problem. A simplified CAAP could include: a rapid assessment of the most important sources; monitoring results from a minimal set of air pollutant concentration monitors; comparison with air quality standards; impacts on public health and the environment; and identification of air quality objectives, control measures and key projects or sectors (Schwela & Haq, 2004; Clean Air Asia, 2011).

6.1.3 Developing a clean air action plan

In general, the process of developing a CAAP typically includes four steps (Clean Air Asia, 2011), with stakeholder participation and communication being part of the whole process:

(1) Assessment
(2) Action plan development
(3) Implementation and enforcement
(4) Review and improvement

Assessment of current and projected scenarios is a starting point for CAAP development. This includes review and analysis of the status and trends of air quality [See *Guidance Area 1 on Ambient air quality standards and monitoring*]; impacts on public health and the environment [See *Guidance Area 3 on Health and other Impacts*]; information on key pollutants and sources of pollutant emissions [See *Guidance Area 2 on Emissions inventories and modeling*]; indicators of economic growth, energy use and population growth and their projections in future years; baseline emissions inventory (EI) for targeted pollutants; and projected levels of emissions. In addition, for identified domain area and pollutants, source apportionment (SA) information may be used to prioritize the source types that need to be dealt with. For example, motorized vehicles – being ubiquitous and a ground-level source – may result in higher impact as compared to a localized large industry emitting through an elevated stack. Prioritizing emission sources based on SA using source-oriented or receptor-oriented modeling would essentially include sources that have larger contributions to ambient air pollution levels [See *Guidance Area 2 on Emissions inventories and modeling*]. A case study of India's CAAP development, which illustrates the CAAP assessment process including air quality measurements, EI, and receptor-based modeling is provided in Box 6.4.

Action plan development is a way to address the existing situation as well as future scenarios, with due consideration of projected population growth; demand and management of services (energy, transport, among others); sector-specific developmental plans (e.g., road network, housing, industries) from municipal corporations and urban and industrial development agencies; and expected technological advancements (e.g., new vehicles with better engine and emission control devices). The action plan development encompasses identification of different types of control measures, estimation of effect of the control measures on pollutant emission reduction, cost-effectiveness of the control measures, and co-benefits.

A survey on the state of clean air action planning in cities was conducted by Clean Air Asia in 2011 with the aim of understanding the current situation, fostering learning and sharing best practices, and strengthening the capacity of cities (Clean Air Asia, 2013). The key components of plans and the outlines of contents across the 16 action plans from seven Chinese cities and nine international cities were listed and summarized with the same details. The structure of the key components reflects the DPSIR (Driving Forces-Pressures-State-Impacts-Responses) framework:

- Driving forces: introduction and background
- Pressures: causal analysis of effects and attribution to individual sources
- State: current status, Air Pollutant Index, comparison to objectives/standards, EI, and key pollutants
- Impacts: impact on public health and the environment
- Responses: development and implementation of the action plan and following components

This study identified the recommended components of a CAAP which are tabulated in **Annex V-A of the Information Sourcebook**. The content of each component and the degree of detail in each step may be different, depending on the local

situation and current air quality status. Baseline assessment, goal setting, and evaluation are the essential steps for either a detailed CAAP or a basic one. As cities and countries progress to different stages of CAAP development, the content and level of detail of the CAAP components could be expanded to respond to local needs and capacities.

Implementation and enforcement are key to reducing air pollutant emissions and achieving air quality objectives. A successful and implementable CAAP needs clear institutional framework and responsibilities, stakeholder coordination and communication, political support, allocation of financial resources, technical capabilities, and review and improvement (Clean Air Asia, 2012). Three factors determine the success of a city or country in providing better air quality:

- the existence of policies and action plans, and their implementation details (mechanism, timeline, assignment of responsibility);
- provision of enough resources to implement the policies and action plans; and
- actual implementation of the policies and action plans.

Review and improvement refers to the process to track and report on implementation of measures and overall changes in emissions (comparing the plan and change in monitored air quality). It is important to identify mechanisms and responsibilities for monitoring/tracking progress to enable review of the effectiveness of available control measures; and to determine if changes are needed to achieve greater reductions, address excessive costs or amend measures, as appropriate.

While customized to the local needs, constraints, and air quality objectives, the process of CAAP development is also evolving. Several trends have emerged in CAAP development (Clean Air Asia, 2012): move from single pollutant to multiple pollutant action planning; expansion to regional AQM; involvement of multiple stakeholders in the development and implementation process; planning for long-term air quality improvement; and integration of CAAP and greenhouse gas (GHG) mitigation plan.

In summary, the CAAP is useful as cities or countries move up the stages of AQM development. A good CAAP benefits from the following good practices:

- draws inputs from the assessment of air pollution sources and emissions, ambient air pollution levels (adequately representing temporal and spatial variations), air quality goals (standards or target values) [See *Guidance Area 1 on Ambient Air Quality Standards and Monitoring*], information on SA and exposure assessment (through dispersion modeling) [See *Guidance Area 2 on Emissions inventory and modeling*], and international experiences;
- evaluates source mitigation and control options for their efficacy (based on cost-benefit or cost-effectiveness analysis), technical feasibility, and ease of implementation;
- sets targets and timelines for actions;
- is discussed with all major stakeholders, and delineates their roles and responsibilities;
- addresses implementation issues such as institutional arrangements and partnerships, infrastructure, and financial resources [See *Guidance Area 6 on Governance*];

Box 6.4
India's Clean Air Action Plans

In India, the National Environmental Policy and Regulatory framework to deal with air pollution is in place (Central Pollution Control Board [CPCB], 2011). Ambient air quality standards comparable with international practices and sector-specific emission standards are published and revised periodically. During 2007–2010, a comprehensive SA study was undertaken in six cities. The study involved air quality measurements for key pollutants, detailed primary emissions inventory, receptor-oriented modeling for estimating PM_{10} source contributions, and dispersion modeling for evaluating a large number of sector-specific control options. Indigenous source emission profiles and vehicle exhaust emission factors were also developed as part of the study. The study recommends AQM plans at national and city levels. At the national level, progressive vehicle emission and fuel quality standards, framing policy to deal with old vehicles, as well as guidelines for road construction to minimize road dust were suggested, among others. City clean air action plans included sector-specific action points required to meet published national ambient air quality standards. As an additional measure, clean air action plans recommended restriction of activities in a few hotspots.

- considers future activity growths and projected air pollution scenarios;
- is progressive and gives due consideration to technological advancements;
- defines monitoring and evaluation mechanism
- provides opportunities for mid-term corrections; and
- is periodically reviewed and upgraded

6.1.4 Policies and control measures to improve air quality

The CAAP encompasses short-term, medium-term, and long-term mitigation and control measures to reduce emissions from mobile (transport), stationary (industry), and area sources. Several different types of measures for improving air quality can be broadly identified and categorized as follows:

- Conservation: reducing the use of resources through energy conservation
- Efficiency: carrying out the same activity, but doing so more efficiently, thus reducing resource use and emissions of air pollutants
- Abatement: applying a technological approach to reduce emissions
- Fuel switching: substituting a lower emission fuel for a higher emission fuel
- Demand management: implementation of policies or measures which serve to control or influence the demand for a product or service
- Behavioral change: changing the habits of individuals or organizations in such a way as to reduce emissions – e.g. travelling by bus instead of by car

These measures can be brought about in many different ways through legislation, economic instruments, voluntary agreements, and available technologies [See *Guidance Area 6 on Governance*]. Specifically, measures to reduce air pollution from mobile and stationary sources – i.e. transport sector, industrial, and area sources – can be summarized as follows:

a) Measures to reduce emissions from transport
Emissions from motor vehicles are determined by vehicle technology, fuel type and quality, land use, and use of vehicle. Hence, controlling emissions involves addressing each one of the following measures:

(1) improved emissions standards and technologies;
(2) cleaner fuels;
(3) improved fuel efficiency;
(4) improved inspection and maintenance;
(5) improved transport planning and traffic demand management;
(6) shift to public transport, promotion of non-motorized/active transport (i.e. cycling, walking)

Some of the measures can only be taken together with other specific interventions. For example, more stringent emissions standards cannot be achieved without imposing stricter fuel quality standards. Table 6.1 presents an overview of measures to control emissions from transport.

Two case studies in Japan that introduced the CAAP multiple pollutant approach in reducing emissions from the transport sector and from factories are presented in Box 6.5 and Box 6.6. The cases also highlight rigorous monitoring and review system, demonstrating air quality improvement over time.

b) Measures to reduce air pollution from industrial sources
Measures to reduce air pollution from industrial sources may include the following key areas:

i. Land use planning and zoning
- use of planning regulations to restrict the location of new industries and to establish suitable industrial areas/zones;
- compulsory environmental impact assessment for specified new major industries to require assessment of their potential for air pollution and to recommend improvement in location, processes, fuels, industry technology and emission limits; and
- relocation of existing industries away from residential and other sensitive land uses.

ii. Promotion of cleaner production
- increase the efficiency of industrial processes;
- energy and materials saving;
- use of improved quality fuels (e.g. with lower sulfur content) or switch to cleaner fuels such as natural gas; and
- adoption of new technologies.

iii. Reduction of emissions in industry
- setting priorities by focusing on emissions from the major emission sources;
- requirements for use of cleaner fuels;
- requiring the use of – and providing an action plan for implementation of – best available technology for specific industrial processes;
- compulsory notification of accidents;
- licensing of specified polluting processes;
- compulsory emission standards required, as well as an enforcement strategy for such; and
- setting strict fines for exceeding emission standards.

Table 6.1 Overview of measures to control emissions from transport

Measure	Regulation	Economic
Emissions standards and technologies	• Maximum emission standards for conventional emissions (carbon monoxide (CO), hydrocarbons, nitrogen oxides (NO_x), particulate matter (PM) and for toxic air pollutants • Certification and assembly line testing	• Tax differentials favoring abatement technology • Vehicle taxes for emission levels • Incentives/disincentives • Fiscal incentives for scrapping old vehicles
Cleaner fuels	• Fuel quality standards for gasoline (lead, volatility, benzene, aromatics) • Fuel quality standards for diesel fuel (volatility, sulfur, aromatics, cetane number, polyaromatic hydrocarbons) • Limitations on fuel additives	• Differentiated fuel pricing favoring cleaner fuels
Fuel efficiency	• Fuel efficiency for vehicle fleets • Maximum power/weight ratios • Speed limits • Various traffic management measures to increase share of optimal anti-congestion measures, combined with measures controlling vehicle kilometers traveled	• Broad based carbon tax on fuels/emission charges • Fuel-economy based vehicle taxes • Research and Development incentives (direct funding, tax credits, emissions test exemptions)
Inspection and maintenance	• Mandatory inspection and maintenance, anti-tampering and enforcement programs • Diesel smoke control programs	
Transport planning and traffic demand management: to increase load of fleet, reduce travel demand times and reduce travel time	• Public transportation system • Parking control measures • Individual ownership limitations • Pedestrian-only zones in cities • Car use restrictions • Privileges (e.g. restricted highway lanes) for high-occupancy vehicles • Improvement of biking/walking conditions • "Park and ride" programs • Limitations and restrictions on freight transport	• Road-based carbon tax on fuel • Emission-related vehicle taxes • Road pricing or distance charges • Parking charges • Fiscal incentives for carpool programs • Insurance adjustment for distance • Land-use and physical planning instruments to reduce commuter travel and redistribute urban activities • Redistribute mechanisms for financing more efficient transport modes

Source: Adapted from Stockholm Environmental Institute (SEI), 2008

c) Measures to reduce air pollution from area sources
Burning of biomass, open burning of waste, forest fires, and dust from soil, roads and construction sites can be major area sources in a city. Measures to control these emissions may include:

- enforcement of bans on burning of materials or waste;
- promotion of alternatives to burning;
- better waste management; and
- paving roads, revegetation programs in dust control areas and use of street sweeping equipment.

Actions requiring low cost with high effectiveness and shorter implementation period are better than those having high effectiveness but high costs or long implementation period. A few promising scenarios with select combination of options may be evaluated using a source model. Model predictions should particularly focus on hotspots. Alternative plans may be discussed with stakeholders (e.g., fuel quality improvement program with petroleum oil companies, stricter norms for vehicles with automobile manufacturers) and the most appropriate one may be adopted.

Choosing between technology-based options (cost-intensive) and management-based options (less costly but may be difficult to enforce) will always be a dilemma. As a guiding principle, impact of cleaner technology options is long-lasting. For example, stricter fuel quality and emission standards such as EURO IV, V, and VI may provide better dividend, in the long run. Similarly, use of natural gas in place of coal for industrial combustion and/or efficient control systems (Electrostatic Precipitator and/or bag filter) may offer better results. However, a few technology-based interventions (e.g., improving auto fuel quality) are decided at the national level and not at the local scale (nonetheless, they can influence such decisions).

Certain measures – such as cleaner transport and energy – may require substantial financial resources, and at times, delay implementation. Necessary funds may be organized through internal or external sources. Internal funds provide a sense of ownership, which may result in more efficient implementation of CAAP. In addition to public funding, private partnership may be explored. The "polluter pays principle" may be applied and "pollution tax" may be levied for generating funds [See *Guidance Area 6 on Governance*]. External funding from international financial institutes or donor agencies may also be available. Cost-benefit analysis (also incorporating health costs) for "business as usual" and CAAP scenarios may be useful, and may result in larger commitment and efforts from stakeholders [See *Guidance Area 3 on Health and other impacts*]. Table 6.2a and Table 6.2b provide guidance in determining cost-effective strategies and actions.

Box 6.5
Basic policies and plans for area-wide emission reduction of NOx and particulate matter in designated three metropolitan areas of Japan

In Japan, development of basic policies and plans for area-wide emission reduction of NO_x and PM emitted from vehicles is mandatory in three designated highly populated metropolitan areas (Figure 6.1) under the Law Concerning Special Measures to Reduce the Total Amount of Nitrogen Oxides and Particulate Matter Emitted from Motor Vehicles in Specified Areas (Automobile NO_x and PM Law) enacted in 2001. The goal was set "to attain environmental quality standards in most monitoring stations in the designated areas by 2010".

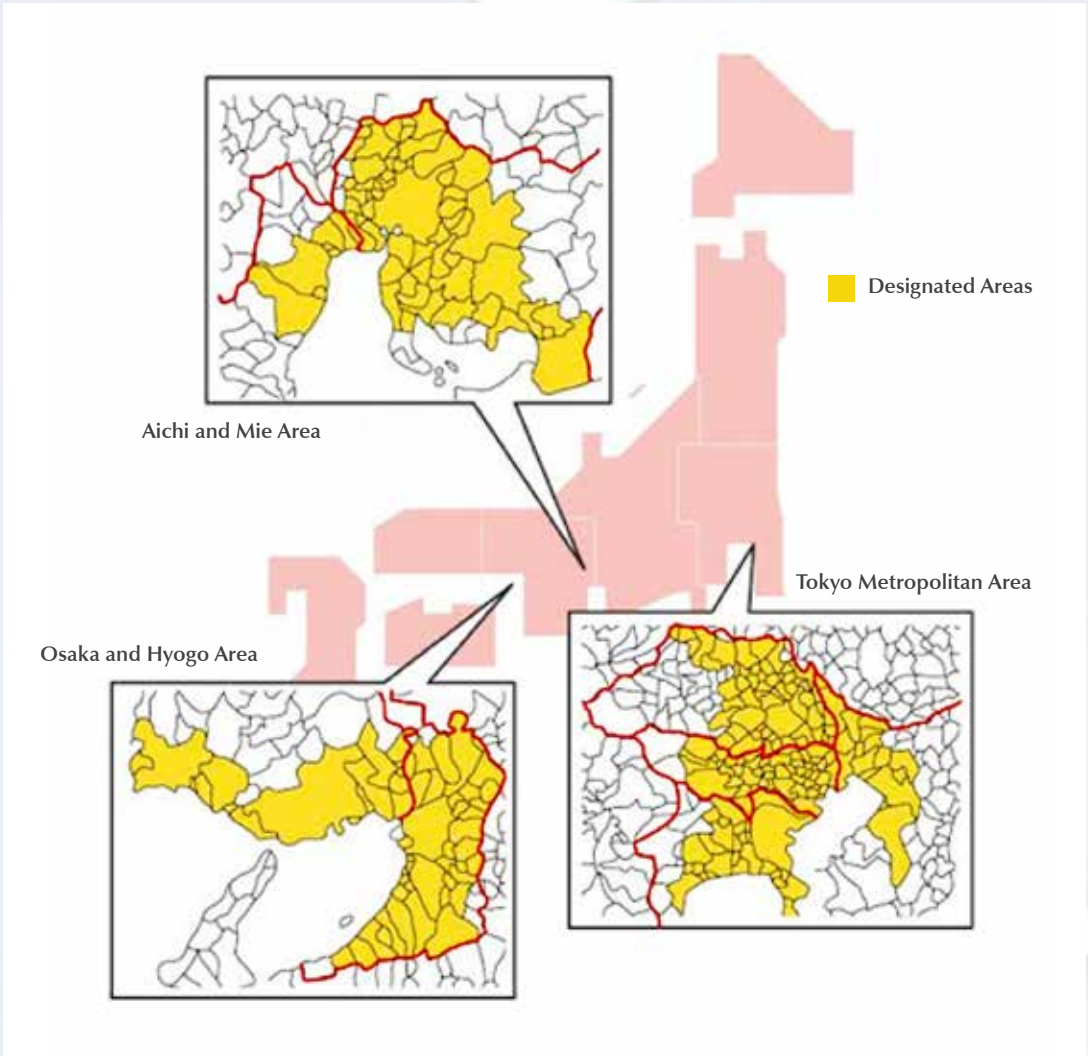


Figure 6.1 Areas Designated under the Automobile NO_x and PM Law

Source: Ministry of the Environment, Japan and Ministry of Land, Infrastructure, Transport and Tourism, (n.d.)

In addition to basic policies and plans, the following measures have been introduced in the designated areas:

- **regulation on in-use vehicles** (ban on the use of vehicles not meeting specified emission standards for trucks, buses, and diesel vehicles; this applies only to the vehicles registered in the designated areas)
- **emission reduction by business operators** (development of vehicle management plans by large business operators)
- measures to address **localized pollution** and **incoming traffic from outside the designated areas**[2]

The goal has been achieved and the annual average concentration of suspended particulate matter (SPM) in the designated areas – 294 ambient air quality monitoring stations and 165 roadside monitoring stations – has shown gradual but steady improvement as illustrated in Figure 6.2.

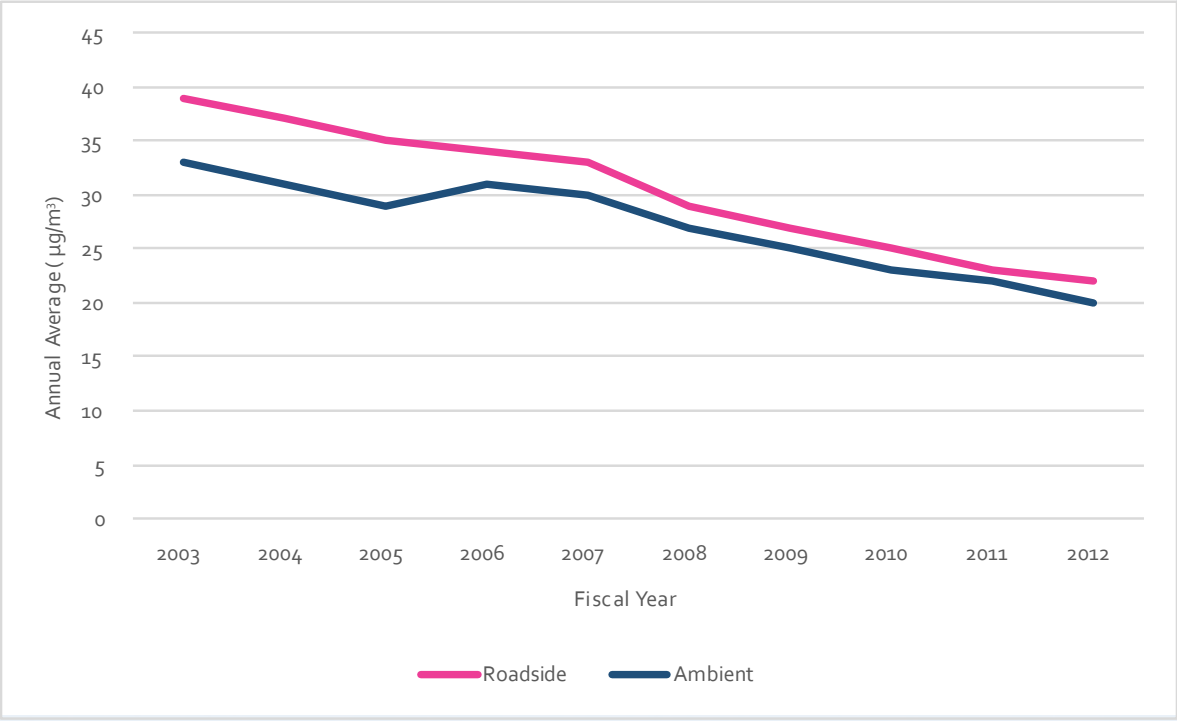


Figure 6.2 Annual Average Concentration of SPM in Designated Areas under the Automobile NO_x and PM Law

Source: Ministry of Environment Japan, 2014

2 These measures were introduced in 2008, following the partial amendment of the Automobile NO_x and PM Law in 2007.

Box 6.6
Total emission control plans by Kawasaki City, Japan

The Japanese city of Kawasaki experienced rapid industrial development during the 1950s and adverse health effects due to very serious air pollution. In response, the city has since made various efforts to control air pollution. Plans to control total emission were among the distinct features of the city's policy.

The city introduced its own **total emission control system**, known as the "Kawasaki Method", under the Pollution Prevention Ordinance in 1972. Based on the ordinance, the city sets its own environmental target values for air pollutants, which are more ambitious than national environmental quality standards. For each of these pollutants, it sets area emission limits taking into account the locations and emission status of the emission sources (such as factories). Under the total emission control system, different emission standards were set for each facility based on the simulation results of ambient concentration using an atmospheric dispersion model. The pioneering total emission control system from Kawasaki played an important role in promotion of pollution control at both the national and local levels.

In addition, as the character of environmental problems became more complex, **a comprehensive total emission control (also known as a basket regulation) to reduce SPM** was introduced under the Ordinance for Conservation of Living Environment including Pollution Prevention in 1999. The basket regulation not only addressed the primary sources of SPM (soot and dust) but also its precursors, such as SO_x, NO_x, and hydrogen chloride. Under the regulation, emission standards related to PM were established for new business facilities over a certain size. The regulation was extended to cover existing facilities in 2005.

As a result, annual emissions of soot and dust from factories have deceased over time and the ambient concentrations of SPM began to fall (Figure 6.3). The attainment status has been fairly good since 2004, with all the ambient monitoring stations meeting the environmental quality standards except in 2006 and 2010.

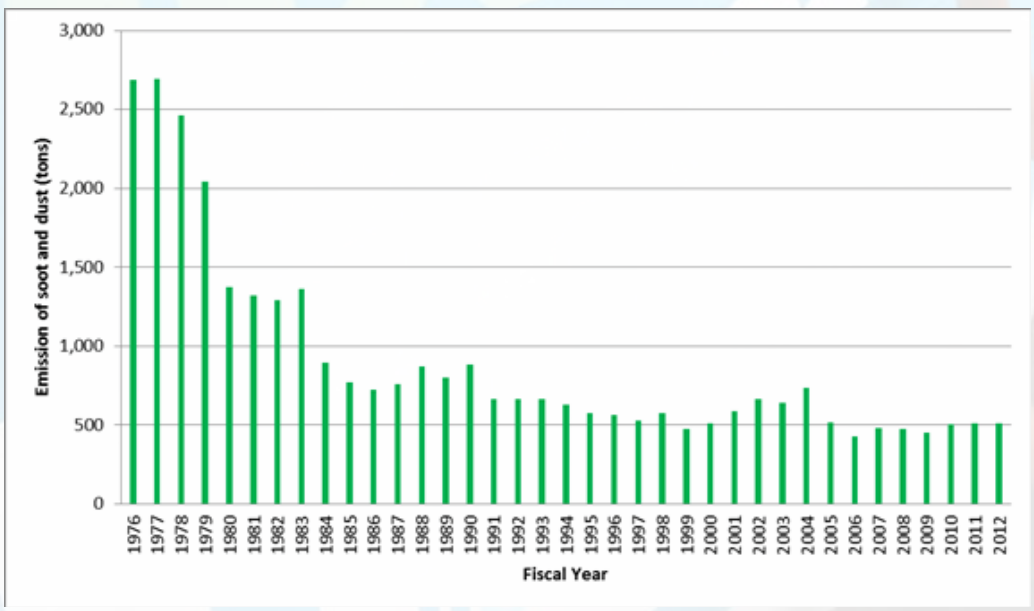


Figure 6.3 Annual Emissions of Soot and Dust from Factories in Kawasaki

Source: Kawasaki City, 2013 and Kawasaki City, n.d.

Table 6.2a Evaluation of emission control options

Source group	Control option	Expected reduction and impacts[1]	Technical feasibility[2]	Requirement of financial resources[3]	Implementation period (short / mid / long-term)	Time target for implementation[4]	Responsible agency(ies)	Any other information

1 Preferably, quantify each priority pollutant. Otherwise, a qualitative statement (low/medium/high) may be given.
2 Whether it is technically feasible (e.g., replacing coal with natural gas may not be feasible, if its sustained availability is not assured); whether any implementation issues exist (e.g., low-income group may not have finances to use liquefied petroleum gas for cooking) ; assess its control efficiency
3 Estimate the total costs (investment and maintenance costs) over the duration of implementation period, and provide sources of financing.
4 Define the expected start and completion year (e.g., 2015-2020).

Table 6.2b Evaluation of implementation barriers and required actions

		Identified barriers				Required actions			
No	Control option	Institutional, regulatory, and policy framework	Economic, investment, and market	Human resources and private sector support	Public awareness	Institutional, regulatory and policy framework	Economic, investment and market	Human resources and private sector support	Public awareness

6.1.5 Co-benefits and integration of clean air action plan and GHG mitigation plan

Air pollution control measures tend to be local or regional in scale, but their impact on climate change is long-term and global. Looking at air quality and climate change from an integrated perspective – and addressing these issues simultaneously – offers potential for large cost-reductions in public health and risks to ecosystems. Co-controlling air pollution and GHGs will be more effective than targeting each one individually, particularly for developing countries in Asia where economic and social development is a higher priority than climate change mitigation (SEI, 2008). An integrated approach will maximize synergies and co-benefits; measures to mitigate climate change can reduce air pollution, and actions reducing air pollution can reduce GHG emissions. Table 6.3 presents measures which are likely to lead both to reductions in emissions of both air pollutants and GHGs.

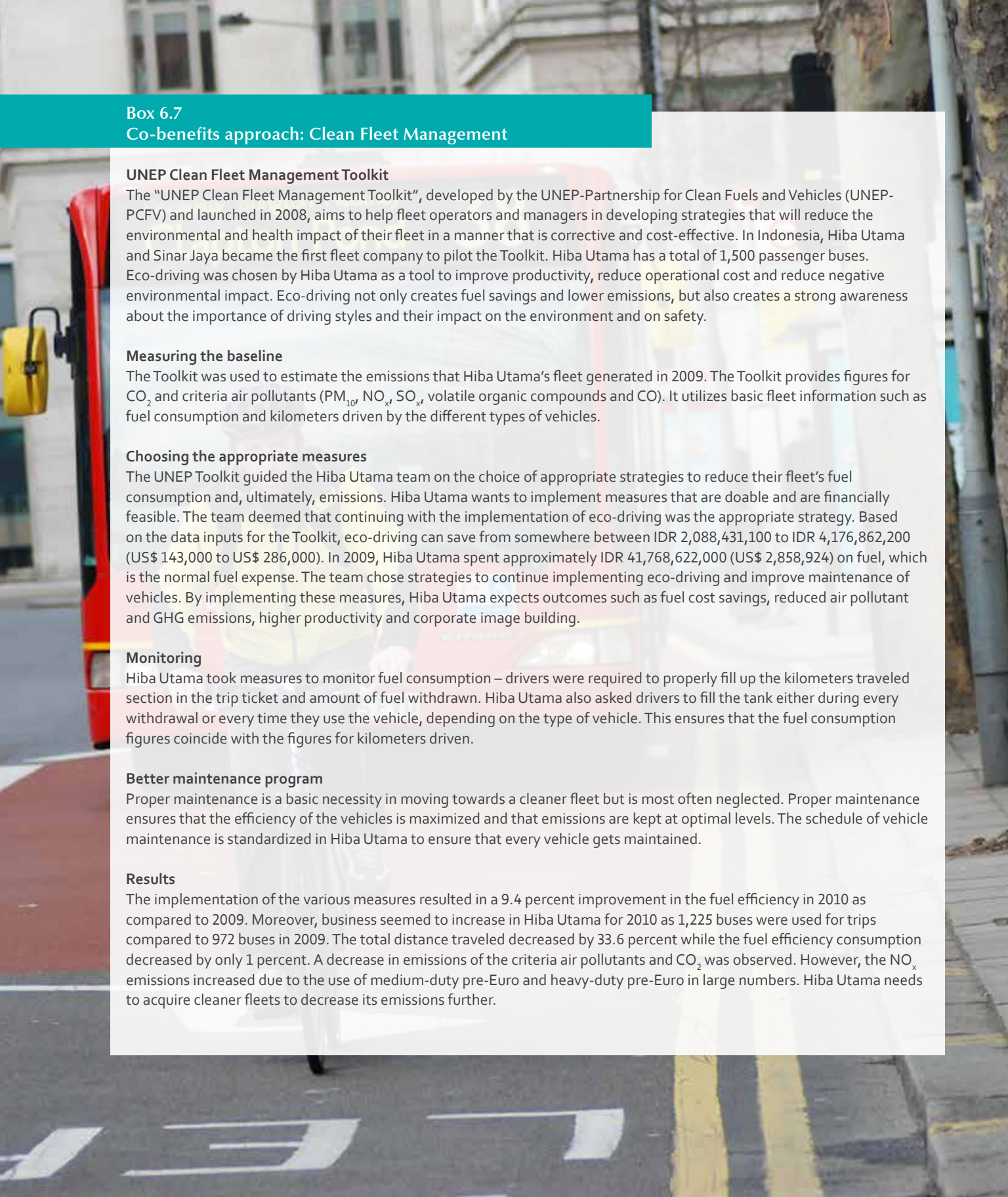
Co-controlling **air pollution and greenhouse gases** will be more effective than targeting each one individually, particularly for **developing countries** in Asia where **economic and social development** is a higher priority than **climate change mitigation**.

Table 6.3 Examples of measures to reduce emissions of air pollutants and GHGs

Measure	Effect
Switching from coal to natural gas for power generation	Reduces carbon dioxide (CO_2) emissions for each kiloWatt generated. Emissions of sulfur dioxide (SO_2) and NO_x are also reduced.
Efficiency improvements in domestic appliances and industrial processes	Reduces emissions of both types of pollutant, but efficiency measures sometimes result in increased demand, which must be avoided.
Energy conservation (use less energy)	Reduces emissions of both types of pollutant.
Use of new technologies in road transport, e.g. • hybrid vehicles • hydrogen from natural gas or from renewable energy sources • lean burn petrol vehicles fitted with nitrogen oxide traps	Reduces CO_2 emissions for each kilometer traveled and also emissions of NO_x and PM. It is essential that the whole fuel/vehicle cycle is analyzed (e.g. the emissions associated with hydrogen generation).
Demand management/behavioral change: improved public transport coupled with disincentives for private car usage.	Reduces emissions of both types of pollutant.

Source: United Kingdom Department for Environment Food and Rural Affairs, 2014

Box 6.7 illustrates an example of co-benefits approach applied by a bus company in Indonesia using the United Nations Environment Programme (UNEP) Clean Fleet Management Toolkit to monitor and evaluate the impact of the interventions on fuel efficiency and air pollutant and CO_2 emissions.



Box 6.7
Co-benefits approach: Clean Fleet Management

UNEP Clean Fleet Management Toolkit

The "UNEP Clean Fleet Management Toolkit", developed by the UNEP-Partnership for Clean Fuels and Vehicles (UNEP-PCFV) and launched in 2008, aims to help fleet operators and managers in developing strategies that will reduce the environmental and health impact of their fleet in a manner that is corrective and cost-effective. In Indonesia, Hiba Utama and Sinar Jaya became the first fleet company to pilot the Toolkit. Hiba Utama has a total of 1,500 passenger buses. Eco-driving was chosen by Hiba Utama as a tool to improve productivity, reduce operational cost and reduce negative environmental impact. Eco-driving not only creates fuel savings and lower emissions, but also creates a strong awareness about the importance of driving styles and their impact on the environment and on safety.

Measuring the baseline

The Toolkit was used to estimate the emissions that Hiba Utama's fleet generated in 2009. The Toolkit provides figures for CO_2 and criteria air pollutants (PM_{10}, NO_x, SO_x, volatile organic compounds and CO). It utilizes basic fleet information such as fuel consumption and kilometers driven by the different types of vehicles.

Choosing the appropriate measures

The UNEP Toolkit guided the Hiba Utama team on the choice of appropriate strategies to reduce their fleet's fuel consumption and, ultimately, emissions. Hiba Utama wants to implement measures that are doable and are financially feasible. The team deemed that continuing with the implementation of eco-driving was the appropriate strategy. Based on the data inputs for the Toolkit, eco-driving can save from somewhere between IDR 2,088,431,100 to IDR 4,176,862,200 (US$ 143,000 to US$ 286,000). In 2009, Hiba Utama spent approximately IDR 41,768,622,000 (US$ 2,858,924) on fuel, which is the normal fuel expense. The team chose strategies to continue implementing eco-driving and improve maintenance of vehicles. By implementing these measures, Hiba Utama expects outcomes such as fuel cost savings, reduced air pollutant and GHG emissions, higher productivity and corporate image building.

Monitoring

Hiba Utama took measures to monitor fuel consumption – drivers were required to properly fill up the kilometers traveled section in the trip ticket and amount of fuel withdrawn. Hiba Utama also asked drivers to fill the tank either during every withdrawal or every time they use the vehicle, depending on the type of vehicle. This ensures that the fuel consumption figures coincide with the figures for kilometers driven.

Better maintenance program

Proper maintenance is a basic necessity in moving towards a cleaner fleet but is most often neglected. Proper maintenance ensures that the efficiency of the vehicles is maximized and that emissions are kept at optimal levels. The schedule of vehicle maintenance is standardized in Hiba Utama to ensure that every vehicle gets maintained.

Results

The implementation of the various measures resulted in a 9.4 percent improvement in the fuel efficiency in 2010 as compared to 2009. Moreover, business seemed to increase in Hiba Utama for 2010 as 1,225 buses were used for trips compared to 972 buses in 2009. The total distance traveled decreased by 33.6 percent while the fuel efficiency consumption decreased by only 1 percent. A decrease in emissions of the criteria air pollutants and CO_2 was observed. However, the NO_x emissions increased due to the use of medium-duty pre-Euro and heavy-duty pre-Euro in large numbers. Hiba Utama needs to acquire cleaner fleets to decrease its emissions further.

Success and Challenges

The project achieved its objective on its first year of implementation. Management support was instrumental in the rapid adoption of the changes that needed to be made to realize the benefits of the chosen measures. The project pioneered in contributing to awareness raising and emissions reduction. However, substantial improvements need to be conducted by Hiba Utama. The most urgent measure that needs to be taken is replacing pre-Euro vehicles with vehicles that correspond to European emission standards. Hiba Utama needs to improve its inspection and maintenance program since in 2010, many odometers were reported broken.

Conclusions

The initial success of the project ensured its continued implementation. Hiba as a whole, is currently moving towards the adoption of the different measures that are being implemented in Hiba Utama. Moreover, Hiba Utama has adopted the recommendation of the project team to mandate a refresher course on eco-driving for those drivers who value safety and high performance.

Source: UNEP Clean Fleet Management Toolkit – Indonesia Pilot Study Report, 2010

6.2 Stages of clean air action plan development

Air quality management, in its fully developed stage, entails a CAAP that is comprehensive and routinely updated. For CAAP to be effective, its scope should respond to emerging local needs and capacities. As an initial step to enable cities to develop and implement CAAPs, Table 6.4 presents indicators that would aid cities in identifying their current state of AQM development.

The following are the key indicators that should be considered in progressing from underdeveloped to fully developed stage:

- Science-based approaches to CAAP formulation
- Level of stakeholder involvement in CAAP development
- Availability of financial resources
- Set-up of early warning system/emergency response plan
- Definition of implementation framework

Air quality management, in its fully developed stage, entails a **clean air action plan** that is **comprehensive and routinely updated**. For clean air action plan to be **effective**, its scope should **respond** to emerging **local needs and capacities**.

Table 6.4 Stages of clean air action plan development

Stages	Indicators
Underdeveloped	Air pollution control measures, policies, plans, and strategies are developed without solid support from data and assessments
	Addressing air pollution is generally covered in National Environmental Acts or Laws
	Only implementing agencies of air pollution control measures, policies, plans and strategies are involved in formulating the measures
	Lack of financial resources to support CAAP development
	An early warning system to mitigate impacts during high air pollution episodes is not available due to lack of/limited monitoring systems
Developing	Air pollution control measures, policies, plans, and strategies are based on air quality data from ad hoc monitoring
	Air pollution-specific policies are in place at the national and local levels
	Ad hoc projects to reduce emissions are available
	Input from stakeholders other than implementing agencies of AQM is obtained during formulation of air pollution control measures
	Financial resources to support CAAP development are limited and highly rely on external support
	An early warning system to mitigate impacts during high air pollution episodes is not available due to lack of/limited monitoring systems
Emerging	Air pollution control measures, policies, plans, strategies are based on limited air quality monitoring data for selected pollutants and hotspots, and with more support from EI results and/or SA assessments
	Air-pollution specific policies are in place at the national and local levels and implementation is envisaged
	CAAP measures to address key/major sources have been formulated but operationalization (identifying lead agencies, timeline, budget, etc.) of measures is not yet clear
	Sector-specific growth and development plans[3] include measures to control key emission sources
	CAAPs are beginning to be developed but are not aligned with sector development plans
	Activities to promote for multi-sectoral coordination and stakeholder engagement in CAAP formulation are being initiated
	There is sufficient government budget and potential funding support from other sources for CAAP development
	An early warning system to mitigate impacts during high air pollution episodes is in place; initial information on health and other impacts of pollution are considered

3 e.g. for industry, transport, energy, housing, and land use

Maturing	CAAPs are developed based on adequate air quality monitoring data, EI, simple dispersion models and assessment of pollutant exposure Air pollution-specific policies are in place at the national and local levels and are implemented A framework (comprised of lead agencies and stakeholders, timeline, budget, etc.) for implementing and financing of measures is included in the CAAP There is prioritization of measures based on emission reduction potential of key sources, cost-effectiveness, and technical feasibility CAAPs are aligned with sector-specific development plans[4] Mechanisms[5] for multi-sectoral coordination and stakeholder engagement, including public involvement are becoming more common in CAAP formulation There is sufficient government budget for CAAP development. The government also allots budget for the CAAP to be regularly updated in response to the needs of the area covered Initiatives are made to secure funding support from other sources aside from government (i.e. international organizations, partnerships with private sector) to support CAAP development An early warning system and emergency response plan to mitigate impacts during high air pollution episodes is in place; updated information on health and other impacts of pollution are systematically considered
Fully developed	Identification of control measures is science-based and cost-effective A full range of AQM activities are used as basis of CAAP development: air quality monitoring system, bottom-up EI, dispersion modeling, SA, testing compliance with emission and air quality standards, potential abatement assessment, cost and benefit analysis results, and assessment of health and environmental impacts Air pollution-specific policies are in place at the national and local levels and are fully implemented A clear framework (comprised of lead agencies and stakeholders, timeline, budget, etc.) for implementing and financing measures is defined in the CAAP A system for monitoring and evaluation of CAAP implementation is formulated CAAPs are in place with comprehensive and prioritized mitigation actions and integrated into sector-specific and socio-economic development plans including climate change mitigation Mechanisms for multi-sectoral coordination, stakeholder engagement, and public involvement in CAAP development are in place and fully implemented The government allots sufficient budget annually for CAAP development and update. Financial support for CAAP development and regular updating is sustainable Strategies are in place to access a wide mix of financing resources to support CAAP development An early warning system and emergency response plan to mitigate impacts during and to predict high pollution episodes is in place and regularly reviewed; studies on health and other impacts, socio-economic cost of pollution, and benefits of pollution control are available

4 e.g. industry, transport, energy, housing, land use

5 Examples include the formation of working group involving all concerned government, private and other sectors, roadmap development/ vision and goal setting with stakeholders, public consultations and forums

6.3 Issues and challenges

Although a number of Asian cities have already developed CAAPs, they remain to be exceptions rather than the rule. Most Asian cities have yet to develop CAAPs due to the following considerations:

Institutional

- **Insufficient human resources within the government with knowledge of AQM** as well as technical skills that enable them to understand and lead the process of improving air quality.
- **Difficulty in securing support from other local agencies in developing and implementing CAAP.** The CAAP is a multisectoral and multidisciplinary issue. Other local agencies may not see the CAAP benefits and its contribution to their agency's development objectives. Hence, addressing this problem is the key in securing support.
- **Lack of coordination and a clear framework for implementation and enforcement** between relevant agencies – including regulatory and governance requirements, institutional arrangements and processes, as well as enforcement procedures. The CAAP process requires a concerted effort not only from environmental agencies but also from other sectors such as energy, transportation, industry, land use, planning and health, among others.
- **Lack of political support from decision-makers and the public, and leadership of relevant stakeholders.** Leadership plays a major role in driving the process of CAAP and ensuring that progress is being made.
- **Lack of public interest and awareness,** which might be influenced by lack of information on the health impact of air pollution as well as the benefits and the urgent need to address the underlying problems of air pollution. Efforts to gain full public support in the development and implementation of CAAP should be made to attain acceptability, consistency, and follow-through. In many Asian cities, the problem often lies with the absence of civil society groups with interest in the issue of air pollution.

Management and Technical

- **Limited information on pollutant sources, emissions and air quality levels** to identify effective measures to reduce pollutant concentrations.
- **Current practices lack the incorporation of air pollution and climate change policies with sustainable development.** At the local and national levels, AQM and climate change mitigation strategies must be integrated, especially where overlaps are apparent – such as in the energy, transportation, and industrial sectors.
- **There is lack of CAAP ownership by other relevant agencies,** including the ones responsible for development planning. This would hinder CAAP from being adopted and implemented. Relevant agencies must recognize that the air pollution issue is also a development issue.
- **There is lack of periodic monitoring and review of CAAP implementation.** These are critical in measuring the progress made. These will determine the effectiveness of control measures in achieving the air quality objectives.

Financial

In most of the developing Asian countries, insufficient financial resources is often seen as the real challenge in AQM. The allocation of public funding towards environmental management has remained a small fraction of the total development spending. There are other funding sources outside public financial sources such as public-private partnerships and grants or loans from international lending institutions that the government can tap in. However, lack of information, willingness, and attempts to access these sources undermine the efforts towards developing and implementing CAAP, policies, and measures.

6.4 Roadmap for clean air action plan development

The CAAP – intended to improve air quality and public health by identifying measures to reduce emissions from various sectors – has proven to be an effective instrument of air pollution control. Without it, managing limited resources for AQM is impossible in the first place. Hence, sufficient resources – financial and human – should be allocated for development of a CAAP as befits a city or country's stage of AQM development. Table 6.5 gives the recommended steps, following an assessment of a city's AQM status, towards progressing to the next stage and overcoming the challenges involved in developing and implementing a CAAP.

Table 6.5 Steps to follow to implement a roadmap for clean air action plan development and implementation

Developmental stages	Steps to follow
Underdeveloped	**Management Process** • Identify key stakeholders, decision makers and influencers to bring air pollution onto the public agenda • Build capacity for basic AQM planning and activities (i.e. ad hoc projects to reduce emissions) among key stakeholders, decision makers and influencers • Conduct stakeholder meetings to increase awareness on the impact of air pollution on health and the environment, and push for a political decision to include AQM as a development sector • Conduct targeted public awareness raising (e.g. through earn media communication) to educate the public and increase their interests in air pollution issues • Establish a Technical Team comprised of representatives from government and non-government stakeholder groups to oversee the process of adoption of air pollution-specific policies at the national and local levels, air quality standards and measures to reduce emissions **Technical Process** • Build capacity for identifying and monitoring hotspots using a minimal set of air pollutant concentration monitors [See *Guidance Area 1 on Ambient air quality standards and monitoring*]
Developing	**Management Process** • Continue public awareness raising to sustain public interests on air pollution and demand for control measures (e.g. include a mixed-media communication approach in conveying key messages to the public) • Strengthen coordination and communication among responsible institutions, and integration of AQM policies with other sector policies through a regular reporting mechanism • Ensure that sector-specific growth and development plans include measures to control key emission sources • Ensure sufficient government budget and potential funding support from other sources for CAAP development • Conduct stakeholder meetings and public input workshops to draw roadmap towards CAAP development and initiate formulation of CAAP measures to address major emission sources • Conduct Vision and Goals Workshop and Public Communication Strategy Workshop to define outreach and awareness program • Plan for implementation of air pollution-specific policies at the national and local levels **Technical Process** • Enhance capacity for air quality monitoring stations to deliver data on key pollutants of known quality • Build capacity for identifying air pollutant sources and estimation of emissions using available methodology, taking into account data availability [See *Guidance Area 2 on Emissions inventories and modeling*] • Consider air quality monitoring results and estimation of emissions as basis of CAAP • Build capacity for identification of initial health risks and/or other impacts of air pollution [See *Guidance Area 3 on Health and other impacts*] • Build capacity to develop early warning system to mitigate impacts during high pollution episodes

Emerging	**Management Process**
	• Define roles of stakeholders including government departments/agencies and public participation in CAAP process
	• Conduct series of public input workshops as part of or independent of government development planning processes to gather input for air quality improvement programs and actions. Conduct Findings and Options Workshop to consolidate reporting of all findings and possible options for consideration by public and decision makers, and define roles and responsibilities of stakeholders
	• Establish a clear institutional framework and mechanisms (within lead agencies, stakeholders, and public sector) to support implementation of measures including monitoring and evaluation system
	• Ensure sufficient government budget for CAAP development and review; explore funding support from external sources
	• Use information on adequate air quality monitoring, initial EI, simple dispersion models, pollutant-exposure assessment, and initial health impact assessment as basis for CAAP and policy development
	• Implement air pollution-specific policies at the national and local levels
	
	Technical Process
	• Enhance capacity for:
	  o air quality monitoring
	  o development of initial EI
	  o simple dispersion models
	  o assessment of pollutant-exposure using simplified approaches
	  o estimation of health risks and/or other impacts
	  o evaluation and monitoring system for implementation of emissions reduction measures
	• Issue regular early warning system to mitigate impacts during high pollution episodes

Maturing	**Management Process**
	• Establish a robust CAAP process:
	  o Conduct Proposals Workshop to evaluate cost-effectiveness/cost-benefit, technical feasibility, and implementation strategy
	  o Conduct CAAP Presentation and Implementation Workshop to present completed CAAP, review of remaining issues, and initial implementation steps
	  o Establish Guidance Board and commence regular meetings. The Board could be formulated as an outcome of the initial public input workshop. The role of the Board is to guide the overall process of CAAP formulation, and review recommendations from the Technical Team. In general, the Board needs to include key government departments that will be responsible for implementing CAAP. This can be complemented by key stakeholders from outside the government to improve the ability of the Board to reflect the needs of all stakeholders.
	• Prepare implementation programs. The Technical Team shall take lead in the CAAP preparation and development of implementation programs for the selected actions, with input from stakeholders. The roles and responsibilities of stakeholders must be clearly identified and defined within a clear institutional framework, and agreed upon in order to commit their time and efforts.
	• Ensure that CAAPs are implemented with comprehensive and prioritized mitigation actions that are aligned with sector-specific and socio-economic development plans including climate change mitigation
	• Ensure sustainable funding for CAAP development and regular review; explore a wider range of external funding sources
	• Fully implement air pollution-specific policies at the national and local levels

Maturing	**Technical Process** • Define the domain area (geographical boundaries for which CAAP is to be prepared) • Develop an annotated outline of the CAAP. Examples of processes for CAAP development as well as an annotated outline of Palembang City for maturing developmental stage of CAAP are provided. The process for the Germany Clean Air Implementation Plan and San Francisco Bay Area clean air plan are also described to progress to the fully developed stage of CAAP (See **Annex V-B of the Information Sourcebook**). • Review the state of air quality and emission sources in the area (air quality monitoring results vis-à-vis standards, EI, spatial distribution of pollutant concentrations, assessment of sources and pollutants of concern, and SA for selected pollutants) [See *Guidance Area 1 and 2 for guidelines*] • Assess real and/or potential health and environmental impacts, either by use of burden of disease approaches or rapid epidemiological/ecological studies, commit resources for implementation, make projections for the future, and assess the costs of control and the health and environmental benefits. Describe the CAAP outline first, followed by the process of achieving the set goals • Prepare a list of all potential control options for each of the selected priority sources with additional input obtained through public input workshops • Evaluate source mitigation and control options for their efficacy (based on cost-benefit or cost-effectiveness analysis and expected impacts). In addition, technical feasibility (practicality, "low-hanging fruits" approach, accessibility to technology, and ease of implementation), implementation period (short-, mid-, or long-term), requirement of financial resources, and responsible agencies may be tabulated, as given in the example in section 6.1.4. In some cases, social feasibility (public acceptability, security, aesthetics) may be added, as well as having co-benefits of addressing air pollution and climate change issues. • Identify implementation barriers and required actions to support and optimize implementation, such as policy and regulatory framework, human resources and private sector support, market opportunities, and public awareness. Table 6.2a and 6.2b serve as guide in evaluating the barriers and required actions to address the barriers. • Define a monitoring and evaluation mechanism that provides opportunities for mid-term corrections. The CAAP shall be periodically reviewed and upgraded. An appropriate monitoring mechanism may be set up at a Guidance Board or senior decision-making level of the government to review progress and take mid-term corrective measures. • Adopt CAAP and integrate into sector-specific, socio-economic, and city development plans (i.e. including climate change mitigation). Once approved, CAAP shall be made binding through local/national development planning system. • Issue regular early warning system and emergency response plan to mitigate impacts and predict high pollution episodes; develop a regular review process for the system

Fully developed	**Management Process** • Develop CAAP regularly with tightening air quality improvement targets, linking with socio-economic plans and climate change mitigation • Sustain a clear framework for implementation and enforcement of CAAP, including roles of related departments, multi-sectoral coordination mechanism, and involvement of public, as well as regular assessment of the CAAP • Sustain public participation in CAAP process through a clearly defined mechanism (i.e. public input workshops) • Secure financial support for CAAP development and ensure that implementation is secured within the government budget and a wide mix of external funding sources • Continually enhance the integration of all assessments into policies and strategies through a clear mechanism • Regularly evaluate technical feasibility and implementation strategies of CAAP • Regularly and systematically report CAAP implementation results to stakeholders (including policymakers and the public) to influence policies using targeted communication strategies **Technical Process** • Identify control measures, which are science-based and implemented on a cost-effective approach • Implement and continue to enhance capacity for a full range of AQM activities: air quality monitoring system, bottom-up EI, dispersion modeling, SA, testing compliance with emission and air quality standards, potential abatement assessment, cost-effectiveness and cost and benefit analysis results, and assessment of health and environmental impacts. • Establish studies on other impacts of air pollution (e.g., on buildings and agriculture) as well as ensure that studies on socio-economic cost of pollution and benefits of pollution control are available. • Conduct air quality projections to support the policy making process

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